Submissions for the Water Supply, Wastewater and Stormwater Bylaw review

Submission ID	First name	Last name	Organisation	Comments on the proposed replacement bylaws
43769	Gavin	Treadgold		Broadly I support these changes. A couple of points I'd make as relevant to our property that has an open council stormwater drain run through it, and disappear underground at the bottom edge of our section. 1. Issue 4: We have a landbanked overgrown section behind ours on the Port Hills. It is unmanaged, and there is no residence on it. The rain runoff is forming natural soaks - some of which come down behind our house, and others eroding the hillside. I am very supportive of any measures to require property owners to take more responsibility for water runoff and erosion. Note that this is not from wells/springs, but rainfall runoff. I also greatly support the increased requirements on managing the capture of development sediment in runoff - this would be a significant issue if this section behind us was ever developed. Any plans by developers would have to be consented by neighbours that may be impacted by the erosion, impacts on slope stability, and increased rockfall risk from development on a slope. 2. Issue 5: We have an open council stormwater drain running through the bottom of our section. Council has generally been good at maintaining and upgrading the drain. For this I'd like to thank the engagement and relationship we've had with council over the open drain. However, the slopes near the drain are unrestrained, and continue to erode in heavy rains (which are likely to increase with climate change). I had been keen to install some timber retaining walls (with plastic liner) to improve bank stability and prevent/slow erosion - particularly if the drain overtops the drain structure. With this proposed bylaw change, I wouldn't be prepared to do the protection works myself, and I'd be asking council to take responsibility for the additional erosion protection required - since the bylaw is effectively expanding the councils land responsibility from 1m to 3m. * These are initial thoughts, we may update this further after we have disgested and discussed it further.
44157	Richard	Sheridan		We strongly support regional cooperation and resource sharing between communities, as well as application of the most up-to-date scientific advice, and coordination with other local authorities and central government. Hence, we strongly support the central government's Three Waters proposals, as well as appropriate use of fluoride in drinking water. We do not consider that it is helpful, useful or wise to campaign against central government proposals on the basis of narrow parochial perspectives. This is particularly the case when we belong to such a small country, which has too many examples of inadequate and unsafe drinking, waste and storm water facilities.
44448	Alexandra	Davids	Waikura Linwood-Central-Heathcote Community Board	Refer to attachments
44471	James	Lacey		If said bylaws come into effect, will there be tighter restrictions placed on property owners with existing easements on their land? And if so, would there be cause to remove and relocate said easements from property if easements directly cause the lowering of the lands value. Or compensation for the lack of use of land taken up by easement?
44684	Beverley	Collins		I'm concerned about the new charges on using excess water. There seems to be a double standard here as in one hand the council wants chch residents to take pride in their property's , and by doing this give out "community pride garden award" certificates, given out by some council members at special event. My question is how do you keep a large garden and lawn healthy and green without using water, you the council can't have it both ways. This I feel is totally unfair and doesn't make me want to have a nice garden as you obviously don't appreciate the effort
44691	Bebe	Frayle	Waitai Coastal-Burwood Community Board Submissions Committee	The Waitai Coastal-Burwood Community Board appreciates the opportunity to make a submission to the Christchurch City Council on the Water Supply, Wastewater and Stormwater Bylaw Review. The Board wishes to be heard in support of this submission. SUBMISSION

				Comments on the proposed replacement bylaws: Overall, the Board is happy with the intent of the update to the bylaw. Separating the Water Supply, Wastewater and Stormwater Bylaw into two bylaws makes sense, as wastewater requires quite different management than the other two waters, particularly in Christchurch. While the general approach of the bylaws is good, the Board would like to make the following suggestions: • It is important that there is adequate Council staffing to oversee and enforce the bylaws. • An emphasis be given to educating property owners about their responsibilities regarding issues like tree root damage to underground infrastructure, 'excessively' watering of gardens, ensuring metres are accessible to metre readers, and navigating insurance companies and EQC when damage is found in underground infrastructure. • It is good to see that the explanation of the bylaw changes have been written in plain English, but the issues relating to three waters are very complex. There are some explanatory notes, but we would like to see these expanded via specific pamphlets that provide more detailed information on some issues (see above for examples). The Board notes the following in relation to specific issues: Water supply and Wastewater Bylaw – Issue 7 While Clause 16.3 details what water 'waste' is, and what is considered 'excessive' the Board has a concern that this issue is still open to interpretation by Council staff assessing situations, and could lead to inequity for property owners. Water supply and Wastewater Bylaw – Issue 9 The Board is concerned that it is difficult for property owners to comply with this clause as they may not realise that they are planting trees in places that may interfere with underground infrastructure, or may purchase a property with trees that create a problem in the future for which they are liable. It isn't reasonable for property owners to cover the full cost of mitigation if tree removal is required. The Board suggests that a cost share be explored. The Board also notes that there are issues with trees on Council land causing damage on property owner's land and this should also be addressed in the bylaw. Water supply and Wastewater Bylaw – Issue 11 Given the amount of damage caused to underground infrastructure during the Canterbury Earthquake sequence, the Board is concerned that many property owners will have damage that they are not aware of. We highlight this issue, and ask that the Council provide support and advice to property owners regarding insurance and EQC claims for earthquake damage. Stormwater and Land Drainage Bylaw – Issue 3 The Board notes that there are retention basin drains in our Board area that are regularly clogged with weeds. If property owners are responsible for maintaining any devices on their property, the Council should also ensure that any stormwater infrastructure on public land is also regularly checked and maintained.
44731	Bridget	Williams	Fendalton-Waimairi-Harewood Community Board	The Board supports separating the existing bylaw into two new bylaws. This should streamline processes as the current bylaw is managing all three waters under one. The Board understands that backflow prevention is important to support the Council's aim of achieving an exemption from mandatory chlorination, and supports the new measures in the bylaw. The Board would appreciate additional information regarding issue two, the prohibition of equipment that may cause pressure surges, and whether historical problems have been due to a lack of appropriate technology. The Board seeks further clarification about issue three, regarding requirements to notify the Council before undertaking certain spraying operations. In practice, could this result in every farmer needing to contact the Council before spraying their crop? The Board recommends clarifying the definition of 'aerial application activities' to make this section easier to interpret. The Board also notes that drone technology is becoming more commonplace and drones designed for spreading fertilizer and sprays have been developed. Is it intended for these technologies to be captured by this bylaw provision? The Board seeks further clarity about how the Council will be aware of, and enforce, offences related to water wastage. The Board also notes that the wording of draft bylaw clause 19(6) is similar to existing clauses in the Local Government Act 2002, so suggests that the stated goal of providing further clarity of what is

				considered 'wastage' could be strengthened by adding examples into the body of the bylaw instead of only putting them in the explanatory note. The Board supports the new provisions to ensure appropriate species of trees are planted in appropriate areas. The Board fully supports planting trees and the amenity and environment benefits they bring, but is aware of a number of problems caused by historic decisions to effectively plant the 'wrong tree in the wrong place'. The Board further recommends clarifying whether the new bylaw provisions will apply to new subdivisions. The Board would not want to discourage developers from planting trees in new developments, but provisions to ensure the rights trees are planted in the right places would be beneficial. The Board supports the Council empowering residents to have a better understanding around the obligations to prevent contaminants entering the wastewater and stormwater networks. The Board recommends that the Council ensures this information is communicated in a clear, effective and inclusive manner.
44733	Kim	Kelleher	Lyttelton Port Company Limited	Refer to attachments
44735	Faye	Collins	Waipuna Halswell Hornby Riccarton Community Board	Refer to attachments
44736	Celia	Coyne		My main concern about drinking water in Christchurch is that it is returned to being chlorine-free. Promises were made by the Mayor Leanne Dalziel that we would have chlorine-free water last year. It hasn't happened. I do appreciate that covid has probably had an impact. But please don't forget that many people in Chch want the chlorine-free water back.
44738	Richard	Smith		I think this initiative is overall great, to ensure everyone plays their part as the way people are now they are more selfish & don't generally have regard for the need of maintaining services. I believe that the start of a lot of these practical issues was with the demise of the Drainage Boards, as Councils then became focused on vanity rather than ensuring public services were maintained in a practical manner Wastewater clause 32 is too broad and will put a huge and potentially unreasonable liability on in particular domestic landowners on larger blocks. Particularly if this is deemed to be the owners responsibility to the main not the boundary (as some other Council's have done), this will pass potentially huge liability (think access and traffic management costs) to many landowners. Stormwater 15(1) is too restrictive. If a person has a stream through their property, this will prevent them doing landscaping (earthworks) or structures (e.g. a pedestrian access bridge or low retaining wall) even if they are unobtrusive and do not restrict maintenance access, or are required to preserve their own structures (e.g a terraced retaining wall system) Stormwater clause 25 is too broad and will put a huge and potentially unreasonable liability on in particular domestic landowners on larger blocks. Particularly if this is deemed to be the owners responsibility to the main not the boundary (as some other Council's have done), this will pass potentially huge liability (think access and traffic management costs) to many landowners.
44741	Rohan	Collett		I object to the removal of any existing structures around or over waterways. I also object to increasing the setback distance. What the councils regard as waterways are often only stormwater drains with water only when it rains. The council has failed to protect waterways in the past with other avtivities like redrilling wells and geothermal heating systems resulting in the drying up of existing streams permenantly distroying existing streams and their ecosystems.
44743	Frank	Visser		This is a submission on the Water and Wastewater Bylaw. Waste Bylaw Clause 27 - it is not clear what the relationship with the Trade Waste Bylaw is. Clause (1)(e) says no one can increase a commercial discharge without Council's written approval. The clause should be amended to include a Trade Waste Permit as a means of approval. Clause 28(1)(c) includes reference to "or discharge into". This should be removed from the clause as it is covered by Clause 31. Clause 29 - makes reference to the 'water supply system' however the clause is within the Waste Bylaw. Is this a drafting error? Clause 31(1) - support reference to approval including a Trade Waste Permit. Waste Bylaw - it is generally noted that there is a lack of cross reference to the Trade Waste Bylaw. An Explanatory Note somewhere would be useful.

Submissions for the Water Supply, Wastewater and Stormwater Bylaw review

44751	Malcolm	Long	Ōpāwaho Heathcote River Network	Refer to attachments
44753	Simon	Cooper	Winstone Wallboards Limited	Refer to attachments
44761	Felicity	Blackmore	Christchurch International Airport Ltd	Refer to attachments
44766	Chantel	Lauzon	Canterbury District Health Board	Refer to attachments
44768	Kathleen	Crisley	NZ Association of Metal Recyclers	Refer to attachments
44770	Trent	Sunich	4Sight Consulting	Refer to attachments
44772	Eleanor	Linscott	Federated Farmers NZ	Refer to attachments
44774	Karolin	Potter	Waihoro Spreydon-Cashmere Community Board	Refer to attachments
44784	Julian	Odering	Oderings Nurseries	My name is Julian Odering . I am a Director of Oderings nurseries ,that produces over a hundred of thousand plants per year for the Garden city. Last year we were audited by the CCC and this year we have been excluded from discharging water into the Council Stormwater network. Now we have to apply to E can to discharge Stormwater, at great expence. The nursery in Barrington was incorporated in 1929 and has operated since . I tried hard to comply with Council demands including bunds ,socks and filters including pumping out sumps several times and even finding 2 native Eels living in one of the sumps. I believe this proposed draconian legislation is unwarranted as it is unfair to pick on a business as old and established as ours. Bureaucratic decisions like this and many others are forcing us out of Ch Ch city .I wonder if the nursery was replaced by 50 inbuilt houses would the Stormwater quality be worse ,given run off from rooves , fertilized and weed killed lawns and plants .oil leaks ,heavy metal discharges from break pads ect. It is unfair to pick on businesses ,when the CCC have discharged sewerage into the avon river after the earthquakes ,and even now after the Bromley fire ,can they prove untreated sewerage is not discharging into the Estuary?. During the Roy Eastman Detention pond creation the CCC was discharging silt and mud directly into the Casmere Stream . What gives the CCC the right to have a high and mighty hypocritical approach when they have been guilty themselves.
44788	Marie	Gray	Summit Road Society	Refer to attachments

Submissions for the Water Supply, Wastewater and Stormwater Bylaw review

44790	Bethany	Barker	Styx Living Laboratory Trust	Refer to attachments
44793	Anita	Fulton	Environment Canterbury	Refer to attachments
44849	Kit	Doudney	Avon-Heathcote Estuary Ihutai Trust	Refer to attachments

SUBMISSION TO: Christchurch City Council

ON: Draft Stormwater and Land Drainage Bylaw 2022

BY: Waikura Linwood-Central-Heathcote Community Board

CONTACT
Alexandra Davids
Chairperson Linwood-Central-Heathcote Community Board
Care of: Arohanui Grace, Community Governance Manager
PO Box 73052, Christchurch 8154
Phone: 941 6663 Email: arohanui.grace@ccc.govt.nz

1. INTRODUCTION

1.1. The Waikura Linwood-Central-Heathcote Community Board (the Board) appreciates the opportunity to make a submission to the Draft Stormwater and Land Drainage Bylaw 2022.

1.2. The Board acknowledges that the Council holds the discharge permit for the city's stormwater and manages the network to prevent/manage the city's drainage.

1.3. The Board are very much aware of the proposed national "Three Waters Reform" programme. The Board understands that the government's reform is outside the scope of the Bylaw review.

1.4. The Board wishes to be heard in support of its submission.

2. SUBMISSION

2.1. The Board supports that the current bylaw be separated into two with one covering stormwater and land drainage and one for water supply and wastewater. The Board believes that combining the bylaws is confusing for the community. The Board believes that the separation will be easier for our community to find the information they need.

2.2. The Board supports the aim of the draft bylaw to protect the stormwater network from contamination and to manage the risk of flooding and protect the city's land drainage infrastructure.

2.3. The Board supports clause 11 that will prohibit the flow or discharge of water on a private property beyond the property boundaries and create a nuisance or damage to any neighbouring properties.

2.4. The Board supports the setback distances of three metres (previously one metre) for building or earthwork activities near waterways with approval from Council.

2.5. The Board support that property owners be mindful that any private stormwater pipes need to be free from cracks and other defects and to investigate and repair. The Board recommend that a community education promotion to make the community aware of the potential for private stormwater pipes connected to the city's infrastructure can contaminated the network and maybe a public health issue.

Alexandra Davids
Chairperson, Linwood-Central-Heathcote Community Board
23 December 2021

SUBMISSION TO: Christchurch City Council

ON: Draft Water Supply and Wastewater Bylaw 2022

BY: Waikura Linwood-Central-Heathcote Community Board

CONTACT Alexandra Davids
Chairperson Linwood-Central-Heathcote Community Board
Care of: Arohanui Grace, Community Governance Manager
PO Box 73052, Christchurch 8154
Phone: 941 6663 Email: arohanui.grace@ccc.govt.nz

1. INTRODUCTION

1.1. The Waikura Linwood-Central-Heathcote Community Board (the Board) appreciates the opportunity to make a submission to the Draft Water Supply and Wastewater Bylaw 2022 (the draft bylaw).

1.2. The Board acknowledges that the Council manages the city's water infrastructure and network to supply quality water to the city and to manage wastewater and that the bylaws purpose is to protect the infrastructure from misuse and damage, and in particular in case of the city's water supply to regulate and reduce the potential for contamination.

1.3. The Board are very much aware of the proposed national "Three Waters Reform" programme. The Board understands that the government's reform is outside the scope of the Bylaw review.

1.4. The Board wishes to be heard in support of its submission.

2. SUBMISSION

2.1. The Board supports that the current bylaw be separated into two with one covering stormwater and land drainage and one for water supply and wastewater. The Board believes that combining the bylaws is confusing for the community. The Board believes that the separation will be easier for our community to find the information they need.

2.2. The Board support the aims of the draft bylaw to:

- Protect the water supply from contamination.
- Protect the wastewater and stormwater networks from contamination.
- Protect the land and infrastructure associated with the networks from damage or misuse – including unauthorised access, connections or discharges.
- Encourage the efficient use of water, including promoting resilience.

2.3. The Board supports the requirements in Draft bylaw clause18 for property owners/occupiers to provide information on onsite activity to the Council if requested, including notification of change in activity in relation to backflow risks, and to take any action requested by the Council to ensure backflow prevention. It accepts that this will helps to ensure the appropriate level of backflow protection is installed at properties, based on water use and activity.

2.4. The Board supports the prohibition of the use of equipment that may cause pressure surges in the water supply network that could possibly result in contamination of drinking water or damage to the water infrastructure.

2.5. The Board supports that any chemical spills near drinking water protection zones be notified to the Council and Environment Canterbury and that both local authorities ensure that the matter has been reported to both authorities.

2.6. In relation to aerial spraying for agricultural or firefighting purposes that the Council be notified if it is to occur over the Council's jurisdiction. The Board supports that the papatipu Rūnanga are also notified as many of small settlements rely on open waterways for their drinking water and mahinga/moana kai.

2.7. The Board fully support the draft bylaw clause 16(3) that makes water wastage a bylaw offence. However, the Council needs to lead by example by promptly addressing instances of network/infrastructure leakage.

2.8. As stated in the Board's Long Term Plan submission the Board opposed volumetric charging and continues to oppose it. In order to be consistent the Board would ask the Council to install water meters at Council owned properties to monitor Council's own use of the city's water.

2.9. The Board support the draft bylaw clause 31 on the items that are not permitted to be disposed of into the wastewater network and that this is no exception approval be given.

2.10. The Board supports the new requirements on property owners including Council to:
- Maintain private wastewater drains in a state which is free from cracks and other defects.
- Investigate and rectify any issues where private laterals are not in a satisfactory operating state.

Alexandra Davids
Chairperson, Linwood-Central-Heathcote Community Board
23 December 2021

Lyttelton Port Company

03 February 2022

Christchurch City Council
Attn. Hanna Ballantyne
Civic Offices
53 Hereford Street
Christchurch

Sent via online submission

Dear Christchurch City Council,

RE: Water Supply, Wastewater and Stormwater Bylaw review: LPC Feedback

1 Lyttelton Port Company Limited (*LPC*) wishes to take the opportunity to provide feedback on the Water Supply, Wastewater and Stormwater Bylaw Review (Water bylaws) released for consultation by Christchurch City Council (*CCC*).

ABOUT LYTTELTON PORT COMPANY

2 LPC own and operate Lyttelton Port, which is the most significant port in the South Island in terms of total tonnages of cargo, number of containers handled, the value of exports and the value of imports. By volume, the Port accounts for 34.3% of South Island seaports' overseas exports and 37.4% of overseas imports. By value, the Port handles 41.4% of the South Island's seaports' exports and 67.9% of the South Island's seaports' imports[1].

3 The agriculture, forestry and fishing industries and the manufacturing industry together generate an estimated 105,000 jobs[2] or 34.4% of total employment in the Canterbury region and underpin much of the economic activity of Greater Christchurch[3] and the wider Canterbury region. These two industry groups are highly dependent upon Lyttelton Port exporting their finished products and importing goods required as inputs to their production activities.

1 For the year ending 30 June 2020. Source: Statistics New Zealand Infoshare, Overseas Cargo Statistics (www.archive.stats.govt.nz/infoshare)

2 Source: Statistics New Zealand NZ Stat. Business demography tables, February 2019 data. Assumes a regional employment multiplier of 2.0.

3 As defined in the Canterbury Regional Policy Statement (inclusive of areas within the Christchurch City, Selwyn, and Waimakariri Districts)

Lyttelton Port Company Limited
Private Bag 501, Lyttelton, 8841,
Christchurch, New Zealand
Phone: +64 3 328 8198
Fax: +64 3 328 7828
Email: enquiries@lpc.co.nz
Web: www.lpc.co.nz

4 Lyttelton Port is recognised as a 'lifeline utility" at a national level[4], and as "strategic infrastructure", forming part of "strategic transport networks" at a Canterbury regional level[5].

5 LPC operates two other key sites within the Greater Christchurch area – CityDepot in Woolston, and Midland Port in Rolleston. CityDepot provides an inland container storage and repair facility in close proximity to Lyttelton Port and is the South Island's largest empty container hub. Midland Port provides for the receipt, storage, packing, devanning and cross docking of full and empty containers and includes direct rail connection to the nine container shipping lines and eight container shipping services that access the Port.

6 Trade through Lyttelton Port has grown considerably across both containerised and general cargo. In the year ending 30 June 2020 the Port handled 446,101 containers, an increase of 2.0% on 2019 (despite the impacts of Covid-19 in the second half of the year ending 30 June 2020) and an increase of 188.5% since 2010[6]. This is equivalent to an average annual growth rate of 11.2%. LPC expects this growth to continue into the foreseeable future, as a result of:

a. Growth in Canterbury and South Island export and imports; and

b. Greater use of Lyttelton Port instead of other South Island ports as shipping companies continue the trend of using larger container ships and reducing services to some ports.

7 LPC forecasts ongoing growth for its container terminal to reach well over one million twenty-foot equivalent units (*TEUs*) by 2045. Non-containerised volumes of export and import trades are expected to continue growing but not as fast as containerised cargo.

8 LPC operates two sites which are affected by the bylaw changes within Christchurch District; these are the Port at Lyttelton and CityDepot in Chapmans Road, Woolston.

9 As CCC has presented the Bylaws in two separate documents we have prepared our feedback in this format as below

FEEDBACK DRAFT WATER SUPPLY AND WASTEWATER BYLAW 2022

Maintenance Access Corridors

10 LPC has a number of CCC owned services through its land holding; particularly at the Port where CCC's wastewater lines cross LPC land to discharge to the CMA. We are concerned by the proposed Bylaw 7(3)(a) and implications this may have for LPC's activities. For example the bylaw proposes to prevent containers being placed above maintenance access corridors CCC has through the Port (See Figure 1). Having such an assessment on a case-by-case basis is not acceptable to LPC who requires the ability to use land for Port activities to operate safely and efficiently. We ask CCC to consider if the bylaw should contain certain exclusions for operations such as LPC.

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[4] See Schedule 1 of Civil Defence Emergency Management Act 2002.

[5] See Canterbury Regional Policy Statement.

[6] Source: LPC Annual 2020 Report page 17 and for 2010 data: www.championfreight.co.nz/largest-nz-ports

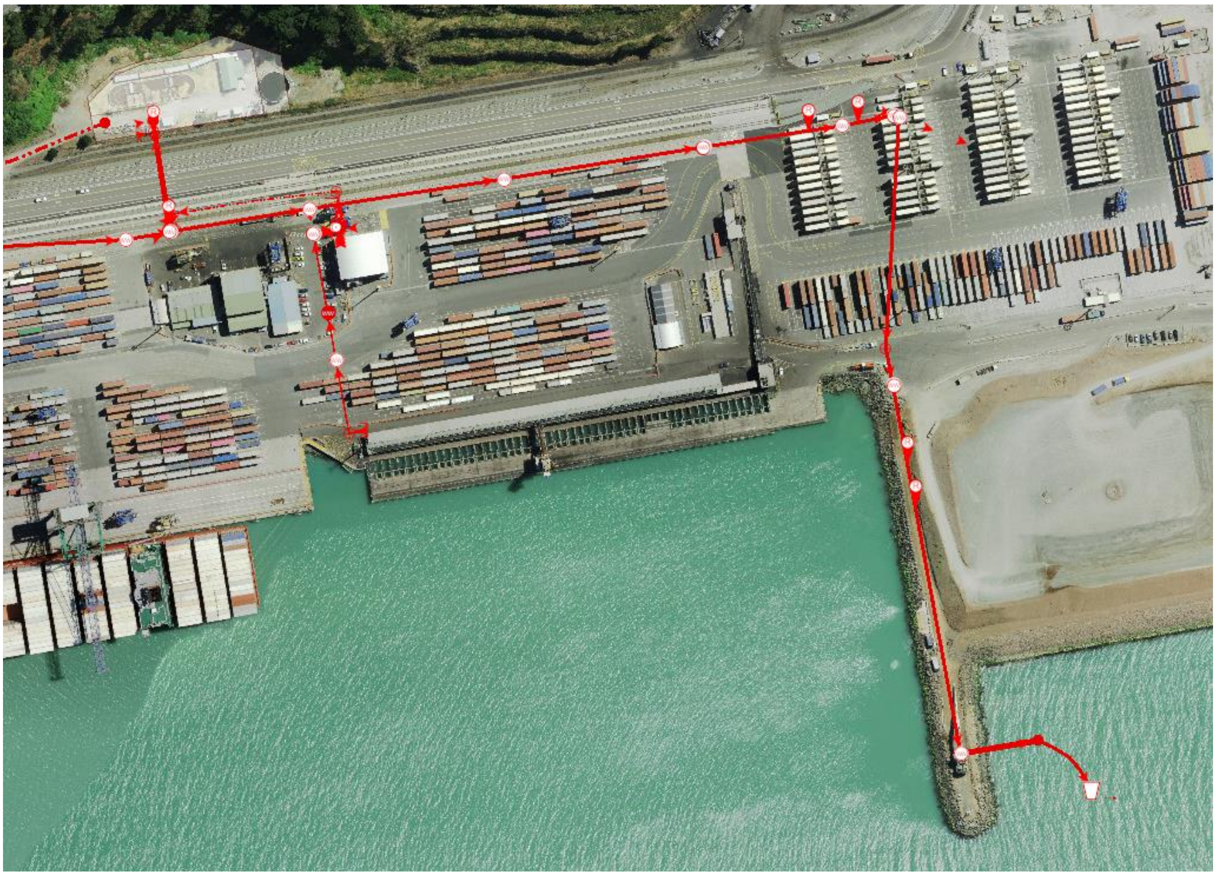

Figure 1: Location of CCC's wastewater pipelines within LPC's land holding and showing containers and hardstand. Image from CCC's GIS (https://gis.ccc.govt.nz/portal/apps/webappviewer/index.html?id=c4ff85ba75724391ae89fbf5f773e00d) on 14/01/2022.

FEEDBACK DRAFT STORMWATER AND LAND DRAINAGE BYLAW 2022

Industrial Site Discharge Licenses

11 LPC appreciates the need to manage stormwater to prevent contamination and agrees that Bylaws may be a key tool in doing so; however, LPC does not consider the approach proposed in relation to industrial site owners is appropriate.

12 We identify that CCC is proposing an approach of requiring a license to discharge, assigning a risk category to sites and that then forms the basis for fixed annual costs and ongoing costs associated with CCC staff to monitor such sites.

13 Firstly, LPC considers this approach appears to be double charging for stormwater and land drainage rates that it already pays for such services from CCC. In addition during the hearing stages for CCC's comprehensive global stormwater consent, evidence for Brian Norton, CCC, had confirmed existing users would be part of the consent and there was not an indication there would be charges applied to such sites.

14 Secondly, the application requirements, risk matrix assignment and charging system is not provided in sufficient detail for industrial site owners to understand how this may impact their business.

15 In particular, we question how the Port may be assessed in this system where selected catchments discharge via CCC's network, but is limited to certain activities and is a historical connection. We ask CCC provide information on this type of scenario in order for industrial site users to understand what charges may be applied.

Requirement for Erosion and Sediment Control Plans

16 We support the need to apply rigour to earthworks as appreciate without proper management this can lead to increased sedimentation in the waterways and receiving coastal environment. LPC works to a Construction Environmental Management Plan for all works; but considers the definition used on 'Earthworks' could be improved and in particular what is considered 'substantial'. We suggest there needs to be a set bulk or area based level for ease of understanding when CCC may require a suitably qualified person to be engaged. Additionally we wish to understand why this is required when related thresholds in district and regional plans are already in effect for earthworks.

Notification of spills

17 LPC supports the need to for CCC as a network operator to know if spills have entered the stormwater network as these will ultimately enter the environment if not controlled or cleaned up. We do wish to query how CCC is planning to manage this in order to understand if spills require attention.

18 In businesses, such as LPC, which have procedures and equipment in place to manage spills, we can notify CCC of every small scale spill which may occur on land (and is cleaned up) but this may distract from other spills in Christchurch which are not controlled nor reported.

19 We therefore suggest CCC consider providing a self-reporting platform to minimise workload that may be created otherwise to allow staff to be focused on key spills to the network.

Maintenance Access Corridors

20 LPC has a number of CCC owned services through its land holding; particularly at the Port where Lyttleton's brick barrels the land to discharge to the Coastal Marine Area. We are concerned by the proposed Bylaw 17 and implications this may have for LPC's activities. For example the bylaw proposes to include hard stand which is present above the stormwater lines CCC has through the Port (See Figure 2). Having such an assessment on a case-by-case basis is not acceptable to LPC who requires the ability to use land for Port activities to operate safely and efficiently. We ask CCC to consider if the bylaw should contain certain exclusions for operations such as LPC.

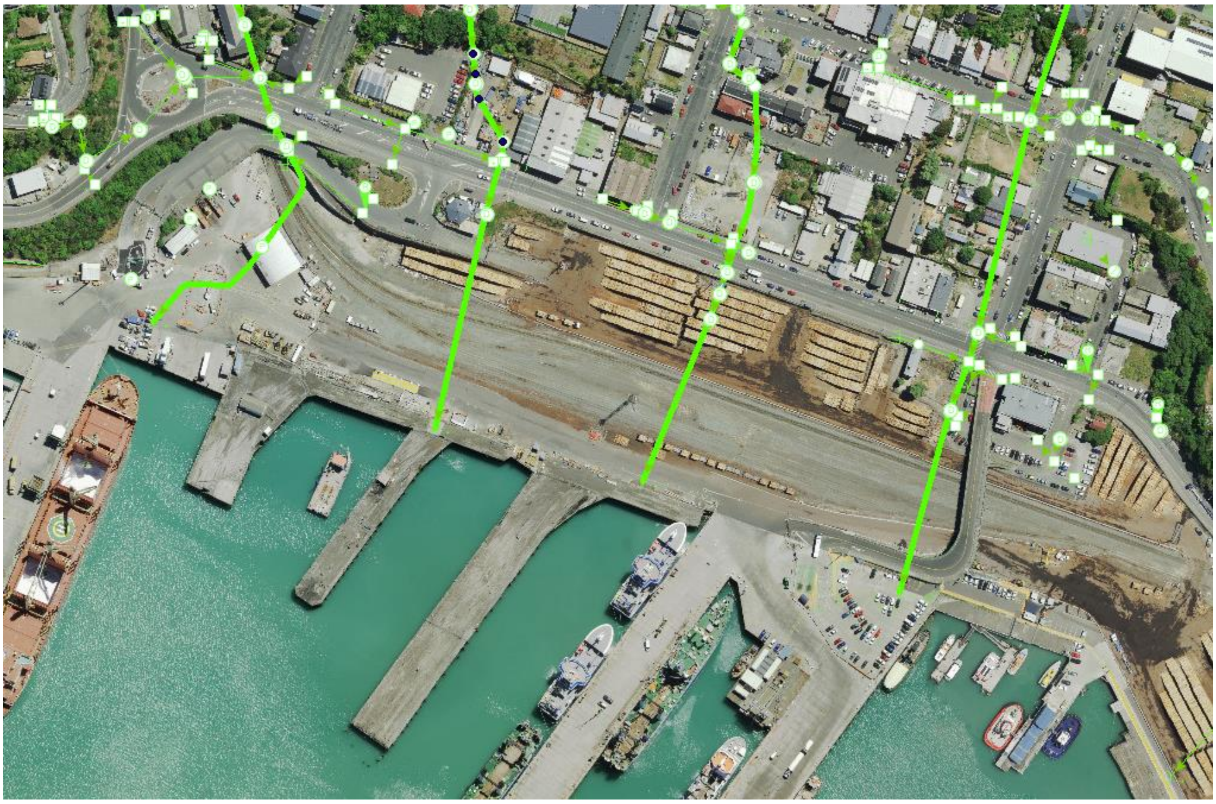

Figure 2 CCC Stormwater pipes in LPC's landholder with hard stand and log yards above. Image from CCC's GIS (https://gis.ccc.govt.nz/portal/apps/webappviewer/index.html?id=c4ff85ba75724391ae89fbf5f773e00d) on 14/01/2022.

21 Finally, LPC welcomes Christchurch City Council to contact us for any further discussion on matters raised in this letter.

Yours sincerely,

KIM KELLEHER
Head of Environment and Sustainability

SUBMISSION TO:	Christchurch City Council
ON:	**Draft Water Supply and Wastewater Bylaw 2022**
BY:	Waipuna Halswell-Hornby-Riccarton Community Board
CONTACT:	Faye Collins Community Board Adviser faye.collins@ccc.govt.nz

1. INTRODUCTION

The Waipuna Halswell-Hornby-Riccarton Community Board ("the Board") appreciates the opportunity to make a submission on the Draft Stormwater and Land Drainage Bylaw 2022 ("the draft bylaw").

This submission was compiled by the Board's Submission Committee under the delegated authority granted by the Board.

The Board wishes to be heard in support of its submission.

2. GENERAL

2.1 The Board recognises that the Council manages the infrastructure and network to supply water to the city and to carry wastewater and that it has bylaws to protect the infrastructure from damage or misuse, regulate activities and behaviours to reduce the potential for contamination of drinking water or damage and to protect public health and safety.

2.2 The Board further recognises that the bylaw is local legislation that applies to Christchurch and Banks Peninsula but that other general governmental controls also apply so that issues of mandatory chlorination or fluoridation of drinking water supplies, resource consents for water takes (e.g. for water bottling), and wider reform of the three waters sector foreshadowed in the Government are outside the scope of the Draft bylaw.

2.3 The Board acknowledges the Council's current bylaw that regulates stormwater matters is the Water Supply, Wastewater and Stormwater Bylaw (2014) is required to be reviewed by no later than 2024, but that it is being reviewed sooner to help meet the Council's new stormwater obligations under the Comprehensive Stormwater Network Discharge Consent as well as to improve and update the bylaw to ensure it is fit-for-purpose.

3. SUBMISSION

3.1 The Board **supports** the approach to separate the current bylaw into two with one covering water supply and wastewater, and the other for stormwater and land drainage. The Board agrees that the stormwater network of pipes, drains, and overland flow paths is very different to the drinking water and wastewater networks of closed pipes and it is logical to have separate provisions.

3.2 The Board **supports** the aim of the Draft Bylaw to:
• protect the water supply from contamination
• protect the wastewater and stormwater networks from contamination
• protect the land and infrastructure associated with the networks from damage or misuse – including unauthorised access, connections or discharges
• encourage the efficient use of water, including promoting resilience.

3.3 The Board **supports** the requirements in Draft bylaw clause18 for property owners/occupiers to provide information on onsite activity to the Council if requested, including notification of change in activity in relation to backflow risks, and to take any action requested by the Council to ensure backflow prevention. It accepts that this will helps to ensure the appropriate level of backflow protection is installed at properties, based on water use and activity.

3.5 The Board **supports** the Draft bylaw clause 9(4) prohibition (unless approved) of the use of equipment that may cause pressure surges in the water supply network that can result in contamination of drinking water supplies, and/or damage to the public water supply network.

3.6 The Board **supports** Draft bylaw clause 9(5) that introduces a new requirement to immediately notify the Council of any chemical spills in or near community drinking water protection zones. The Board considers that this requirement is necessary to help to protect the quality of the city's drinking water.

3.7 The Board understands the potential for aerial spraying of chemicals for agricultural or firefighting purposes to contaminate source water and therefore **supports** the requirement in Draft bylaw clause 9(6) that the Council be notified of aerial applications of fertiliser, pesticides and other chemicals in or near community drinking water protection zones prior to the application. Advance notification will allow measures to be put in place to avoid or mitigate any contamination risk.

3.8 The Board **supports** Draft bylaw clause 17 that introduces a new provision that may allow one rainwater storage tank to meet multiple separate regulatory requirements (e.g. one tank for both non-potable use and for stormwater detention purposes) in restricted supply areas of Banks Peninsula. The Board accepts that there are practical issues of cost and site space with implementation of multiple requirements for various water storage tanks under a range of regulatory tools and that the provision of Draft bylaw clause 17 will address this.

3.9 The Board **supports** Draft bylaw clause 16(3) that makes water wastage a bylaw offence.
In its submission the Board on the Long term Plan 2021-31 the Board supported the Council's ongoing investment in the city's water networks, particularly as it goes to addressing leakage and water wastage from the network and considers that in addition to holding residents responsible for water wastage the Council needs to lead by example by promptly addressing instances of network leakage and water wastage such as the longstanding flooding issues in Goulding Avenue, Hornby that the Board has drawn attention to on more than one occasion.

3.10 The Board opposes volumetric charging and in particular in its submission on the Long Term Plan 2021-31 it opposed the proposal to introduce an excess water use charge. It does, however, recognise the value of water meters to monitor water consumption and detect leaks. The Board agrees that Council-owned meters should be installed on Council land (unless approved otherwise) and therefore supports Draft bylaw clause: 19(4) and also supports Draft bylaw clause 19(5) that requires the costs of relocation of a meter be met by customers where the relocation has been necessitated by the meter becoming inaccessible due to changes made by the customer.

3.11 The Board **supports** the improved provisions in Draft bylaw clauses 7-8 and 29-30 that aim to ensure that the Council is able to safely access its infrastructure for necessary maintenance and repair.

3.12 The Board appreciates the risk of tree roots damaging underground public water supply and/or wastewater pipes and therefore **supports** the provisions in Draft bylaw clauses 9(7), 9(8), and 33 on planting, trimming and removal of trees.

3.13 The Board further **supports** Draft bylaw clause 31 that lists the things that are not permitted to be disposed of into the wastewater network, without approval. The Board considers that this clearly lists the things that can cause blockages, damage, or reduced capacity wastewater network, and increased costs and prohibits them being disposed of into the network.

3.14 The Board **supports** Draft bylaw clause 32 new requirements for:
• private wastewater drains to be maintained in a state which is free from cracks and other defects
• the property owner to investigate and rectify any issues where private laterals are not in a satisfactory operating state.
The Board considers these requirements will help to prevent damage and unnecessary capacity issues in the public wastewater network Damaged or

3.15 The Board **supports** Draft bylaw clause 27 setting out the application and approval requirements for connection to the wastewater network. This will give clarity to those wanting to connect.

4. CONCLUSION

The Board requests that the council considers the matters set out above in relation to the Draft Water Supply and Wastewater Bylaw 2022.

Mark Peters

Deputy Chairperson Waipuna Halswell-Hornby-Riccarton Community Board

Submissions Committee

Dated 4 February 2022

Submission #44735

SUBMISSION TO:	Christchurch City Council
ON:	**Draft Stormwater and Land Drainage Bylaw 2022**
BY:	Waipuna Halswell-Hornby-Riccarton Community Board
CONTACT:	Faye Collins Community Board Adviser faye.collins@ccc.govt.nz

1. INTRODUCTION

The Waipuna Halswell-Hornby-Riccarton Community Board ("the Board") appreciates the opportunity to make a submission on the Draft Stormwater and Land Drainage Bylaw 2022 ("the draft bylaw").

This submission was compiled by the Board's Submission Committee under the delegated authority granted by the Board.

The Board wishes to be heard in support of its submission.

2. GENERAL

2.1 The Board recognises that the Council manages the infrastructure and network to carry our stormwater and prevent flooding and holds a discharge permit, the Comprehensive Stormwater Network Discharge Consent, to discharge from the system.

2.2 The Board acknowledges the Council's current bylaw that regulates stormwater matters is the Water Supply, Wastewater and Stormwater Bylaw (2014) is required to be reviewed by no later than 2024, but that it is being reviewed sooner to help meet the Council's new stormwater obligations under the Comprehensive Stormwater Network Discharge Consent as well as to improve and update the bylaw to ensure it is fit-for-purpose.

2.3 The Board is aware that proposed national changes have been foreshadowed in the Government's Three Waters Reform Programme and accepts that The Government's reform is separate and outside the scope of this bylaw review.

2.4

3. SUBMISSION

3.1 The Board **supports** the approach to separate the current bylaw into two with one covering water supply and wastewater, and the other for stormwater and land drainage. The Board agrees that the stormwater network of pipes, drains, and overland flow paths is very different to the drinking water and wastewater networks of closed pipes.

3.2 The Board **supports** the aim of the Draft Bylaw to:
• protect the stormwater network from contamination;
• protect the land and infrastructure associated with the network from damage or misuse, including unauthorised access, connections or discharges; and
• manage the risk of flooding and protect land drainage infrastructure.

3.3 The Board **supports** the requirement in Draft bylaw clauses 27-35 for all industrial premises (where business activity has the potential to contaminate stormwater, as defined by the Register of Industrial and Trade Activities) to obtain an Industrial Stormwater Discharge Licence. The Board considers that more monitoring of the discharges from industrial sites is required to reduce contamination of stormwater before it is discharged into the stormwater network and into the environment.

3.4 The Board **supports** the requirements in Draft bylaw clauses 22 and 23 for an Erosion and Sediment Control Plan for earthworks to be prepared by a suitably qualified person (where this is not otherwise required by a building or resource consent) and made available to the Council and for control measures to be put in place before works begin, maintained throughout, and only removed when the land has been stabilised.

The Board has for some time been concerned at the potential for and instances of sediment-laden water from development to entering the stormwater network and polluting the environment. It considers that Draft bylaw clauses 22 and 23 will go some way to addressing this.

3.5 The Board **supports** the provisions of Draft bylaw clause: 9, 19 and 26 that seek to prevent contaminants entering the stormwater network by providing:

• clarity on the subject and application of potential stormwater quality standards that may be resolved by the Council.
• strengthened provisions on what may and may not be disposed of into the stormwater network, including defining “prohibited substances”
• a requirement to notify the Council of any spills or discharges of prohibited substances, which may end up in the stormwater network and be discharged to land or water.
• a requirement for property owners with required stormwater devices to maintain the device in good operating condition and to make maintenance records available to the Council on request.
It considers that these provisions, if adhered to should work together to limit the contaminants entering the stormwater network.

3.6 The Board **supports** Draft bylaw clause11 that will prohibit the flow or discharge of water from an artesian spring or well on a private property beyond the property boundaries and requires the property occupier to manage any such water so it does not create a nuisance or damage to any neighbouring property.

3.7 The Board **supports** Draft bylaw clause 15(1) that provides increased setback distances of three metres for building or earthwork activities near waterways without the Council’s approval.
The Board considers that the setback distance in the current bylaw of one metre does not provide sufficient protection for the waterway and is pleased to support the proposal for an increase.

3.8 The Board **supports** Draft bylaw clause 17 that introduces a new requirement for Council approval for activities and uses on land that could restrict access to public infrastructure as this will ensure that the Council will be able to access underground infrastructure if and when necessary even where it is under private land.

3.9 The Board understands that Damaged or broken private stormwater laterals can cause inefficient drainage, contaminated stormwater discharges and public health issue and therefore it **supports** Draft bylaw clauses 24 and 25 that require property owners to maintain private stormwater pipes free from cracks and other defects and to investigate and rectify any issues.

4. CONCLUSION

The Board requests that the council considers the matters set out above in relation to the Draft Stormwater and Land Drainage Bylaw 2022.

Mark Peters

Deputy Chairperson Waipuna Halswell-Hornby-Riccarton Community Board Submissions Committee

Dated 4 February 2022

Submission on the Draft 2022 Water Supply, Wastewater and Stormwater Bylaws

7 February, 2022

Ōpāwaho Heathcote River Network Inc.

Email: info@ohrn.nz
Website: www.ohrn.nz
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Phone: 027 6727 497

Thank you for the opportunity to make a submission on the Draft 2022 Water Supply, Wastewater and Stormwater Bylaws. This submission has been prepared by members of the Ōpāwaho Heathcote River Network.

The Ōpāwaho Heathcote River Network (OHRN) is a community-based catchment group. It was established out of frustration at the lack of integrated management of the Ōpāwaho Heathcote River.

The OHRN is a voice for the river. It advocates on its behalf to promote the regeneration of the health and mauri of the awa and connects with and supports communities within the river catchment. It is recognised for its community-led delivery of collaborative actions to improve the health of the river.

The ŌHRN acknowledges the significant amount of work that the Christchurch City Council (CCC) has carried out in the preparation of these draft bylaws. It also recognises the role that these bylaws will play in making it possible for CCC to achieve some of the objectives of the Ōpāwaho Heathcote River Stormwater Management Plan and some of the requirements of the Comprehensive Stormwater Network Discharge Consent (CSNDC).

The OHRN supports the goal of progressive stormwater improvement through the CSNDC and the Council's strategic objective for water, namely "Surface water quality is essential for supporting ecosystems, recreation, cultural values and the health of residents."

The OHRN vision, as set out in our Constitution and Strategic Plan, is also for an ecologically healthy river. While the OHRN supports most of the draft Bylaws, we contend that they can be strengthened in two areas: the greater protection of artesian springs and reducing zinc pollution caused by runoff from large industrial buildings.

We urge the Council to take this opportunity to increase the pace at which zinc pollution is decreased and to make the river's improvement a higher priority than commercial considerations by implementing source control as required by **Goal 2: Water quality and ecosystems are protected and enhanced** in the Council's own **Te Wai Ora o Tāne Integrated Water Strategy**.

Our submission comprises;

A. General comments on the draft Bylaws

B. A commentary on the Draft Water Supply and Wastewater Bylaw 2022

C. A commentary on the Draft Stormwater and Land Drainage Bylaw 2022

D. A commentary on the Register of Industrial and Trade Activities

E. Actions sought: changes to Bylaws requested by OHRN

A: General comments on the draft Bylaws

1. The Ōpāwaho Heathcote River Network (OHRN) **strongly supports** the intention of the CCC to split the Water and Wastewater bylaws from those applying to Stormwater and Land Drainage.

   1.1. While all Three Waters are obviously linked in several ways, the urgent requirement for the better management of stormwater and drainage from land to improve water quality in all Christchurch waterways demands separation of these matters into a separate bylaw. This will provide greater clarity for all those involved in applying and monitoring the intentions of the bylaws.

2. The Ōpāwaho Heathcote River Network (OHRN) **strongly supports** the decision of the CCC to proceed with the revision of these bylaws at this time despite the proposed nationwide changes to Three Waters provision.

   2.1. By the time any proposed changes to Three Waters is implemented, the 2022 versions of these bylaws will have had time to be in place and operationalised. This will provide a solid foundation for any future changes to Three Waters implementation.

3. These bylaws, once adopted, need to be widely promulgated in the community.

   3.1. While the subject matter and detail of these two bylaws may be uninviting for some residents to read as a whole, the general principles, as well as the ongoing specific actions required of residents to fulfil their obligations under these bylaws, need publicising clearly.

   3.2. The requirement for owners to ensure that their private sewer laterals are checked for cracks and faults, and repaired appropriately, must be publicised widely to help reduce the incidence of sewer overflows into the river during rain events.

   3.3. The OHRN, through the Canterbury Waterways Partnership, is prepared to assist in regard to the dissemination of these messages.

B: Commentary on the Draft Water Supply and Wastewater Bylaw 2022

4. In general, the OHRN **strongly supports** all clauses in this bylaw. In particular, the OHRN supports the following clauses:

4.1. **Clause 31: DISCHARGES INTO THE WASTEWATER SYSTEM.**

4.1.1. Greater enforcement of this clause in conjunction with greater public awareness of prohibited items such as stormwater, cooking fats & oils, and “flushable” wipes should help reduce avoidable sewage overflows into waterways and hence help improve overall water quality in these waterways.

4.1.2. The public awareness aspect is particularly important. The OHRN is prepared to assist the CCC in promoting this.

4.2. **Clause 32: MAINTENANCE OF PRIVATE WASTEWATER DRAINS.**

4.2.1. Greater public awareness of the responsibility of house owners to maintain the integrity of sewer laterals, along with increased enforcement as necessary, will be important in helping to reduce the infiltration of stormwater into the wastewater system. This in turn will reduce the frequency of wastewater overflows into waterways and hence help improve overall water quality in these waterways.

4.2.2. Sufficient resources must be made available by CCC in its Annual Plan to ensure that inspection and assessment of wastewater lines to identify faulty laterals will take place on a schedule which will make enforcement of this requirement more likely.

4.2.3. The public awareness aspect is particularly important. The OHRN is prepared to assist the CCC in promoting this.

C: Commentary on the Draft Stormwater and Land Drainage Bylaw 2022

5. In general, the OHRN **strongly supports** all clauses in this bylaw. In particular, the OHRN supports the following clauses:

5.1. Clause 10: REQUIREMENT FOR ON-SITE STORMWATER MANAGEMENT

5.1.1. The OHRN **strongly supports** CCC having the power to require retrofitting of stormwater devices that will improve the quality of stormwater being discharged into the system.

5.1.2. Over time, as the National Policy Statement for Freshwater Management principles of Te Mana o Te Wai are implemented through the regulatory system, it will be increasingly important for the CCC to require improvements to the water quality of discharged stormwater.

5.1.3. For some industries, this will require retrofitting of treatment devices at some cost. It is important that the ability for CCC to require this is clearly stated.

5.2. Clause 11: MANAGING DRAINAGE FROM ARTESIAN SPRINGS AND WELLS ON PRIVATE LAND

5.2.1. While the OHRN **supports** this clause as written, we submit that there is an opportunity here to provide greater protection to artesian springs.

5.2.2. The base flow of the Ōpāwaho Heathcote River is fed by artesian springs at its headwaters and at points along its length. Without adequate protection, particularly in a time of global climate change likely to reduce rainfall, the base flow of the river could be severely compromised by interference with artesian springs.

5.2.3. The OHRN suspects that land developers are capping springs that appear in inconvenient places during sub-division creation. Such action, without a specific resource consent or the written consent of CCC to do so must be clearly signalled by this bylaw as illegal.

5.2.4. The OHRN submits that the CCC should include under this clause appropriate powers to:

5.2.4.1. Require the incidence and location of artesian springs to be notified to the CCC.

5.2.4.2. Prevent action not directly approved by a resource consent or by CCC in writing to cap, interfere with or divert the natural flow of an artesian spring.

5.3. Clause 19: PROHIBITED SUBSTANCES MUST NOT ENTER THE NETWORK

5.3.1. The list of prohibited substances must be publicised widely to improve public awareness and thereby help reduce the possibility and incidence of pollution of waterways.

5.3.2. The public awareness aspect is particularly important. The OHRN is prepared to assist the CCC in increasing public awareness of prohibited substances.

5.4. Clauses 22 & 23: REQUIREMENTS FOR EARTHWORKS

5.4.1. The OHRN **strongly supports** these clauses, particularly the requirement for Erosion and Sediment Control Plans to be in place and implemented prior to earthworks being undertaken.

5.4.2. It will be vital that there are sufficient resources made available by CCC in the Annual Plan for the close monitoring and enforcement of these clauses. Knowledge that there will be active inspection and appropriate follow-up will ensure contractors implement these control measures properly.

5.5. Clauses 24, 25 & 26: MAINTENANCE REQUIREMENTS

5.5.1. The OHRN **strongly supports** these clauses as a means of ensuring that sediment control measures continue to function appropriately.

5.5.2. It is vital that there are sufficient resources made available by CCC in the Annual Plan for the close monitoring and enforcement of these clauses.

5.5.3. It is vital that CCC maintains an appropriate, functioning and updated database of private stormwater systems that have been installed in fulfilment of a resource consent or by request of the CCC.

5.5.4. Without regular inspection and follow-up, owners may neglect or refrain from appropriate and timely maintenance of control systems. This will only be evidenced by sediment pollution during rainfall events by which time the environmental damage (sediment carried into the river) will have already occurred.

5.5.5. Increased public awareness of the responsibility of property owners to maintain their stormwater systems, along with increased enforcement as necessary, will be important in helping to reduce sediment entering the river.

5.5.6. The OHRN is prepared to assist the CCC in increasing public awareness of the requirement to maintain private stormwater systems.

5.6. Clauses 27 - 39: MANAGEMENT OF STORMWATER DISCHARGE FROM INDUSTRIAL PREMISES

5.6.1. The OHRN **strongly supports** the purpose, processes and most of the detail in these clauses.

5.6.2. The OHRN notes that the indicated fee for sites designated after inspection as having a "High Risk" of stormwater contamination is probably not high enough to deter large operators from a casual attitude towards their responsibilies. We would be supportive of a significantly higher fee to encourage the prioritising of stormwater protection on such sites.

5.6.3. The OHRN **is concerned** that the Register of Industrial and Trade Activities avoids addressing the risk of stormwater contamination that arises from zinc control from industrial building roofs and walls.

5.6.4. This management strategy is timely. Despite the ongoing efforts of both Environment Canterbury and CCC over many years to encourage voluntary improvements by individual commercial enterprises, little real progress has been made in improving the water quality in waterways that pass through industrial areas of Christchurch.

D: Commentary on the Draft Register of Industrial and Trade Activities

6. Register of Industrial and Trade Activities

6.1. The Register of Industrial and Trade Activities captures most of the obvious possible pollution sources from industrial activity.

6.2. However, the OHRN **is concerned** that the Register of Industrial and Trade Activities avoids addressing the risk of stormwater contamination that arises from large buildings which have roofs and walls clad with zinc-plated steel.

6.2.1. Zinc-plated steel products include:

6.2.1.1. Galvanised steel products which have a coating of 100% zinc,

6.2.1.2. Zincalume® steel which has an alloy coating of 43.5% zinc, 55% aluminium and 1.5% silicon,

6.2.1.3. Painted galvanised steel products such as Colorsteel® which consists of a Zincalume® steel base to which a painted finish is applied.

6.2.2. We note that the Christchurch City Surface Water Quality Annual Report 2020 indicates "(Water quality testing) sites within areas with high industrial and commercial land use, such as Addington Brook, Haytons Stream and Curlett Road Stream, typically had higher concentrations (of dissolved zinc) than the rest of their respective catchments".[1]

6.2.3. In 2020, under the CSNDC, the CCC monthly water quality monitoring data was assessed for the Christchurch City Surface Water Quality Annual Report 2020 against the consent Objectives and Attribute Target Levels (ATLs) for TSS, copper, lead, and zinc. 32 of the 51 sites monitored did not meet the CSNDC ATLs in 2020 and the report noted that "Dissolved metals are a concern in all catchments, except the Pūharakekenui-Styx River."[2]

6.2.4. 2016 research by the Hydrological and Ecological Engineering Research Group, Department of Civil and Natural Resources Engineering, University of Canterbury[3] found that galvanized roofs are key contributors

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[1] CCC Surface Water Quality Annual Report 2020, page 9
[2] CCC Surface Water Quality Annual Report 2020, page 24 - 27
[3] Predicting Sediment and Heavy Metal Loads in Stormwater Runoff from Individual Surfaces, 2016, F J Charters, T A Cochrane, A D O'Sullivan

of zinc, producing 81% of the catchment zinc load primarily in dissolved form. This research also indicated that:

6.2.4.1. Zinc-plated roofs are responsible for greater dissolved zinc in stormwater than roads, a result which emphasizes the importance of action on zinc from roof sources.

6.2.5. We also note that the Auckland Unitary Plan Stormwater Management Provisions (2013)[4] stated:

6.2.5.1. "... that zinc-coated steel roofs represent a significant source of zinc and a significant opportunity to reduce the zinc load to (the) receiving environment."

6.2.5.2. "Galvanized steel has been recognised as a significant source of zinc for many years. The data indicates that unpainted galvanized steel discharges zinc at concentrations two orders of magnitude higher than the Discharge Effluent Quality Requirements (DEQR). Painting or coating galvanized steel improves this significantly, although concentrations may still be an order of magnitude higher than the DEQR."

6.2.5.3. "The Contamination Load Model (CLM) data indicates that unpainted zinc-aluminium coated steel discharges zinc at approximately 200 µg/L, which is an order of magnitude lower than the runoff from galvanized steel. The value in the CLM is mid-way between the concentration reported in an Auckland Regional Council report (Kingett Mitchell & Diffuse Sources, 2004), which found the median discharge to be 432 µg/L; and a report prepared for the NZ Metal Roofing Manufacturers Inc., which indicated that median zinc concentrations from zinc-aluminium coated steel were 124 µg/L and 94 µg/L for new and old unpainted substrate (Tonkin & Taylor, 2004). Even the lower values are three to four times the zinc DEQR, and are approximately equivalent to the concentrations from roads with 5,000 to 20,000 v.p.d. (vehicles per day)"

6.2.5.4. "As such, unpainted zinc-aluminium coated steel represents a significant source of zinc and a significant opportunity to reduce the zinc to Auckland's receiving environments."

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[4] Auckland Unitary Plan stormwater management provisions: Technical basis of contaminant and volume management requirements, 2013, Auckland Council, page 48

6.2.5.5. Analysis of sources of zinc to stormwater in an Auckland industrial environment indicated that 75% of source was from building roof materials.[5]

6.2.6. We note that BHP NZ Steel, the manufacturers and distributors of zinc-coated metal roofing products such as Galvsteel®, Colorsteel® and Zincalume® have previously claimed in their submission[6] to Environment Canterbury on the draft CSNDC that the introduction of Colorsteel® and Zincalume® into the building market in 1994 will have improved stream water quality with respect to zinc in many urban environments, and that this will continue to improve.

6.2.7. Water quality monitoring by CCC for the CSNDC provides no evidence of reductions in dissolved zinc to any discernible degree in Christchurch's waterways which pass through its industrial suburbs. This indicates that:

6.2.7.1. Either, there are significant residual installations of unpainted galvanised steel roofing which are continuing to pollute stormwater flowing into our local waterways with dissolved zinc, masking the improved performance of new products,

6.2.7.2. Or, there are increased new areas of Colorsteel® and Zincalume® roofing which are releasing dissolved zinc into stormwater, albeit at a lower rate than older products, which have made up for any gains from the reduction of the area of unpainted galvanised metal roofs,

6.2.7.3. Or, the time scale for the effect of the introduction of Colorsteel® and Zincalume® roofing to be discernible in water quality monitoring is greater than 26 years which seems unlikely.

6.2.8. The OHRN is convinced that the evidence is compelling for taking action at this time to reduce zinc contamination of stormwater from industrial buildings.

6.2.9. The OHRN acknowledges that the Council is not willing at this time to **require** the replacement or renovation of existing large areas of unpainted zinc-plated steel even though these are almost certainly discharging contaminated stormwater into its network.

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[5] Kennedy, P., & Sutherland, S. (2008). Urban Sources of Copper, Lead and Zinc. Prepared by Golder and Associates for Auckland Regional Council. Auckland: Auckland Regional Council
[6] CON520: Submission on a Resource Consent Application – CRC190445, New Zealand Steel Limited (NZ Steel), page 2

6.2.10. The OHRN accepts that it would be ideal for local authorities nationwide to coordinate their response to zinc contamination of stormwater from residential and industrial buildings. However, the time scale required for this to eventuate prevents the CCC adequately meeting its stormwater quality objectives through source control as required by *Goal 2: Water quality and ecosystems are protected and enhanced* in the Council's *Te Wai Ora o Tāne Integrated Water Strategy*.

6.2.11. Currently, the Council does not have a means of readily identifying industrial buildings which have large areas of unpainted zinc-plated steel roofs and walls that may be discharging contaminated stormwater into its network.

6.2.12. The OHRN therefore seeks that Clause 28 (1) of the Bylaw should be amended to include a second additional criterion which requires that the occupier of every industrial premises with a total combined roof area of more than $100m^2$ to apply for an Industrial Stormwater Discharge Licence.

6.2.12.1. Subsequent assessment by the CCC under that licencing system would mean that, as a first step towards zinc control from industrial building roofs and walls, the Council would be able to:

6.2.12.1.1. Identify, map and register the site of existing large unpainted zinc-plated surfaces, and

6.2.12.1.2. Encourage, through information and the education of owners, the reduction of such areas of unpainted zinc-plated surfaces, or

6.2.12.1.3. Encourage the installation of appropriate stormwater treatment facilities to remove or reduce dissolved zinc entering the waterways, and

6.2.12.1.4. Maintain a database of large unpainted zinc-plated surfaces with the intention of implementing future remedial action once local authorities have agreed a national response to this source of contamination.

6.2.12.2. All of these measures would certainly have a relatively swift positive impact on reducing the level of dissolved zinc in stormwater originating from industrial premises through voluntary action by owners.

6.2.12.2.1. These measures would also allow the Council to be better prepared for future action to reduce zinc contamination of stormwater from industrial roof runoff by knowing where these areas of zinc-plated steel actually are.

6.2.12.3. The OHRN suggests $100m^2$ as a guide threshold roof area but would be pleased to support a lower figure should the CCC decide that this is warranted.

E: Actions sought: changes to Bylaws requested by OHRN

7. Clause 11: MANAGING DRAINAGE FROM ARTESIAN SPRINGS AND WELLS ON PRIVATE LAND

7.1. Include under this clause appropriate powers to:

7.1.1. Require the incidence and location of artesian springs to be notified to the CCC

7.1.2. Prevent action not directly approved by CCC to cap, interfere with or divert the natural flow of an artesian spring

8. Clause 28: REQUIREMENT TO APPLY FOR AN INDUSTRIAL STORMWATER DISCHARGE LICENCE

8.1. Amend Clause 28 (1) to insert a second additional criterion which requires that the occupier of every industrial premise with a total combined roof area of more than $100m^2$ to apply for an Industrial Stormwater Discharge Licence.

Thank you for the opportunity to provide a submission on the Draft 2022 Water Supply, Wastewater and Stormwater Bylaws.

The Ōpāwaho Heathcote River Network recognises the endeavour of CCC staff in the development of these bylaws and the consultation process.

We wish to be heard at the hearings for these draft bylaws.

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Annabelle Hasselman
Chair
Ōpāwaho Heathcote River Network

SUBMISSION ON CHRISTCHURCH CITY COUNCIL'S
WATER SUPPLY, WASTEWATER AND STORMWATER BYLAW REVIEW

To: Christchurch City Council
PO Box 73012
Christchurch 8154

Submitter: Winstone Wallboards Limited
219 Opawa Road
Christchurch 8022

Attention: Dean Shuttleworth
[redacted]

Introduction:

1. This is a submission by Winstone Wallboards on Christchurch City Council's Water Supply, Wastewater and Stormwater Bylaw review. This submission relates to the Draft Stormwater and Land Drainage Bylaw 2022 (Bylaw) and the associated Industrial Stormwater Discharge Licence (Licence).

2. Winstone Wallboards Limited (Winstone Wallboards) is a wholly owned subsidiary of Fletcher Building Limited. It is the only New Zealand based manufacturer of what is commonly called plasterboard or "GIB®", and has been manufacturing in New Zealand since 1927. The company currently has two manufacturing sites (Auckland and Christchurch) and is currently developing a new manufacturing site at Tauriko near Tauranga, and produces the majority of plasterboard used in New Zealand.

3. [redacted]

4. Winstone Wallboards has approval from Christchurch City Council to discharge stormwater into the Christchurch City Council stormwater network under the Global Stormwater Discharge Consent (CRC090292). An Industrial Stormwater Audit was undertaken at the site in May 2019, finding that Winstone Wallboards has "very commendable controls and practices in place at present for stormwater management."

Reasons for submission:

5. This submission is made in support of the Draft Stormwater and Land Drainage Bylaw 2022.

6. Winstone Wallboards appreciated the opportunity to speak with Council at the information session on 1 February 2022, and acknowledges that Council staff are still developing and finessing technical elements.

7. However, Winstone Wallboards has concerns that a number of elements of the Bylaw and Licence have not yet been confirmed. This lack of clarity and detail creates uncertainty for businesses and industry should the Bylaw be adopted in May and come into force on 1 July 2022.

8. The main concerns that the submitter has with the Bylaw are:
   a. That stormwater quality standards under Clause 9 have not yet been thoroughly identified or justified;
   b. Uncertainty around the assignment of a risk classification under Clause 29 in terms of what parameters would form part of the risk assessment calculation/framework and how Council proposes to differentiate between low, medium and high-risk premises and define risk threshold profiles; and
   c. Lack of detail on the Industrial Stormwater Audit Programme set out in Clause 32 in terms of how often a site would be audited and against what parameters i.e. the sampling/testing and other information requirements, and the associated fees.

Decision Requested:

9. Winstone Wallboards seeks that Christchurch City Council continues to engage and consult with businesses and industry prior to the finalisation of standards, frameworks and processes associated with the Bylaw and Licence.

10. Winstone Wallboards requests that the Draft Stormwater and Land Drainage Bylaw 2022 and associated Industrial Stormwater Discharge Licence are adopted subject to the matters set out above.

Submission at Hearing:

11. Winstone Wallboards does not wish to be heard in support of their submission at a hearing.

DATED this 8th day of February 2022

Simon Cooper
Winstone Wallboards Ltd

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9 February 2022

Christchurch City Council
53 Hereford Street
Christchurch

CHRISTCHURCH CITY COUNCIL WATER SUPPLY, WASTEWATER AND STORMWATER BYLAW REVIEW 2022

Submitter: Christchurch International Airport Limited (*CIAL*).

CIAL **would** like to be heard in support of this submission.

Introduction

1 Thank you for the opportunity to comment on the Council's water supply, wastewater and stormwater bylaw review.

2 Christchurch International Airport (*the Airport*) is the largest airport in the South Island and the second-largest in the country. It connects Canterbury and the wider South Island to destinations in New Zealand, Australia, Asia and the Pacific.

3 Just under 7 million travelling passengers per year and their associated 'meeters and greeters' pass through the Airport.[1] Combined Airport activities see between 25,000 and 30,000 people visiting the Airport every day. The Airport is home to several international Antarctic science programmes and their associated facilities. The Airport is also the primary air freight hub for the South Island, playing a strategic role in New Zealand's international trade as well as the movement of goods domestically. On that basis, the Airport is a significant physical and economic resource in national, regional and local terms.

4 The activities at Christchurch International Airport make a significant contribution to the social and economic wellbeing to the communities and economies of Christchurch, Canterbury, the South Island and New Zealand. Airports have a strong multiplier effect on the economies they serve. Independent estimates indicate that for every $1 Christchurch Airport earns, the wider South Island economy earns $50.[2] The Airport's contribution to economic wellbeing is expected to grow nearly $4 billion

[1] Total in 2019 calendar year.

[2] "The shape of Christchurch in 2025, Christchurch International Airport and three economic growth scenarios" BERL, May 2014

by 2031. In the year ended March 2020 the Airport was estimated to contribute $3.02 billion to the GDP of the Canterbury region.

5 CIAL's core business is to be an efficient airport operator, providing appropriate facilities for airport users, for the benefit of both commercial and non-commercial aviation users and to pursue commercial opportunities from wider complementary products, services and business solutions.

6 CIAL owns the Airport terminal and the airfields, and approximately 859 hectares of land at the Airport campus. CIAL has installed and operates its own stormwater drainage and treatment system for the majority of its landholdings and also draws water and treats from its own bores, rather than from the municipal water supply. CIAL also has its own waste management services contract and waste minimisation programme

CIAL'S THREE WATER SYSTEMS

Stormwater

7 CIAL collects and treats all stormwater from its landholdings through its own management system. CIAL holds two resource consents from Environment Canterbury in respect of the stormwater:

7.1 An "landside" consent for discharges from the Airport campus (CRC210218 and CRC030496),

7.2 An "airside" consents for discharges from hardstand within the airfield, (CRC981129.2 and CRC151333).

8 CIAL's network meets the definition of "Private stormwater system" in the proposed Stormwater and Land Drainage Bylaw (*draft Stormwater Bylaw*).

9 CIAL has made a capital investment of approximately $9 million in developing this private system and continues to invest heavily in maintenance and upgrading of its land drainage system, which results in approximately $360,000 per annum in ongoing costs. CIAL maintains its private stormwater system to a high standard and has an excellent compliance record.

10 There are some Council-owned roads on the Airport campus. Stormwater discharges from those roads, drain to the Council's stormwater network.

Water Supply

11 CIAL does not take water from the Council water supply. CIAL has its own bores and network infrastructure providing a treated water supply to the Airport campus. CIAL recently made a capital investment of approximately $5 million to upgrading the existing system, to provide a world class secure UV and chlorine treated water supply. CIAL is proud to be one of the first community drinking water providers in the country to meet the Drinking-water Standards for New Zealand 2005 (Revised 2018).

Wastewater

12 CIAL owns and operates the wastewater management system on the Airport campus and terminal buildings, which services the Airport landholdings. CIAL discharges wastewater from its private network to the Council wastewater network.

NEW BYLAW STRUCTURE

13 The Council has proposed a new structure which splits the current bylaw into two separate new bylaws – one for water supply and wastewater, and the other for stormwater and land drainage.

14 CIAL generally supports the Council's proposals to split these matters into two bylaws and agrees that the stormwater network has distinct features compared to the wastewater and water supply networks.

DRAFT STORMWATER AND LAND DRAINAGE BYLAW 2022

Exception for stormwater discharges that remain under Environment Canterbury regulation

15 As explained above, CIAL owns and operates a private stormwater system to treat and manage the stormwater from both the airfield and wider Airport campus. CIAL operates this private system subject to resource consents granted by Environment Canterbury, which have recently been granted, and regulate all relevant potential and actual adverse effects.

16 Stormwater discharges at the Airport are to remain under the regulation of Environment Canterbury and will not transition to Council management as part of the implementation of the Council's Comprehensive Stormwater Network Discharge Consent.

17 CIAL therefore understands that, as per clause 35(1) of the draft Stormwater Bylaw, all stormwater discharges from the Airport landholdings managed via its Regional Council consents will be excluded from the requirement to apply for an Industrial Discharge Licence under clause 28. CIAL supports this proposed approach – it is an appropriate allocation of responsibility between councils, and avoids double handling.

Residual discharges from private stormwater systems

18 At the boundary of CIAL's landholdings (and indeed at the boundary of all land where there is a private stormwater system in place), there will likely be some de minimis, residual stormwater which flows into the Council stormwater network. It is not possible to establish a hard barrier between two stormwater systems – particularly at points such as (for example) road boundaries or driveways, where some rainfall may flow onto the road, even if the vast majority of stormwater is collected and managed via the private stormwater system on that site.

19 The draft Stormwater Bylaw is silent as to whether (and, if so, how) the Council seeks to manage this type of residual discharge. The benefit and utility of managing such minor discharges at the boundary of private and Council-owned systems is unclear. The discharge at issue is a de minimis portion of the overall stormwater

managed by either system. In the case of a private system, if the Council also required approval as a "catch all" for any residual discharge, the landowner would be burdened twice – once in operating and funding their own system, and a second time in having to apply (and pay associated fees) for Council approval to cover any residual discharge which might flow from the boundary of their land into the Council system. Where a landowner is operating a private stormwater system, they are required to manage the effects of their stormwater discharges and maintain and operate their private system appropriately. There would be very little environmental benefit in "double regulating" private stormwater systems in order to catch potential residual discharges. The administrative burden on the Council's part, and the additional burden on a landowner, would represent a cost.

20 Where private stormwater systems are not performing as intended, the draft Stormwater Bylaw appropriately provides for increased clarity and higher standards applicable to landowners who manage those private systems. Likewise, CIAL's resource consents contain appropriate conditions (including monitoring and review conditions) to manage stormwater discharges from CIAL landholdings. These mechanisms allow for a response to any failure in a private system's performance and would be the more appropriate avenue to address any discharge over the boundary from a private stormwater system into the Council's network, which was more than residual in nature, should that occur.

21 The costs of regulating residual stormwater flows at the boundary of Council-owned and private stormwater systems (in terms of enforceability, additional burden on Council processes and landowners, and risk of overlapping regulation) outweigh any marginal benefit that may be accrued.

22 CIAL seeks clarification that this type of residual discharge, at the boundary of a site that has a privately managed stormwater system, would not require additional approval under the draft Stormwater Bylaw.

DRAFT WATER SUPPLY AND WASTEWATER BYLAW 2022

Water supply

23 As it does not take any water supply from the Council network, CIAL is not affected by the water supply components of the Draft Water Supply and Wastewater Bylaw 2022 (*draft Supply and Wastewater Bylaw*).

Wastewater

24 CIAL owns and operates the private wastewater system for the entire Airport campus, which connects to the Council's wastewater system at two points.

25 Capacity constraints in the Council network currently also constrain CIAL's own network, with limits placed on flows from CIAL's outfall until Council capacity upgrades are complete. This presents a resilience issue for the Airport campus with engineering options required to keep at or below the capacity limits.

26 CIAL is therefore generally supportive of the clauses in the bylaw which will protect the Council infrastructure and enhance the Council's ability to maintain and build capacity in its network. CIAL considers that clauses 27 through 35 are appropriate.

Definitions and terms used to refer to private systems

27 The proposed definition of “private drainage system” in the draft Supply and Wastewater Bylaw, appears to capture all private networks, from the small-scale infrastructure required for a private dwelling through to large scale systems such as CIAL’s.

28 However, the phrase “private drainage system” does not appear in the text of any clauses in the draft Supply and Wastewater Bylaw. Clause 32, for example, uses the term “private wastewater drains”. The definition and use of defined terms for clauses applicable to private systems should be clarified and made consistent to avoid confusion.

CONCLUSION

29 Thank you for the opportunity to provide feedback on this Bylaw reform. CIAL would welcome the further opportunity to discuss its submission in due course at the hearing.

Yours faithfully

Felicity Blackmore

Environment and Planning Manager

[redacted]

Canterbury
District Health Board
Te Poari Hauora ō Waitaha

Submission on Water Supply, Wastewater and Stormwater Bylaw review

To: Christchurch City Council
53 Hereford Street, Christchurch Central City 8013

Submitter: Canterbury District Health Board

Attn: Rosa Verkasalo
Community and Public Health
C/- Canterbury District Health Board
PO Box 1475
Christchurch 8140

Proposal: The proposed approach is to split the current bylaw into two separate new bylaws – one for water supply and wastewater, and the other for stormwater and land drainage.

SUBMISSION ON

Details of submitter

1. Canterbury District Health Board (CDHB).

2. The submitter is responsible for promoting the reduction of adverse environmental effects on the health of people and communities and to improve, promote and protect their health pursuant to the New Zealand Public Health and Disability Act 2000 and the Health Act 1956. These statutory obligations are the responsibility of the Ministry of Health and, in the Canterbury District, are carried out under contract by Community and Public Health under Crown funding agreements on behalf of the Canterbury District Health Board.

3. The Ministry of Health requires the submitter to reduce potential health risks by such means as submissions to ensure the public health significance of potential adverse effects are adequately considered during policy development.

Details of submission

4. We welcome the opportunity to comment on the Water Supply, Wastewater and Stormwater Bylaw review. The future health of our populations is not just reliant on hospitals, but on a responsive environment where all sectors work collaboratively.

5. While health care services are an important determinant of health, health is also influenced by a wide range of factors beyond the health sector. Health care services manage disease and trauma and are an important determinant of health outcomes. However health creation and wellbeing (overall quality of life) is influenced by a wide range of factors beyond the health sector.

6. These influences can be described as the conditions in which people are born, grow, live, work and age, and are impacted by environmental, social and behavioural factors. They are often referred to as the 'social determinants of health[1].

[1] *Public Health Advisory Committee. 2004. The Health of People and Communities. A Way Forward: Public Policy and the Economic Determinants of Health. Public Health Advisory Committee: Wellington.*

General Comments

7. The Canterbury DHB supports the proposal and has a number of recommendations for consideration which would further improve health outcomes for the community.

Specific comments

8. The Canterbury DHB supports the objectives stated under Part 1: Water Supply – Objectives, particularly 4 (a), (b) and (c) as they contribute to protecting drinking water supply which has implications on public health.

9. The Canterbury DHB supports the objectives stated under Part 2: Wastewater – Objectives, as they contribute to reducing contamination including from blockages which compromise the wastewater/stormwater system.

10. Specific comments on the proposed Issues are detailed in the table below:

Section/ heading	Comments
Issue 1 and 2 Draft Bylaw Clause 18 and 9(4) Backflow prevention and pressure surges	11. The Canterbury DHB strongly supports the proposed solutions as these would contribute to managing the risk of contamination of the public water supply.
Issue 3 and 4 Draft Bylaw Clauses 9(6) and 9(5) Contamination of source water by aerial spraying and chemical spills	12. The Canterbury DHB strongly supports these new requirements, as protection of source water from contamination is an important measure to help ensure safe drinking water.
Issue 5 Draft Bylaw Clause 17 Rainwater storage tanks	13. The Canterbury DHB supports this measure as it contributes to resolving the issue of multiple requirements for water storage under different regulatory tools.
Issue 6 Draft Bylaw Clause 16(3) Wasting water	14. The Canterbury DHB supports this proposed solution as it promotes efficient use of a limited resource. However, the Canterbury DHB notes that it needs to be ensured that water users are not penalised when leaks and/or excessive water use

	are not under their direct control (e.g. a landlord of a property who refuses to repair water leaks on the property).
Issue 7 Draft Bylaw Clauses 19(4) and 19(5) Water meter inaccessible for maintenance	15. The Canterbury DHB supports the new additions to protect the accessibility of meters. However, the Canterbury DHB recommends that it be ensured that if, for any reason, the meter's location is not under the control of the householder or the property owner, there is an option for the Council to move or re-install the meter without charge.
Issue 8 Draft Bylaw Clauses 7-8 and 29-30 Insufficient access to water/wastewater networks for maintenance	16. The Canterbury DHB supports the proposed solution as it addresses a practical problem for the Council's access for maintenance of water and wastewater networks.
Issue 9 Draft Bylaw Clauses 9(7), 9(8) and 33 Damage to water/wastewater pipes from tree roots	17. The Canterbury DHB notes that with the proposed solutions, there is a risk of creating areas in which there are few or no trees, even though generally tree planting is supported. However, there are no issues identified with property owners being responsible for removing or trimming trees which are interfering with the network.
Issue 10 Draft Bylaw Clause 32 Prohibited materials entering wastewater network	18. The Canterbury DHB supports the strengthened provisions as they would provide greater clarity about what may be disposed of into the wastewater network and help prevent blockages.
Issue 11 Draft Bylaw Clause 32 Damaged or broken private wastewater drains causing infiltration	19. The Canterbury DHB supports the new requirements as they contribute to preventing avoidable capacity issues in the wastewater network.

Issue 12 Draft Bylaw Clause 27 Applications/approvals for connection to the wastewater network	20. The Canterbury DHB supports the new clause as it will improve clarity for applicants and consistency in how applications are processed and handled.

Conclusion

21. The CDHB does not wish to be heard in support of this submission.

22. If others make a similar submission, the submitter will not consider presenting a joint case with them at the hearing.

23. Thank you for the opportunity to submit on Water Supply, Wastewater and Stormwater Bylaw review.

Person making the submission

Dr Cheryl Brunton Date: 9/02/2022

Medical Officer of Health/Public Health Specialist

Contact details

Rosa Verkasalo

For and on behalf of
Community and Public Health
C/- Canterbury District Health Board
PO Box 1475
Christchurch 8140

[redacted]

Submission #44768

NZ Association of Metal Recyclers, Inc

PO Box 16 0020, Hornby, Christchurch 8441 P:(03) 344 3006 E: gm@nzamr.org.nz W: www.nzamr.org.nz

9 February 2022

Hannah Ballantyne
Engagement Advisor
Stormwater & Land Drainage Bylaw Feedback
Christchurch City Council
PO Box 73 016
Christchurch 8140

Dear Hannah

This is the submission/feedback of the New Zealand Association of Metal Recyclers, a not-for-profit industry body representing member companies which collect, process, use and export metal commodities.

Please note that we are only commenting on the aspects of the Draft Stormwater & Land Drainage Bylaw document that are relative to our concerns for our members and industry.

- **Interpretations**

We are concerned that some of the interpretations used are too vague and may create confusion and/or an unnecessary burden. For example:

Earthworks *means any mechanical excavation, or substantial manual excavation, such as levelling, filling, retaining, contouring or landscaping a site; and includes moving, removing, placing or replacing earth, rock or soil.*

The use of the term 'any mechanical excavation' is too encompassing, likewise the general use of the word 'landscaping' is also too encompassing. Poorly defined interpretations such as these have the potential to create a significant administrative burden on a business which, under this interpretation for example, would be required to develop an Erosion and Sediment Control Plan just to plant a tree on their site.

We recommend revising the interpretations to better reflect the intention of what will be truly required by business operators. Well defined interpretations in the new bylaw will be critical to ensuring everyone understands their obligations and rights.

- **Specific Clauses**

7.(1) The Council may, at any time, review a stormwater connection or stormwater discharge approval, and any associated conditions

While this clause does have an explanatory note included in the draft, it is also noted in the draft that explanatory notes are NOT part of the bylaw. Given this, our concerns are that this clause, as it is simply written, is too open. The council should not have the ability to undertake a review without just cause (especially at the applicant's cost) and such causes should be included in the bylaw, so it is clear to all.

9.(1) The Council may, by resolution, specify standards for discharges to the stormwater network.

We are concerned that there appears to be no consultation involved in this process. If the council is going to set, and impose standards, then consultation should be a requirement to ensure that a robust outcome is achieved. Given that **clauses 9(2) -9.(4)** then detail the obligations of the occupiers to comply with the standards, and the powers of the council in regards to this, then consultation should be a part of the process of setting any new standards.

10.(2) The Council may require the implementation of specific site management practices to manage discharges from all or part of the property.

We are concerned that this clause, as it is currently written, gives too much power to the council and may result in onerous and impractical requirements for the occupier. Any site management practices that are considered necessary for the site should be discussed with the occupier first and consideration should be given as to whether the practice is practicable for the site.

While the council will be in a good position to make suggestions on various site management practices, as they do not run the business, they will not be able to decide if the practice is feasible for it. For example, performing various activities undercover may seem like the best site management practice from the council's perspective, however this option may not be economically viable or practical for the occupier due to several issues that moving the activity undercover would create. Consultation is needed, and should be included in this clause, along with the recognition that any site management practices that are required will be given a timeframe in which the occupier can implement them.

17.(3) No person may, without the Council's written approval under this bylaw, carry out the following restricted activities:
(a) Build, place or install, or allow to be built, placed or installed, any structure (other than a boundary fence), over or within a Maintenance Access Corridor;

This clause has a lengthy explanatory note attached to it, however, as explanatory notes do not form part of the bylaw, and as parts of this note are also of concern, we feel that less restrictions should be included. Specifically, the use of the term ‘placed’ and the lack of acknowledgement that reinstatement will be made by the council.

While we recognise the need for the council to be able to access the network, where this network is underground on non-council land, the clause should not be worded to unreasonably restrict the occupier’s use of the land. There should be no restriction on the occupier *placing* or *storing* items on their land (e.g., containers, storage tanks) so long as such structures can be readily moved to allow the council access to the network.

Furthermore, the bylaw should include in this clause the recognition that the council will reinstate the areas utilised for access to the same or equivalent condition that it was prior to their use of the area.

19.(1) No person may cause or allow any prohibited substance to:

Our main concern here is that there is no detailed list of prohibited substances provided. This should be included as part of this bylaw. While it is easy to state that ‘only rainwater’ should be permitted into the stormwater network, this is not helpful in aiding occupiers to understand their obligations and to assess their sites for risk.

25.(3) If the Council believes that stormwater drains on private property are damaged, blocked, or otherwise not in a satisfactory operating state, the Council may require the property owner to investigate the drain and rectify any issues, at the owners cost.

We feel that this clause is unreasonable as it does not require the council to provide evidence for their concerns. Given that the costs of investigating the drains is borne by the owner then it is reasonable to expect the council to provide evidence for their belief that the state of the drains require investigation.

Furthermore, we query why the occupier should bear the costs of the investigation (including those listed in **Clause 25.(4) (a) and (b)**) if the result of the investigation shows there is no issue with the drains and the council’s concern was misplaced. In this instance the cost of investigation should be borne by the council.

29.(1) The Council will assign a risk classification to an industrial premises based on the information provided by the occupier in the application for an Industrial Stormwater Discharge License, and on any other relevant information.

It would be helpful if the bylaw provided some information on how each industry was assessed, especially for those industries that have been assessed as high risk. This would provide occupiers with better information for understanding the risks associated with their industry, and for recognizing what information might be useful for them to supply as part of their application -i.e., for high risk industries, occupiers will be able to see the risks for their industry as determined by the council and if their site has put in measures to address these risks then they can supply the necessary information in their application to demonstrate these measures.

29.(4) When a risk classification has been confirmed, the occupier must pay any applicable Industrial Stormwater Discharge License fee.

It is our understanding that the fees being proposed are:

High Risk Sites	$3,358.00/pa
Medium Risk Sites	$ 335.00/pa
Low Risk Sites	No Charge

We have several concerns regarding the fees as we are struggling to understand how justification can be made to charge high risk sites over TEN TIMES the annual fees of a medium risk site, and how a low-risk site will incur NO fees at all?

We understand that the increased fee for high-risk sites is loosely based upon the time investment required by council officers to work with the occupier to help them improve their stormwater discharge. While we acknowledge that more time will likely be required to work with some of the high-risk sites, this will not be true of *all* of them, and yet they will all be subjected to this fee.

Furthermore, as the council has only managed to work with 100 high risk sites since 2016 -so a rate of roughly 20 sites per year -we are concerned that a large amount of occupiers who are classified as high risk by the council will bear the cost of this annual fee for possibly years before they receive the time investment they are being charged for.

Given that industries have already been allocated their risk level by the council, and the onus is on occupiers in high-risk industries to prove their risk level is lower than their industry classification, this fee structure is particularly unfair. If an occupier is unable to get approval from the council to move lower on the scale of risk without an audit, (having *already* had to pay additional fees for a re-assessment) and this audit can't happen for several years due to a lack of council resources, why should the occupier bear the burden on an annual basis of such a high fee?

This current fee structure bears the hallmarks of a 'polluter pays' approach, without a fair and reasonable approach of how the 'polluter' is determined. An occupier in a high-risk industry is not necessarily a high-risk operator but will potentially be treated as such until they prove otherwise - basically guilty until proven innocent.

And while we understand the need for a hierarchy, are we to assume based on the lack of a fee that low risk sites will *never* be audited or checked by the council? Surely at some point these businesses will need to be checked. **Clause 29.(5)** states that all licensed industrial premises will be included in the council's Industrial Stormwater Audit Programme so how is the council justifying a 'no charge' approach for these industries?

31.(1) The Council may review an Industrial Stormwater Discharge License (including its risk classification or conditions) at any time.

We are concerned by the words '*at any time'* in this clause. While the explanatory notes suggest a number of reasons as to why a review would be triggered, these are not currently part of the bylaw. We believe that the words '*at any time'* should be removed and replaced with a list of reasons as to why a review can be reasonably triggered by the council, *especially* given that the costs associated by any review would be borne by the occupier. It is unreasonable to give the council the right to review a license 'at any time' without a justifiable reason to do so.

33.(2) Monitoring and inspections may include, at the discretion of an authorized officer;
(a) entering the premises; and

This clause should be amended to acknowledge that entering the premises should be done after giving notice to and/or booking a time with the occupier to do so. Given that many sites will have a range of health and safety requirements for visitors to meet, officers should not turn up unannounced at any site.

36.(4) The Council may require the payment of an additional fee to meet the actual costs of any monitoring, lab costs or sampling costs.

Given the annual fees payable by license holders, we do not believe the council is justified in seeking payment from occupiers for the costs associated with monitoring and inspections -this is what the annual fee is charged for! It is unreasonable to charge a license holder an annual fee to be a part of the Industrial Stormwater Audit Programme and then to further charge them for the work involved in monitoring their compliance.

We would be happy to speak further on these matters with the Hearings Panel and to answer any questions they may have about our submission.

Kind regards

Suzanne Billsborough
President

4SIGHT CONSULTING

9 February 2022

Hannah Ballantyne
Engagement Advisor
Christchurch City Council

Submitted via online form

Dear Hannah,

RE: SUBMISSION TO THE DRAFT STORMWATER AND LAND DRAINAGE BYLAW 2022

1. Introduction

1.1 This submission is lodged on behalf of BP Oil New Zealand Limited, Mobil Oil New Zealand Limited, and Z Energy Limited (*the Fuel Companies*).

1.2 Within Christchurch City, the Fuel Companies have bulk petroleum storage facilities, retail outlets, and are suppliers of petroleum products to individually owned retail outlets and commercial clients.

1.3 This submission is focussed on the issues the Fuel Companies perceive may inappropriately restrict existing and future operations.

1.4 In parallel, the Fuel Companies are inputting to the development of the risk matrix under the Comprehensive Stormwater Network Discharge Consent (*CSNDC*) held by Christchurch City Council (*CCC*). The Fuel Companies' response to the latest drafts of the risk matrix are at Appendix 1 and should be read in conjunction with this submission, noting the important links between the matrix and the bylaw.

1.5 The Fuel Companies wish to be heard in relation to this submission.

2. Background to management of stormwater by the Fuel Companies

2.1 Discharges from petroleum industry sites are addressed in the Environmental Guidelines for Water Discharges from Petroleum Industry Sites in New Zealand (Ministry for the Environment, 1998, *the Guidelines*). The Guidelines provide specific measures to ensure water discharges from petroleum industry sites do not cause significant adverse effects on the environment. They were prepared by a working group comprising industry, central, and regional government and continue to be widely recognised as good practice. This is reflected in their wide recognition in plans around the country, including in the Auckland Unitary Plan (Chapter E33) and the Waikato Regional Plan which both provide a permitted activity pathway for stormwater discharges from Guideline compliant sites.

2.2 Discharges from service station forecourts are Category 2 discharge under the Guidelines. This reflects that there is potential for stormwater to contain oil contaminants and that these require appropriate treatment prior to discharge. The Guidelines require that these areas be directed by appropriate surface grading into grated sumps/gutters/rain gardens leading to drainage systems or treatment devices prior to discharge. If not within the forecourt, tank fill points must be similarly treated.

2.3 The Guidelines set out detailed criteria for sizing of treatment devices based on local rainfall intensity and require that separators have the capacity to contain a 2,500-litre spill of hydrocarbons – the maximum credible spill. Devices which use gravity separation are recognised as the most practicable option to remove oil from water and achieve the desired discharge quality. The Guidelines explain the methodology and results of the trial of an American

LAND. PEOPLE. WATER.

Petroleum Institute (API) separator. That exercise confirmed that the API could retain a 2,500litre spill with the outlet valve in the open position while also achieving a discharge quality of less than 15milligrams per litre of total petroleum hydrocarbons. A SPEL separator has been similarly tested and subsequently certified by the former Auckland Regional Council as being compliant with the Guidelines. Both SPEL and API devices are now widely used around the country.

2.4 The Guidelines recognise that the maximum levels of contaminants allowable in discharges are 15 and 100 milligrams per litre (*mg/L*) for total petroleum hydrocarbons (*TPH*) and total suspended solids (*TSS*) respectively (when averaged over the design storm event) and that operating within these limits will ensure minimal adverse toxic effects. The Guidelines draw parallels to roads and highlight that monitoring has demonstrated that discharges from such sites are no worse (and often better) than discharges from roads and high turnover car parks.

2.5 In terms of effects, the Guidelines refer to modelling work demonstrating that typical oil discharges will have no significant adverse effects on receiving water, except for at the most sensitive sites.

2.6 Coupled with the physical components at the Fuel Company sites to manage stormwater runoff quality and the risk to receiving environments from accidental spills are procedural documents specifying maintenance frequency for site stormwater systems and oil and water separator devices. Typically, these procedures document matters such as oil and water separator inspection and cleanout frequency as well as spill response procedures and requirement for clean out and disposal in the event of a spill.

2.7 In summary the Guidelines are embedded in the Fuel Companies' operations and are widely accepted as good practice for management of sites which store and use petroleum hydrocarbons. This means that Fuel Company site operations which present potential risk to stormwater runoff contamination leading to discharges to surface water or groundwater are mitigating those risks through the key mechanisms:

i) Segregation of fuel transfer activities from balance site areas using site contouring, bunding and dedicated drainage systems;

ii) The operation and maintenance of oil and water separators deigned to treat TPH and TSS entrained in stormwater runoff to a maximum discharge standard of 15mg/L and 100mg/L respectively while also providing for spill containment up to 2,500L; and

iii) Site practice and procedures documenting matters such as maintenance inspection and clean out frequency for the oil and water separators and steps that should be taken in the event of an accidental spill.

3. General reasons for submission

3.1 The Fuel Companies acknowledge that the draft bylaw is proposed to be used as a tool to assist with contributing to the receiving environment outcomes required under the CSNDC held by Christchurch City Council CCC. However, for the reasons set out below, the Fuel Companies oppose several aspects of the draft bylaw which they do not consider are appropriate for achieving those outcomes or protecting the network.

i) Consultation on the draft bylaw is occurring concurrently with development of the risk matrix[1] under the CSNDC, including with the liaison group required under that consent. The Fuel Companies disagree with several aspects of the latest draft of the risk matrix provided to the liaison group, including the points system which as drafted will mean that retail service stations and facilities such as truck stops are at best classed as high risk.

ii) Consistent with evidence presented to the independent hearings panel for the CSNDC, the Fuel Companies maintain that retail service stations and truck stops designed, operated and maintained in accordance with the Guidelines do not present a high risk to stormwater discharges.

[1] Refer Condition 3 of the CSNDC

iii) The Fuel Companies' concern with the same are reinforced by the annual licence fee of $3,358 for high-risk sites. Across a combined retail network of approximately 72[2] sites, this is a significant cost and one that is not commensurate to the level of risk to stormwater quality. Further there is no justification for the cost of the annual licence fee where other jurisdictions are considerably less and it is unclear what the licence duration will be.

3.2 The Fuel Companies seek that the revision of the bylaw be suspended pending development of an appropriate risk matrix to incorporate into the bylaw.

4. Specific reasons for submission

4.1 The Fuel Companies seek the bylaw be suspended until the draft risk matrix has been finalised appropriately through Condition 14 of the CSNDC and reviewed by the Stormwater Technical Peer Review Panel. However, if CCC chooses to proceed with the bylaw review in parallel then the Fuel Companies have the following concerns with the current provisions.

Section 5 – Interpretation

4.2 The definition for 'Risk Classification' does not currently include reference to the CSNDC risk matrix. The CSNDC risk matrix document is fundamental to the derivation of risk relevant to the network and the corresponding status for dischargers applying for Industrial Stormwater Discharge Licences under the bylaw. The current wording implies that the level of risk is at CCC's discretion and does not recognise that a consultative process has been established through Condition 3 of the CSNDC requiring CCC to require development of a risk matrix for just this purpose.

4.3 As expressed to CCC through consultation on the risk matrix, the Fuel Companies are concerned that CCC appears to be considering the risk matrix only as a transitional measure. The Fuel Companies' view is that the matrix is a fundamental tool for ongoing management of the network and that this is clearly reflected in the CSNDC and in CCC's position at the hearing re the same.

Section 9 – Stormwater Quality Standards

4.4 Section 9 addresses stormwater quality but does not appear to be linked to the operational requirements the stormwater network within the remit of the LGA. Further, there is no terms of reference regarding what stormwater quality standards would be applied, including if a site were to be audited under Sections 32 and 33 of the bylaw, and how stormwater quality standards would be reasonably applied within a best practicable option framework typically applied to contaminant source control and stormwater contaminant treatment methodologies. For example, the ANZ[3] guidelines are typically applied for freshwater and marine receiving environments. If Section 9 is retained, specification of the ANZ guidelines or other recognised guidelines (e.g. industry specific MfE Guideline) would assist in providing certainty for users of the bylaw, including allowance for matters such as reasonable mixing.

Section 10 – Requirement for onsite stormwater management

4.5 Section 10(1) should reference the application of the best practicable option when referring to the requirement for stormwater devices. This will recognise that subject to typical sizing methodology, diminishing returns are observed relative to marginal improvements in treatment efficiency and additional cost of constructing and operating the treatment devices.

Section 19 – Prohibited substances must not enter the stormwater system

4.6 The explanatory note for Section 19 appears absolute in its application for prohibiting various substances from entering the stormwater network such that all stormwater running off pervious and impervious surfaces (including roads) would not be able to comply given the existence of contaminants such as sediment in varying concentrations, including from non-anthropogenic sources.

[2] Across the BP, Mobil, Z Energy, and Caltex networks

[3] Australian & New Zealand Guidelines for Fresh and Marine Water Quality, www.waterquality.gov.au/guidelines/anz-fresh-marine

Section 22 – Erosion and Sediment Control Plan

4.7 Section 22 appears to enable construction phase stormwater discharges to the stormwater network subject to the implementation of erosion and sediment control plans. The Fuel Companies periodically undertake earthworks (e.g. minor maintenance, tank removals, pipe upgrades) and acknowledge the need for the development, installation, and maintenance of erosion and sediment control measures for earthworks activities and seek to confirm that subject to the same, CCC will provide its permission for these discharges. This is important to the application of Rule 5.93A of the Canterbury Land and Water Regional Plan which only provides for construction phase stormwater discharges as a permitted activity subject to permission from the owner of the reticulated system. The Fuel Companies' experience to date is that CCC will not provide its permission for the same which necessitates a regional consent requirement, irrespective of risk to the network.

Sections 28 and 29

4.8 The proposed matrix does not recognise that, unlike a range of other contaminants and industrial activities, the key contaminants at petroleum industry sites can be appropriately managed by way of oil-water separators and that well maintained API and SPEL devices have been demonstrated to achieve a high standard of mitigation for hydrocarbons and sediment (relative to the low sediment loads from the forecourts). This has been investigated and reported by PDP and URS (Refer Appendix 2), and the Auckland Council at catchment level. The degree of mitigation provided by these devices is recognised in a potential permitted activity pathway for Guideline compliant discharges in the majority of regional plans around the country, including the Auckland Unitary Plan.

4.9 The Fuel Companies presented evidence at the CSNDC hearing regarding how their networks of retail fuel outlets are designed and operated to manage stormwater risks. The intent of this evidence was to demonstrate to the hearing panel (and CCC) that sites operating in accordance with the Guidelines are good practice and do not present a high risk to the CSNDC. The Fuel Companies understood from the evidence of CCC's experts that there was some agreement with this view and that CCC's expert's concerns were regarding how CCC might ensure ongoing compliance with the same. Unfortunately, this is not reflected in the draft risk matrix.

4.10 The scoring system proposed by CCC would categorise typical Guideline compliant retail fuel outlets of any size as high risk and result in an annual licence fee of $3,358 per site based on the current draft bylaw. This is a significant financial and compliance burden across a significant network in the opinion of the Fuel Companies is not commensurate to the stormwater risk profile presented by sites operating in accordance with the Guidelines.

4.11 In summary, the Fuel Companies seek incorporation of an appropriate risk matrix into the bylaw that is in turn reflected in an appropriate licencing regime that is commensurate with risk for petroleum industry sites designed and operated in accordance with the Guidelines.

Register of Industrial and Trade Activities

4.12 The Register of Industrial and Trade Activities table in the draft bylaw is duplicated in the latest draft of the risk matrix. Through the industry liaison group, the Fuel Companies have set out particular concerns with the approach to the table. Regarding the site area threshold, the focus on the entire site area rather than the particular area that may generate stormwater contaminants is not risk based with no clear allowance for non-contaminant generating areas such as landscaping, buildings, or vehicle manoeuvring areas which are no different to comparable areas on non-industry sites and which should be addressed consistently across the stormwater network. Further, there appears to be no justification for how the site area thresholds have been set, noting a zero threshold has been applied to all retail service stations and truck stops.

4.13 Chapter E33[4] of the Auckland Unitary Plan addresses these matters this by defining the activity area as follows:

[4] Chapter E33. Industrial and trade activities, Auckland Unitary Plan, Operative in Part.

Industrial or trade activity area

The area of land or coastal marine area where a particular industrial or trade activity is being undertaken, which may result in the discharge of environmentally hazardous substances associated with that activity onto or into land or water.

The calculation of the industrial or trade activity area must be based upon the following areas:

- *all roof areas onto which environmentally hazardous substances generated by the activity are deposited;*
- *all outdoor storage, handling or processing areas of materials and/or products that may contribute to the quality or quantity of environmentally hazardous substance discharges (including occasional or temporary use of areas);*
- *the area at risk from failure of the largest unbunded container used for the activity that may contribute to the quality or quantity of environmentally hazardous substance discharges: and*
- *all areas (including roofs) that contribute runoff to the Industrial or trade activity area.*

The calculation of the industrial or trade activity area excludes the following areas:

- *all areas that discharge lawfully into an authorised trade waste system;*
- *areas that are not used for or affected by the industrial or trade activity;*
- *all indoor or roofed areas which do not discharge onto or into land or water; and*
- *areas used for the storage of inert materials, provided that if suspended solids are generated by the materials and entrained in stormwater, the stormwater from such*
- *storage areas is treated in accordance with the best practicable option or is otherwise*
- *lawfully authorised.*

5. Relief Sought

5.1 That the bylaw review be suspended until development of the risk matrix between CCC and the Industry Liaison Group has been resolved appropriately. Specifically, this should include recognition that service stations and truck stops designed and operated in accordance with the Guidelines are not high risk.

5.2 In the alternate, if the CCC proceeds with the bylaw review, then the following relief is sought:

i) Amend the definition of Risk classification to include reference to the risk matrix. The risk matrix is a key document to define risk in the context of the Industrial Stormwater Discharge Licence and is a transparent means of assigning risk with limited ability for Council discretion. Proposed wording is as follows:

Risk Classification *means the level of risk for stormwater contamination, as assessed by the* *CSNDC Risk Matrix.* ~~*Council, based on the activities and practices of an industrial premises.*~~

ii) Add a definition of activity area or comparable term to define the area(s) of an industrial and trade activity that may present particular risk to stormwater to differentiate from other areas that are consistent with non-industrial activities. Other contaminants arising on such sites, for instance zinc from tyres and copper from brakes, are not unique to the activities undertaken and should be controlled at source (e.g. through the specification of alternative vehicle borne contaminant sources, inert building materials) or more broadly, for instance through treatment at a catchment wide level, not targeted to industry through the risk matrix. This definition should provide for similar outcomes to the Auckland Unitary Plan definition outlined above, thereby excluding areas of a site which are inert such as landscaping and roofs, or areas of a site where the industrial activity is not taking place. Consequential changes are also sought to replace the 'Site Area Threshold' in the Register of Industrial and Tade Activities with 'Activity Area Threshold'.

iii) Amend Section 10(1) as follows:

Section 10 – Requirement for onsite stormwater management

The Council may require a stormwater device representing the best practicable option to be retrofitted to manage the stormwater quality or quantity being discharged from a property.

iv) Amend Section 19 as follows to define the purpose of the section and emphasise the potentially physical effects on the network of discharging prohibited substances:

(1) No person may cause or allow any prohibited substance that may adversely affect the operation of the stormwater network to.

v) Incorporate the risk matrix in Sections 28 – 31 such that it is the mechanism for determining risk and corresponding Industrial Stormwater Discharge Licence requirements. The risk matrix should recognise that Guideline complaint sites are not high risk and should be included as a schedule to the bylaw.

vi) Amend Section 32 of the bylaw to require submission of an operational stormwater management plan, including stormwater monitoring and maintenance records to CCC upon request. This could be achieved by amending section 32 as follows:

32 Industrial Stormwater Audit Programme

Explanatory note: Any ~~Every~~ occupier can ~~holding an Industrial Stormwater Discharge Licence (including High Risk by default premises) will~~ be included in the Industrial Stormwater Audit Programme.

(2) The occupier of an industrial premises must co-operate with the Council's Industrial Stormwater Audit Programme, including, but not limited to:

a) enabling access to enter the premises;

b) upon request, providing an operational stormwater management plan, including any stormwater monitoring results and maintenance records from the previous 12 months, ~~documents, plans and other information~~; and

c) enabling on-site sampling and testing.

vii) Amend Section 22 to explicitly recognise that construction phase stormwater from sites lawfully connected to the network can be discharged subject to appropriate erosion and sediment control measures and avoid regional resources consent requirements under Rule 5.93A of the Canterbury Land and Water Regional Plan. This could be achieved by amending Subsection 4 as follows:

(4) Any person undertaking earthworks must submit ~~make~~ an ~~the~~ Erosion and Sediment Control Plan ~~available~~ to the Council ~~on request~~.

Explanatory note:

Submitting an Erosion and Sediment Control Plan to the Council is deemed to constitute an approval as directed by Rule 5.93A of the Canterbury Land and Water Regional Plan.

6. The Fuel Companies wish to be heard in support of this submission.

Dated in Auckland this 9th February 2022.

Signature on behalf of The Fuel Companies,

Trent Sunich
Principal Environmental Consultant
4Sight Consulting Ltd
[redacted]

Appendix 1: Fuel Companies correspondence with CCC regarding the draft CSNDC Risk Matrix

Trent Sunich

From:	Mark Laurenson
Sent:	Thursday, 19 August 2021 2:53 pm
To:	Norton, Brian
Cc:	jenny.watters@ecan.govt.nz
Subject:	OilCo response re draft matrix - email 1 of 2
Attachments:	Proposed CSNDC Risk Matrix for ILG 2021-06-17 - OilCo tracked changes.pdf; Proposed CSNDC Risk Matrix for ILG 2021-06-17 - OilCo tracked changes.docx
Importance:	High

Good afternoon Brian

Thank you for the opportunity to input to the proposed matrix. Detailed comments are included below and in the attached. A second email will follow with the technical reports referenced below. Please confirm receipt.

Firstly, review of the risk matrix cannot occur in isolation and requires the context of the draft Stormwater Bylaw which the matrix documentation references. This will allow the parties to understand how the matrix will interact with those requirements.

Setting that aside, Z Energy Limited, BP Oil New Zealand Limited, and Mobil Oil New Zealand Limited (*the Oil Companies*) anticipated that the matrix would draw on a range of sources to inform risk relating to the key contaminants or substances used and handled by the listed industries/activities. To target the specific industry contaminants the Oil Companies expected issues/events and monitoring data for the relevant catchments, industry good practice, and relevant research undertaken in relation to particular activities and contaminants to be taken into account and reflected in the approach. As relevant to activities undertaken by the Oil Companies, that research includes:

- URS, 2008 – Stormwater and Sediment Monitoring Data from Service Stations and Control Sites in the Auckland Region.
- PDP, 2013 – Stormwater Treatment Devices Monitoring at Representative Z Service Stations in the Auckland Region.
- Auckland Council, 2016 - Technical Report TR2016/010 - The Management of Hydrocarbons in Stormwater Runoff: A Literature Review
- PDP, 2017 – Performance Monitoring of Stormwater Treatment Devices at Z Moorhouse
- Golder Associates, 2019 – Contaminant Load Profiles on Service Stations and Adjacent Roads in Auckland.

These reports, and a 2019 summary report prepared by PDP in relation stormwater discharges from service stations and truck stops, will follow in a second email and have been discussed with Council previously.

The Oil Companies are concerned that the proposed matrix is not risk focused and will lead to consideration of petroleum industry sites that are designed and operated in accordance with good practice being considered high risk (at best). The rationale for this approach is not justified and concerns re this same point was set out in detail through submissions and evidence on behalf of the Oil Companies in relation to the network discharge consent. The approach introduces potential to impose significant costs associated with (as yet unspecified) monitoring and compliance which cannot otherwise be justified. Feedback is provided by way of tracked changes and comments to the draft matrix as circulated with a number of specific matters also addressed below.

The rationale for the proposed activity types and scales and corresponding credit/points that form part of the matrix are particularly unclear. Both the categories and thresholds appear to be arbitrary and not reflected by risk from the specific activities to the network or to the environment. For instance, in terms of activities in Table 1 of the proposed risk matrix, the storage and handling of hydrocarbons undertaken by the Oil Companies at terminals will fall to be considered under bulk storage and handling centres. The corresponding activity area threshold to achieve a is 2,000m2. A zero threshold will apply for refuelling facilities. Those thresholds will not provide for any of the activities undertaken by the Oil Companies. The effect is to remove the potential for such activities to benefit from the 15 point reduction proposed for activities compliant with the threshold and in itself is the difference between a site starting at 100 points and unacceptably high risk and 85 points and medium risk.

In contrast to the 15 points of credit on offer for compliance with activity area thresholds, only 3 points are proposed for compliance with the Environmental Guidelines for Water Discharges from Petroleum Industry Sites in New Zealand (Ministry for the Environment, 1998, *the MfE Guidelines*). This is despite the MfE Guidelines being specific to management of the key contaminants of concern related to petroleum industry activities (hydrocarbons) and extending from site design through ongoing operation and maintenance. The proposed matrix does not recognise that, unlike a range of other contaminants and activities, the key contaminants at petroleum industry sites can be appropriately managed by way of oil-water separators and that well maintained API and SPEL have been demonstrated to achieve a high standard of mitigation for hydrocarbons. This has been investigated and reported by PDP and URS at a site and Auckland Council at catchment level. The degree of mitigation provided by these devices is recognised in a potential permitted activity pathway for MfE Guideline compliant discharges in the majority of regional plans around the country, including the Auckland Unitary Plan which is specifically referenced but which takes a very different approach.

The rationale for other credits is also unclear. For instance credit appears to be offered for activities undertaken in weatherproof enclosures when it would seem that activities in these areas should not be considered activity areas relevant to stormwater discharges if there is no risk of a hazardous substances being entrained by stormwater. In contrast, service station canopies which reduce potential rainfall on areas where hydrocarbons are used, would not receive credit.

Credits for "first flush" treatment in relation to petroleum industry sites fails to recognise that the key contaminants of concern are hydrocarbons and appropriately addressed via oil-water separators. Other contaminants arising on such sites, for instance zinc from tyres and copper from brakes, are not unique to the activities undertaken and should be controlled at source or more broadly, for instance through treatment at a catchment wide level, not targeted to industry through this matrix. To do otherwise is inequitable and imposes disproportionate costs on these activities which in fact generate contaminants at significantly lower levels than surrounding roads for instance, as demonstrated by the Golder Associates report.

Despite the importance of oil-water separators in managing risk at petroleum industry sites, no credit for that spill control is provided on the basis that this is already deemed by Council to be required by the Stormwater Bylaw 2014. This fails to recognise that that they are the key determinant of risk at petroleum industry sites and that they have proven to be very effective at managing risk to the environment. As set out in Technical Report TR2016/010, TPH is not a significant environmental issue in Auckland.

Apart from excluding sites deemed to have an unacceptable risk, the proposed matrix provides no clarity regarding requirements and obligations that will be placed on discharges in other risk categories. Further information is required in this regard and it is requested that a copy of the draft Stormwater Bylaw be provided so that the parties can understand how this matrix will interact with those requirements.

Regards

Mark Laurenson
Principal Planner & Auckland Planning Manager

[redacted]
4Sight.Consulting   LinkedIn

From: Norton, Brian <Brian.Norton@ccc.govt.nz>
Sent: Thursday, 17 June 2021 2:14 PM
[redacted]

Submission #44770

[redacted]

Subject: RE: CCC Industrial Liaison Group Meeting - DRAFT Minutes and Presentation

Dear Industrial Liaison Group Members,

Following on from our first Industrial Liaison Group Meeting in December of last year, please find attached our DRAFT proposed Industrial Site Risk Matrix for transitional sites as required under Condition 3(b) of Council's Comprehensive Stormwater Network Discharge Consent. Please have a look and provide any comments back to us in writing prior to 5PM on 19 August 2021. I've left the document in WORD format in case you would prefer to track comments or changes into the document.

Let me know if you have any questions around the process or have any trouble with the document.

Kind Regards,

Brian Norton
Senior Stormwater Planning Engineer
Asset Planning-Stormwater&Land Drainage

03 941 8394
Brian.Norton@ccc.govt.nz
Te Hononga Civic Offices, 53 Hereford Street, Christchurch
PO Box 73014, Christchurch 8154
ccc.govt.nz

Christchurch City Council

Trent Sunich

Subject: RE: CSNDC - Post liaison meeting follow up

From: Mark Laurenson
Sent: Tuesday, 11 January 2022 2:18 PM
To: Norton, Brian <Brian.Norton@ccc.govt.nz>
[redacted]
Subject: CSNDC - Post liaison meeting follow up

Hi Brian

At the liaison group meeting late last year it was discussed that CCC would provide the detail of the experts on the TPRP group and provide a copy of the TPRP's first review of the draft risk matrix. It would be appreciated if you could flick that through this week.

In terms of condition 3 (risk matrix and transition plan) and next steps, the Oil Companies' interpretation of the process required by condition 3b is provided below. We understand that CCC is now to provide the minutes and points of agreement and disagreement (3(b)(iv)) no later than 16 January 2022 and any further changes proposed to the matrix at least 2 months prior to submission to the regional council.

(i) Draft matrix provided 17 June 2021
(ii) Comments requested by 19 August 2021
(iii) CCC response provided 19 November 2021, meeting scheduled for 16 December 2021
(iv) Minutes and points of agreement and disagreement between the parties to be provided by 16 January 2022 (to be provided by CCC)
(v) Any changes to the draft risk matrix to be provided to the industry liaison group for feedback no less than 2 months prior to being submitted to the regional council (to be provided by CCC, assuming amendments)

In addition, the Oil Companies note that condition 14(a) appears to require any amendments to the risk matrix to be reviewed by the TPRP (i.e., it is not just a review of the first draft). This intent is reinforced in the closing legal submissions of CCC at the hearing, where Mr Pizzey clearly addresses the review of the matrix post comments from the liaison group (see paragraph 93 of his closing submissions, which are attached).

To help inform CCC's preparation of minutes and its next steps, key outstanding concerns of the Oil Companies re the proposed risk matrix are summarised below. This should be read alongside the detailed comments provided to the first draft (response attached, see both the document and covering email). The CCC response to the Oil Companies' comments prior to the liaison group meeting and the discussions at that meeting did not address these concerns.

- The proposed matrix is not risk based and will likely lead to the exclusion of a range of discharges which do not pose an unacceptably high risk to the network and will certainly lead to a significant number of discharges being considered high risk. While CCC purports to draw on other plans, like the Auckland Unitary Plan, it takes a very different position in determining risk. Under the Auckland Unitary Plan industrial and trade activity provisions, all MfE Guideline compliant service station sites are moderate risk. Truck refuelling facilities less than 1,000m^2 are similarly moderate risk. Under the Auckland Unitary Plan moderate risk sites are permitted subject to clear standards. In contrast, the same sites in CCC will be high risk and subject to significant monitoring and compliance costs which are not justified, and which will be a significant cost when applied across networks of sites (upwards of 50 for Z, BP, and Mobil). CCC's justification for this is not set out and appears to simply be CCC's 'appetite for risk' as opposed to anything substantive.

- In providing a credit of only 3 points for compliance with the MfE Guidelines, by comparison to 15 points for compliance with arbitrary activity area thresholds, the matrix does not appropriately recognise the effectiveness of petroleum industry specific good practice management. This is despite the MfE Guidelines being specific to the management of the key contaminants of concerns related to the industry; extending from site design through ongoing operation and maintenance; and having a proven record of effectiveness.
- CCC's response to the Oil Companies' comments re the draft matrix demonstrate a lack of understanding how separators work and are managed. An example of Z's operational EMP is attached to provide an example of good practice management of such devices. The effectiveness of these measures in managing contaminants arising on petroleum industry sites is well documented in various reports provided to CCC.
- No credit is provided for oil-water separators, despite them being key to management of risk at petroleum industry sites.
- The matrix extends to seeking to address areas trafficked by commercial vehicles. These movements are not specific to the industries/activities identified and should be addressed separately and consistently across all activities.
- CCC's position at the liaison group is likely to lead to a continuation of discharges being caught between CCC and ECAN with CCC unwilling to accept that where discharge quality is consented by ECAN that CCC should only address discharge quantity (recent example attached in relation to Z New Brighton). This approach is inappropriate and does not provide for efficient management of the network and discharges. CCC is not responsible for the quality of discharges consented by ECAN and should focus solely on the capacity of the network to accommodate the same. While this may complicate compliance monitoring for CCC's own discharges, that does not justify duplication of management of discharge quality.

In addition, the Oil Companies are concerned that CCC appears to be considering the matrix separate to the transition plan and not as a critical tool for management of discharges to the network moving forward. In the Oil Companies' view, the matrix is a fundamental tool for ongoing management of the network. This was recognised by CCC through the hearing process, including at various points in closing legal submissions, as referenced below:

Para 70 - … the risk matrix that will be used to assess the currently excluded sites and activities and clarify the process that the consent holder will use to manage discharges from the site or determine whether sites or activities remain excluded from the consent.
Para 73 - The proposed changes to the conditions retain the ability for the Council to exclude high risk sites from coverage under the consent, either by not taking over responsibility for them before 2025, by excluding them through the industrial site audit process or by excluding them through the risk matrix.
Para 76 - Proposed condition 3 sets out the transitional process by which sites will be assessed. The risk matrix to be developed following the grant of this consent will help the Council to better understand the excluded sites for the purposes of managed inclusion or, in the more exceptional case, for a site to remain excluded. While the risk matrix to identify and rate the risk associated with the excluded sites is yet to be developed, condition 3 is certain and workable and condition 2 provides a clear transitional arrangement until such time as the risk matrix is complete.
Para 93 - … and review of the draft risk matrix for the Transition Plan following comments by the Industrial Liaison Group.

The Oil Companies also reinforce that they consider the matrix should be developed alongside the bylaw and will be responding separately to that consultation.

Regards

Mark Laurenson
Principal Planner & Auckland Planning Manager

Mobile: 021 0868 8135

4SIGHT CONSULTING

4SIGHT COVID-19 RESPONSE PLAN

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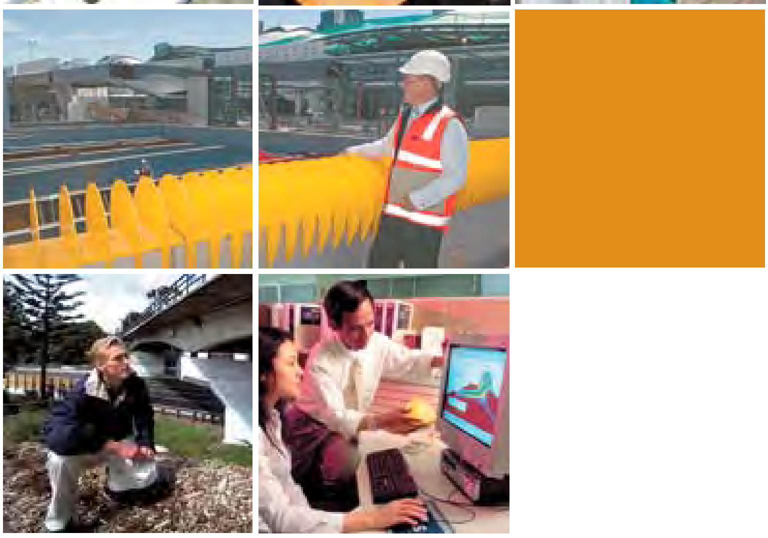
Appendix 2: Reporting from PDP and URS of service station derived contaminant management

Submission #44770

FINAL REPORT

Stormwater and Sediment Monitoring Data from Service Stations and Control Sites in the Auckland Region



Prepared for

Oil Industry Environmental Working Group

C/o Mobil Oil New Zealand Limited
164-188 Beaumont Street
Auckland
New Zealand

7 February 2008

42023044

URS

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Date: 7 February 2008
Reference: R001c
Status: Final Report

Contents

Tables, Figures, Plates, Drawings Appendices

Tables

Appendices

Section 1 Introduction

1.1 Project Background

This report has been prepared by URS New Zealand Limited (URS) on behalf of the Oil Industry Environmental Working Group (OIEWG)[1]. URS understands that the OIEWG wishes to use the findings of this investigation to review the manner in which Auckland Regional Council (ARC) proposes to regulate service station sites in the Auckland region.

Of particular concern to OIEWG are:

- the content, interpretation and implementation of various rules of the Proposed Auckland Regional: Air: Land and Water Plan (PARP: ALW) which relate to the discharge of stormwater from service stations;
- the thresholds used to define 'high risk', 'medium risk' and 'low risk' activity areas under Schedule 3 of the PARP:ALW; and
- the content, use and application of certain elements of ARC Technical Publication 10 (ARC TP10) 'Stormwater Treatment Devices: Design Guideline Manual', in particular:
  - the requirement for 75% total suspended solids (TSS) removal efficiency for stormwater treatment;
  - the ability of existing stormwater treatment systems to achieve a 75% reduction in TSS; and
  - the applicability of the water and sediment quality data used in the development of ARC TP10 to the New Zealand context.

OIEWG members have had ongoing discussions with ARC regarding the above points and consider that the manner in which the ARC proposes to regulate service station sites may be based on limited, incomplete or inaccurate information, in particular with regard to:

- the design, manner of operation of, performance and achievable discharge quality from American Petroleum Institute (API) type interceptors;
- the physical segregation of forecourt and non-forecourt areas of service stations;
- the operation and maintenance practices that are typically employed in service stations;
- the activities that take place in non-forecourt areas of service stations; and
- the quality of stormwater discharges from non-forecourt areas of service stations.

Therefore the OIEWG members wish to gather information to better define the stormwater discharge quality from forecourt and non-forecourt areas (NFA) of service stations.

This report has been prepared in accordance with URS proposals dated 17 November 2005 (stormwater component) and 8 February 2006 (sediment sampling component).

[1] OIEWG currently comprises representatives from the major New Zealand oil companies, namely Mobil Oil New Zealand Limited (Mobil), BP Oil New Zealand Limited (BP), Chevron New Zealand (Chevron), Shell New Zealand Limited (Shell) and Burton Consultants Limited.

1.2 Scope of Work

In order to achieve the study objectives, the following scope of works was undertaken by URS:

- preparation of a stormwater and sediment sampling protocol which details health and safety procedures, sampling locations, sampling conditions, sampling technique and sample storage and transport protocols (Appendix A).
- collection of stormwater samples from five service station sites in the Auckland region, which demonstrate the quality of:
  - stormwater entering the API separator;
  - treated stormwater discharging from the API separator; and
  - stormwater discharging from the NFA at each of the service stations.
- collection of stormwater samples from two control sites in the Auckland region, where control sites represent typical public/commercial car parks.
- collection of sediment samples from the API inlet chamber at each of the selected service stations to determine the quality of sediment retained by the API device.
- assessments of each of the selected service station sites to determine, as far as practical, whether on site drainage systems comply with the 'Guidelines for Water Discharges from Petroleum Industry Site in New Zealand, Ministry for the Environment,1988' (the MfE Guidelines).
- calculation of the total approximate annual contaminant load from all service stations in the Auckland region, based on average contaminant concentrations determined for the service station sites investigated and extrapolated across the number of known service station sites in the Region.
- preparation of a report detailing the findings of the investigation.

1.3 Report Structure

The report has been divided into the following sections:

Section 1: Introduction

Section 2: Sampling Methodology

Section 3: Sample Information and Other Relevant Data

Section 4: Analytical Results, Mass Load and Other Matters.

Section 5: Summary of Findings

Section 6: Conclusions

Section 2 Sampling Methodology

2.1 Site Selection Rationale

Choosing appropriate service station sites was an integral part of this project. Therefore, service station sites were selected based on the following criteria (as agreed with OIEWG):

- Company operated service stations, where site operations are managed and controlled by the oil company.
- Service stations sites that were located on high traffic count roads (i.e. roads with greater than 5,000 vehicles per day).
- Sites that appeared from as-built plans and site walkover, to have been designed and constructed in accordance with the MfE Guidelines e.g. with an oil/water separator (API) servicing the forecourt area.
- Sites with reasonable NFA (i.e. car parks, access ways and shop) where, based on evidence from as-built plans and site walkover it appeared that surface runoff did not discharge to the oil/water separator.
- Sites with clear drainage plans showing segregation of non-forecourt and forecourt drainage.
- Proximity of service station site to the URS office to enable staff to be on site within 15 minutes of a rain event to collect first flush samples.
- Staff safety during sampling.

As-built plans for several service stations were obtained from each of the four OIEWG companies. URS reviewed the plans provided to select sites which met the above criteria. The sites selected for this project were confirmed with OIEWG members. Table 2-1 provides information on age and size for each of the selected sites. As-built drainage plans for the selected sites, identifying sample location points at each service station, are provided in Appendix B.

Two public car parks were selected for this project to represent 'control sites' and are detailed in Table 2-2 below. The 'control sites' were selected to represent typical car parking areas that are not specifically regulated under the PARP: ALW and are therefore considered to represent a 'permitted baseline' scenario.

Site plans for the selected control sites are provided in Appendix B.

Table 2-1 Selected Service Station Sites

Oil Company	Service Station Name	Date of Service Station Development	Approximate Total Site Area (m^2)
BP	Site J	2000	2,630
	Site N	2001	2,930
Caltex	Site U	2001	5,426
Mobil	Site D	Redeveloped May-June 2005	3,270
	Site R[2]	Redeveloped in September 2004	2,360
Shell	Site A	Redeveloped in 1996	3,375

[2] Stormwater and sediment samples from Site R were not able to be collected within the reporting period.

Table 2-2 Control Sites

Control Sites	Location	Approximate Site Area
Asda Plaza car park	4 Fred Thomas Drive, Takapuna (Lot 1 DP 150159)	Total site: 5,915m^2 car park area: ~3,900m^2
Museum car park	Domain car park (around main museum building). The sample may also contain road runoff from Football Road.	Total car park area : ~ 7900m^2

2.2 Sampling Methodology

Stormwater and sediment samples were collected in accordance with the Stormwater and Sediment Sampling Protocol prepared by URS and submitted to the ARC in April 2006. The Protocol was developed to reflect sampling requirements applied by the ARC at other sites. A copy of the sampling protocol is provided in Appendix A. Despite numerous requests by OIEWG, no formal approval of the Protocol has been provided by ARC. The specific elements of the Protocol and some initial sampling results were discussed with ARC technical representatives (Mike Timperley and Earl Shaver) at a meeting on 18 January 2007. No concerns were raised by ARC in relation to the sampling Protocol at this meeting. In the absence of any specific concerns, OIEWG considered this to be ARC's implied endorsement of the Protocol as presented.

Key aspects of the Stormwater and Sediment Protocol are discussed in the following Sections.

Stormwater samples were collected from five of the service stations and the two control sites identified in Section 2.1.

2.2.1 Sampling Location

Stormwater samples were collected from the following sampling points at each of the service stations and control sites:

Service Station

- API Separator
  - Two samples (first flush (FF) and mid storm sample (MS)) from the API inlet.
  - Two samples (FF and MS) from the outlet of the API.
- Two samples (FF and MS) from the non-forecourt area.

In total six stormwater samples were collected from each service station.

Control Sites

Two samples (FF and MS) were collected from each of the two selected car park locations. Samples were collected from manholes draining the majority of the car park area. Refer to Appendix B for specific sampling locations at the two control sites.

Sediment samples were collected from the API separator inlet chamber at each service station.

2.2.2 Sampling Conditions

The sampling protocol developed for this project specified that stormwater samples were to be collected at each site in accordance with ARC requirements for stormwater collection. Samples were to be collected following two to three days of dry weather followed by a heavy rain event (i.e. >5mm). First flush samples were to be collected within the first 15-20 minutes of a rain event, where practicable. The second sample (representing typical mid-storm conditions) was to be collected approximately 20-30 minutes after the first flush event had passed unless otherwise stated in the field sheet (refer to Appendix C).

As the project progressed, it became apparent that obtaining these 'ideal' sampling conditions during a working day was not always possible due to insufficient dry days prior to a storm event, or rain events occurring outside safe working (daylight) hours. OIEWG and URS discussed these concerns with ARC. An agreement was reached between Earl Shaver (ARC), Mike Timperley (ARC), Cameron Taylor (Mobil) and Ken Macdonald (URS) (meeting on 18 January 2007) that stormwater samples could be collected following one or two dry days and under any reasonably intense storm conditions, provided that approximate rainfall during the sampling event was recorded. The outcome of this agreement was that three service stations were sampled after 2 days of dry weather with the remainder, including control sites, after 3 or more days of dry weather. Dates and rainfall recorded during sampling events are provided in Section 3.1 of this report and in Appendix C.

2.2.3 Sampling Technique

Stormwater Samples

Stormwater samples were collected manually (grab samples) by placing a clean sample collection bottle at the end of the sampling pole and positioning immediately underneath the discharge pipe inside the manhole, where available. For stormwater manholes where the inlet or outlet pipe was not directly accessible with a sampling pole, a sandbag was placed inside the manhole to block the outlet which allowed the stormwater to accumulate. Sample bottles were filled with the runoff water collected by filling organic sample bottles first, followed by inorganic samples.

As URS completed the initial rounds of sampling and reviewed the results, it became apparent that some of the dissolved metal concentrations were higher than the total metal concentrations (although all concentrations were relatively low). It was suspected that this could be either due to dissolved metal and total metal results being transposed by the lab or the technique by which total and dissolved metal sample bottles were collected in the field or by small differences in sample make-up due to influences of individual sediment particles. URS sampling techniques were reviewed and determined to be robust and appropriate.

The technique involved the following:

Two one-litre bottles were first filled to represent either first flush samples or mid storm samples respectively. These were then decanted into the individual sample bottles. Sample bottles were filled to the top, leaving no headspace. The above process was repeated at each manhole. A new sample collection bottle was used for each storm event and manhole to avoid cross contamination. All samples were stored in a cool (<4ºC) chilly bin once collected to minimise photo-degradation and thermal effects on the samples. All samples collected were sent to R. J. Hills Laboratories within 48 hours of collection to conform to the holding time requirements for volatile organic compounds.

It was concluded that the most likely cause of the apparent anomaly was the minor difference in sample sediment content.

Sediment Samples

Sediment samples were collected from the API interceptor once all stormwater samples had been collected. The sediment samples were collected from the API separator using a stainless steel Ponar Sediment sampler in accordance with US EPA Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses (1991). The sediment sampler was lowered as slowly as possible into the API separator to avoid the possibility that fine sediments were displaced by the bow wave of the sampler. Two sub–samples were collected for each location. Glass sample containers were used for organic analytes and HDPE containers for metallic analytes. All containers were filled completely to avoid loss of any volatile components and minimise the effects of oxygen of the speciation of individual elements or compounds.

All sediment samples were stored in a cool (<4ºC) chilly bin as soon as they were collected to minimise photo-degradation and thermal effects on the samples. All samples collected were sent to R. J. Hill Laboratories within 48 hours of collection to conform to the holding time requirements of volatile organic compounds.

2.2.4 Contaminants of Concern

Stormwater samples were collected and analysed for the following contaminants of concern (COC), in accordance with the Protocol agreed with ARC and OIEWG:

- pH;
- Electrical conductivity;
- Suspended solids;
- Total and dissolved metals, in particular Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Nickel (Ni) Lead (Pb) and Zinc (Zn);
- Polycyclic aromatic hydrocarbon (PAH);
- Total petroleum hydrocarbon (TPH) and
- Benzene, toluene, ethylbenzene and xylene (BTEX).

Sediment samples were analysed for:

- Total organic carbon (TOC)
- Total reactive phosphorous (TP);
- Heavy metals As, Cd, Cr, Cu, Ni and Pb.
- PAH;
- TPH; and
- BTEX.

2.2.5 Compliance with MfE Requirements

An assessment was conducted at each service station to determine, as far as practical, whether on-site drainage systems were compliant with the four categories listed in the Ministry for Environment (MfE) '*Environmental Guidelines for Water Discharges from Petroleum Industry Sites in New Zealand', 1988.* Results of the survey are discussed in Section 3.2.3 and provided in Appendix C.

Section 3 Sample Information and Other Relevant Data

3.1 Sampling Events

Stormwater and sediment sampling were conducted at the five service station and two control sites between 12 June 2006 and 12 March 2007. Table 3-1 presents sampling dates, estimated rainfall during sampling and rainfall data prior and during sampling. Field observation sheets are provided in Appendix C for reference.

Table 3-1 Summary of Sampling Events

Site Name	Date of Sampling	Time of Rainfall	Collection time of First Sample	Rainfall Recorded during sampling	Rainfall Data*
Site J	30 November 2006	Light showers 15 minutes before heavy downpour at 9.40am	9.45am	~5-6mm over the 2 hour sampling period	No rainfall recorded for 2 days prior to sampling. Approximately 6mm of rainfall was recorded between 9.00am and 11.00am (sampling duration) and 12.6mm over the 24 hour period.
Site N	9 October 2006	Light showers followed by rain at 7.30pm	7.40pm	~3-4mm over the 3 hour period.	No rainfall recorded for 4 days prior to sampling. Approximately 3mm of rainfall was recorded between 7.00 and 10.00pm (sampling duration) and 3mm over the 24 hour period.
Site U	16 October 2006	Light showers for one hour followed by rain at 9.05am	9.05am	~3-4mm over the 3 hour sampling period.	No rainfall recorded for 5 days prior to sampling. Approximately 4mm of rainfall was recorded between 6.00am and 11.00am and 9.8mm over the 24 hour period. A few showers (<1-2mm) occurred prior to sample collection at 9.00am.
Site D	12 March 2007	Light showers (intermittent) and rain at 5.00pm	5.00pm	~2-3mm over 2 hours	No rainfall recorded for 2 days prior to sampling. Approximately 3.6mm of rainfall was recorded between 5.00pm and 8.00pm and 31mm over the 24 hour period.
Site A	30 November 2006	9.40am	9.45am	~5-6mm over the 2 hour sampling period	No rainfall recorded for 2 days prior to sampling. Approximately 8mm of rainfall was recorded between 9.00am and 11.00am (sampling duration) and 12.6mm over the 24 hour period.
Azda Plaza	12 June 2006	Light drizzle from approximately 7.30am. Heavy rain at 9.50am	9.50am	~4mm of rainfall over the one hour sampling period.	No rainfall recorded for 5 days prior to sampling. Approximately 15mm of rainfall was recorded between 8.33am -8.48am, with total of 66.8mm over the 24 hour period. Note however the rain-gauge at Auckland Airport only recorded 10.2 mm of rain during the 24 hour period.

Section 3 Sample Information and Other Relevant Data

Site Name	Date of Sampling	Time of Rainfall	Collection time of First Sample	Rainfall Recorded during sampling	Rainfall Data*
Domain Carpark	12 June 2006	Light drizzle from approximately 7.30am. Heavy rain at 9.50am	9.50am	~4mm of rainfall over the one hour sampling period.	No rainfall recorded for 5 days prior to sampling. Approximately 15mm of rainfall was recorded between 8.33am -8.48am, with total of 66.8mm over the 24 hour period. Note however the rain-gauge at Auckland Airport only recorded 10.2 mm of rain during the 24 hour period.

Source: (*) rainfall data recorded from the rain gauge at Humes Papakura (Data provided by Humes). Airport data as available from Metservice.

3.2 Field Observations

3.2.1 Site Drainage and Sampling

The following drainage information should be considered when comparing analytical results for each site.

Table 3-2 Site Drainage and Sampling Location Information

Site Name	Site Drainage and Sampling
Site J	NFA sample was collected from a manhole which is a combined stormwater and sewer line. Manual stormwater samples were collected from the stormwater outlet pipe, avoiding the sewer line. NFA sample represents runoff from the small carpark area, and driveway. No roof runoff enters this stormwater line. Refer to the site drainage plans provided in Appendix B for further details.
Site N	NFA includes roof runoff water from the site carwash building and small carpark next to the carwash (an area approximately 400m^2). The surface of the car park roof was painted. The API inlet sample was collected from the first API chamber as no other suitable sampling manhole was available upstream of the API. The API outlet sample was collected from a manhole which also collected runoff from the NFA. This was because the manhole originally selected for sampling was not present on site (as identified on the site drainage plan). Consequently, using the API outlet sample for this site to assess API performance must be done with some caution, as the discharge quality could be influenced by the presence of NFA runoff.
Site U	NFA sample was taken from a line that collects roofwater and water from two catchpits in landscaped areas at the rear of the shop. API Outlet sample was collected from the API outlet pipe, avoiding other stormwater inputs. Refer to Appendix B for further details.
Site D	NFA sample does not include roof runoff. API Inlet sample was collected from the API Inlet chamber (first manhole) which contained stagnant water. No sampling location upgradient of the chamber was available. API Outlet sample was collected from the API outlet pipe, avoiding other stormwater inputs. Refer to Appendix B for further details.
Site R	Stormwater sampling for this site was not able to be completed within the reporting timeframe.
Site A	NFA sample represents car park runoff. It is unclear from the site plans whether roof runoff enters this stormwater line. The surface of the roof was painted. The NFA at Site A was asphalt sealed. API Inlet sample was collected from the API Inlet chamber (first manhole) which contained

	stagnant water. No sampling location upstream of the chamber was available.

3.2.2 API Separator Maintenance Schedule

API maintenance/cleanouts for each of the four oil industry companies are conducted by Site Care, an independent contractor. The API separators are monitored and cleaned out by Site Care every six months following each of the oil company-specific management plans. Vacuum tankers are used to remove the sediment build up in the API separators.

API separator maintenance dates were obtained by URS for each of the service station sites sampled in order to determine at what stage of the maintenance regime the API was at the time of sampling. It was considered that this information would assist in the interpretation of the analytical results.

Table 3-3 API Separator Maintenance Schedule

Site Name	API Separator Maintenance Schedule Information
Site J	The API was maintained/cleaned on 28 December 2006 and six months prior to this date. URS collected sediment samples from the forecourt API inlet on 30 November 2006, four months after the June cleanout.
Site N	Information on maintenance was not available from site management.
Site U	The API was maintained/cleaned on 2 November 2006. Prior to this, it was cleaned out on 27 April 2006. URS collected sediment samples from the forecourt API inlet on 16 October 2006, six months after the April cleanout.
Site D	The API was last maintained/cleaned on 26 February 2007. Sediment samples were collected one month after the cleanout.
Site A	The API was last cleaned on 1 October 2006 and 10 January 2007. URS collected samples from the API inlet, one month after the October 2006 cleanout.

3.2.3 MfE Compliance

The Mfe Guidelines provide details on and specifications for the following four categories of drainage areas at service stations in New Zealand:

Category 1 - Drainage systems are dedicated to capture and dispose stormwater from roof areas, paved open areas and unpaved areas.

Category 2- Drainage systems are dedicated to capture and dispose stormwater and product spills from beneath the canopy where vehicle fuelling takes place and the slab around remote fill points.

Category 3 – Drainage systems on site are dedicated to the capture of wastes from car washes, toilets, ablutions and kitchens and similar wastes for disposal to sewers.

Category 4- Drainage systems are dedicated to the capture of washings and waste from workshops

As part of the process of selecting sites for sampling, as-built plans and a number of brief site walkovers were used to assess compliance with the MfE Guidelines. The purpose of these assessments was to identify sites where the drainage areas appeared to have been constructed in accordance with the MfE Guideline categories.

Table 3-4 presents the findings of these pre-sampling, site selection assessments for the service stations that were chosen as the final sampling sites. Refer to Appendix C, visual assessment checklist, for further details.

Table 3-4 MfE Category 1-4 Results

Site Name	Category 1			Category 2			Category 3			Category 4			Comments
	Y	N	NA	Y	N	NA	Y	N	NA	Y	N	NA	
Site J	✓			✓			✓					✓	
Site N	✓			✓			✓					✓	
Site U	✓			✓			✓					✓	
Site D	✓			✓			✓					✓	
Site A	✓			✓			✓					✓	Carwash not operational.

Site drainage at all five sites, appeared to be compliant with Categories 1 to 4 of the MfE service station drainage criteria.

Unfortunately, a number of areas of difference between as-built plans and constructed detail came to light during the sampling process. At two sites, these differences resulted in the drainage arrangements being partially non-compliant with the MfE Guidelines, and it is considered likely that this would have had a bearing on the stormwater quality results obtained at the sites. The two sites affected were:

- Site U – where drainage from a landscaped area to the rear of the shop building, part of which showed evidence of temporary storage of merchandising equipment (steel shelves), was found to connect to the service station NFA drainage; and
- Site A – where drainage from around the car wash area (although not the main drain from the car wash, which was connected to trade waste sewerage), was found to be connected to the NFA drainage

Section 4.3 presents further information on and discussion of these issues in the context of the stormwater results of analysis.

Section 4 Results

4.1 Analytical Results

Analytical results are presented in Tables 4-1 to 4.6 respectively. Analytical results have been compared for each service station, with the relevant guidelines and published data set out below. Results have also been conservatively compared to the lowest detected dissolved and total metal concentrations for the two control sites (first flush and mid storm samples). Table 4.7 presents the minimum and maximum concentrations measured in all samples.

Refer to Section 7 for specific limitation statements relevant to data interpretation. Refer to Table 3.1 and Table 3.2 for sampling conditions encountered during the monitoring.

4.2 Relevant Guidelines and Published Data

Available guidelines and published data which are relevant to this study comprise:

Stormwater

1) Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council (ANZECC), October 2000. Although results have been directly compared to the ANZECC guidelines, it should be noted that the ANZECC guidelines are receiving water guidelines and are not discharge standards. They are designed to be used after reasonable mixing in the environment (which is consistent with section 107 of the RMA (1991)). It should be noted that none of the samples collected represent concentrations in the environment following reasonable mixing.

2) Ministry for the Environment (MfE) Guidelines for Discharges from Petroleum Sites in New Zealand, December 1988 (MfE, 1998) Results from this study have been compared to the maximum concentrations of Total suspended solids (TSS) and TPH allowed by the MfE Guidelines. Data from an ARC study provided in Appendix 2 of the MfE Guidelines have also been used for comparing the monitoring data. It is worth noting that the TPH criterion presented in MfE 1998 is the same as that presented in ARC TP10.

3) Williamson et al, 1991. Urban Runoff Data Book. This report provides metal and total suspended solid concentrations in urban road runoff in New Zealand.

4) American Petroleum Institute Publication, API 1669. Published December 1994 (API, 1994). This study presents the results of a two-part study of constituents present in simulated stormwater runoff from six retail gasoline outlets and four commercial parking lots. Monitoring data from study conducted in USA has been provided for comparison only.

Sediment

1) Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand (ANZECC and ARMCANZ), 2000. Although these guidelines are provided in the results table, sediment quality data from this study have not been directly compared to the ANZECC sediment guidelines as they are designed for the protection of the ecosystem, in particular, macroinvertebrates. Given that the sediment content retained within the API chamber is pumped out using vacuum trucks (as part of the API maintenance regime), the ANZECC criteria are not applicable.

2) Excavation worker exposure limits used for this project are as indicated in the Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand, August 1999 (Tier 1 for maintenance and excavation workers) and MfE Timber Treatment Guidelines, 1997 for commercial land use.

3) ARC Technical Publication 10 Design Guideline Manual, 2003. Table 10-1 provides sediment quality data found in oil and water separators at U.S. petrol stations relative to other land uses.

4) J.N Brown, B.M Peake, 2005. Sources of heavy metals and PAHs in urban stormwater runoff (data from Dunedin studies). Science of the Total Environment.

4.3 Discussion of Results

4.3.1 Control Sites

Heavy Metals

Control Site 1 (Azda Plaza car park) FF and MS samples contained dissolved Cu and Zn concentrations that exceeded the ANZECC water quality criteria. All other dissolved metal concentrations were either below the analytical laboratory detection limit or within the ANZECC water quality standards.

Control Site 2 (Domain car park) FF and MS samples contained dissolved Cr, Cu, Zn and Pb that exceeded the ANZECC water quality criteria. All other dissolved metal concentrations were either below the analytical laboratory detection limit or within the ANZECC water quality standards.

TPH, BTEX and PAH

TPH, BTEX and PAH concentrations measured in the two control site samples were either below the analytical limit of detection or within the ANZECC water quality standards.

4.3.2 Service Station Stormwater Results

Heavy Metals

The water quality discharging from most of the five service stations monitored exceeded the ANZECC water quality guideline levels for dissolved Zn and dissolved Cu. There were also isolated exceedences of ANZECC levels for dissolved chromium and dissolved lead. However, the monitoring results show that the dissolved metals concentrations discharging from the API outlet (FF and MS) and NFA (FF and MS) were generally within the range of concentrations measured in the discharges from the two control sites.

The total Cu, total Pb and total Zn concentrations measured in the NFA and API outlet MS samples at the five service stations were less than or within the ranges measured in runoff from roads and car parks in New Zealand (refer to data from relevant studies, presented in the results table).

TSS

The TSS concentrations measured in the samples collected from the API inlet and API outlet (both FF and MS) at all five service stations clearly demonstrate the efficiency of the API separator with respect to these contaminants. The TSS concentrations measured for API inlet samples (both FF and MS) were generally an order of magnitude higher than the TSS concentrations measured at the API outlet. The TSS concentrations discharging from the API outlet (both FF and MS) at all five service stations were less than the MfE 1998 criterion of 100gm^{-3}. Furthermore, the TSS concentrations measured in samples from all sites were also less than, or within the range for, TSS concentrations measured at the two control sites, and data representing urban road runoff and car parks in New Zealand.

The TSS concentrations measured in the discharges from the NFA (both FF and MS) at Site J, Site A and Site U are generally comparable and within the range discharging from the two control sites. However, the TSS concentration measured in the discharge from the NFA at Site N and Site D are slightly higher (Site D: 69-62 gm^{-3}, Site N: 34 -52 gm^{-3}) than the control site TSS concentrations but are within the MfE 1998 criterion (100gm^{-3}), and within the range of data representing urban road runoff and car parks in New Zealand.

TPH

The TPH concentrations measured in the samples collected from the API outlet (both FF and MS) at all five service stations were less than the MfE 1998 criterion of $15gm^{-3}$.

The TPH concentration of 13.8 gm^{-3} measured in the NFA MS sample at Site A, although elevated, was below the MfE 1998 criterion (15 gm^{-3}). A TPH concentration of 15.2 gm^{-3} was measured in the NFA MS sample at Site U. These elevated concentrations in mid-storm samples, compared with relatively low values in first flush samples from the same locations appear anomalous. Investigation of the TPH traces for these samples indicate the hydrocarbons in question to be similar in character to weathered diesel-range or lube oil range hydrocarbons. Further investigation at the sites identified the presence of drainage arrangements that are considered to be partially non-compliant with MfE Guidelines (refer to section 3.2.3 for details). At Site A, the connection of a catchpit from the vicinity of the car wash, to the NFA drainage line is considered to be the likely cause of elevated TPH concentrations. At Site U, the fact that stormwater from outside the service station may be entering the NFA drainage, is thought to be a possible factor in the elevated discharge TPH concentration.

BTEX

Low concentrations of BTEX (m &p xylene) were measured in the API inlet samples (FF and MS) at Site J but were below the analytical laboratory detection limit in the API outlet sample. BTEX concentrations measured at the other four service stations were below the analytical laboratory detection limit and/or within the ANZECC water quality standards.

PAH

Low concentrations of PAH (anthracene (FF sample only) & phenanthrene) were measured in the API inlet samples at Site U but were below the analytical laboratory detection limit in the API outlet sample. PAH concentrations measured at the other four service stations were below the analytical laboratory detection limit and/or within the ANZECC water quality standards.

4.3.3 Service Station Sediment Results

Heavy Metals

The sediment quality data for the five service stations indicate that all concentrations of heavy metals were significantly less than those reported for service stations in the ARC TP10 publication, regardless of the fact that the APIs at Site J and Site U were in the latter stages of the maintenance schedule (refer Table 3.3).

TPH

The TPH concentrations measured in samples of the API sediments at Site U and Site D are higher than those reported for service stations in the ARC TP10 publication.

A review of the maintenance records for Site U indicates that the API was cleaned out on 2 November 2006. Prior to this, it was cleaned out on 27 April 2006. URS collected sediment samples from the forecourt API inlet on 16 October 2006, which was six months after the April cleaning. It is possible that the results are a reflection of sampling in the late stage of the cleaning cycle. More importantly the results demonstrate that the API interceptor remained effective in removing TPH-impacted sediment as demonstrated by the API outlet stormwater results.

The sediment sample at Site D was collected approximately one month after the API cleanout. Although the TPH concentration in sediment is elevated, the TPH concentration measured in the API outlet stormwater sample is well within the 15 gm^{-3} criterion of MfE 1998, demonstrating the effectiveness of the API in capturing sediment and associated contaminants.

Therefore, regardless of the stage of the cleaning cycle, the API appears effective at capturing TPH contaminated sediments from the forecourt areas of service stations.

TPH concentrations measured in sediments at the other three service station sites were well below the figure reported for service stations in the ARC TP10 publication.

Total Phosphorus

The total phosphorus concentration measured in samples of the API sediments at Site U, Site N and Site A are higher than those reported for service stations in the ARC TP10 publication. It is possible that the results are a reflection of sampling in the late stage of the cleaning cycle. Refer to Table 3.3 for the maintenance schedule for when within the maintenance cycle the samples were collected.

The total phosphorus concentration measured in samples of the API sediments at the remaining service station sites monitored are within the range reported for service stations in the ARC TP10 publication.

PAH

The sediment quality data for the five service stations indicate that all concentrations of PAH were either below the analytical laboratory detection limit and/or within the ANZECC sediment quality standards.

Table 4-1: Surface Water Analytical Results Site J

Sample Details and Analytical Results												Guidelines and Relevant Literature									
URS Sample Reference		SWP623	SWP624	SWP625	SWP 626	SWP627	SWP628	SWG280	SWG281	SWG286	SWG287	ANZECC[1] Fresh Water 95% Level of Protection	MfE Environmental Guidelines for Water Discharges from Service Stations [2]	Data from Relevant Studies For Reference Only							
Laboratory Sample Reference		440498/3	440498/4	440498/5	440498/6	440498/1	440498/2	422002-1	422002-2	422002-3	422002-4			Urban Road Runoff NZ [3]	API 1669 [4]	MfE Publication - Dec 1988					
Date Sampled		30-Nov-06	30-Nov-06	30-Nov-06	30-Nov-06	30-Nov-06	30-Nov-06	12-Jun-06	12-Jun-06	12-Jun-06	12-Jun-06										
Time of Sampling		9.45am	10.40am	10.25am	11.25am	10.00am	11.00am	8.50am	9.50am	8.50am	10.05am										
Rainfall Information		**Field Observations:** Approximately 5-6mm over the 2 hour sampling period. **Rainfall data:** No rainfall recorded for 2 days prior to sampling. Approximately 8 mm of rainfall was recorded between 9.00am and 11.00am (sampling duration) and 12.6mm over the 24 hour period.						**Rainfall Data:** No rainfall recorded for 5 days prior to sampling. Approximately 15mm of rainfall was recorded between 8.33am -8.48am, with total of 66.8mm over the 24 hour period. Note however the rain-gauge at Auckland Airport only recorded 10.2 mm of rain during the 24 hour period.													
Sampling Locations		**Site J**						**Contol Sites**													
		API Inlet First Flush	**API Inlet Mid Storm**	**API Outlet First Flush**	**API Outlet Mid Storm**	**NFA(*1)First Flush**	**NFA(*1)Mid Storm**	**Control 1 First Flush**	**Control 1 Mid Storm**	**Control 2 First Flush**	**Control 2 Mid Storm**					Pananma Rd	Mobil Service Station	Pakuranga	Pacific Steel	Hayman Park	Unitec Sand Filter
Heavy Metals	**Units**																				
Dissolved Arsenic	g.m-3	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	0.001	0.013									
Total Arsenic	g.m-3	0.02	0.003	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.008	0.002				>0.01						
Dissolved Cadmium	g.m-3	0.00016	0.00007	0.00007	< 0.00005	0.00007	< 0.00005	0.00007	0.00006	< 0.00005	< 0.00005	0.0002									
Total Cadmium	g.m-3	0.0097	0.00036	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	0.00008	0.00153	0.00006				>0.005						
Dissolved Chromium	g.m-3	**0.0012**	0.0007	< 0.0005	< 0.0005	0.0005	0.0006	0.001	0.0005	**0.0031**	**0.0015**	0.001									
Total Chromium	g.m-3	0.316	0.0221	0.0017	< 0.0005	0.0008	0.0007	0.0014	0.0027	0.017	0.0042				>0.005-0.011						
Dissolved Copper	g.m-3	**0.0057**	**0.0145**	**0.0064**	**0.0025**	**0.0074**	**0.0046**	**0.0129**	**0.0056**	**0.0698**	**0.0617**	0.0014		0.001							
Total Copper	g.m-3	1.01	0.0889	0.0135	0.005	0.0119	0.0069	0.0084	0.0202	0.197	0.0869			0.0009-0.0021	0.011-0.056	0.024-0.05	0.015-0.05	0.003-.050	0.01-2.42	0.02-0.07	0.002-0.077
Dissolved Nickel	g.m-3	0.0026	0.0013	< 0.0005	< 0.0005	0.0006	< 0.0005	0.0007	< 0.0005	0.0006	< 0.0005	0.011									
Total Nickel	g.m-3	0.136	0.0104	0.001	< 0.0005	0.001	0.0006	0.001	0.0018	0.0125	0.0012				>0.1						
Dissolved Lead	g.m-3	**0.0063**	0.0017	0.0007	0.0004	0.0014	0.0008	0.001	0.0007	**0.0062**	**0.0052**	0.0034		0.00041							
Total Lead	g.m-3	1.86	0.148	0.0131	0.003	0.0049	0.0033	0.0068	0.0113	0.811	0.0258			0.0003-0.075	0.002-0.033	0.027-0.150	0.018-0.050	0.018-.050	0.017-1.660	0.021-1.51	0.005-0.094
Dissolved Zinc	g.m-3	**0.027**	**0.087**	**0.172**	**0.116**	**0.085**	**0.052**	**0.809**	**0.407**	**0.102**	**0.107**	0.008				0.03-0.129	0.01-0.150	0.028-0.321	0.005-.553	0.01-0.840	0.0080.022
Total Zinc	g.m-3	8.75	0.724	0.192	0.125	0.109	0.065	0.435	0.858	0.839	0.139			0.02-0.225	0.1-0.66	0.073-0.179	0.095-2.250	0.063-0.709	0.05-13.5	0.021-1.510	0.013-0.115
pH	pH Units	6.8	6.7	6.5	6.7	6.6	6.8	6.8	6.9	7.3	7.2										
Electrical Conductivity	mS/m	12.5	4.5	3.5	2.5	5.4	3.8	10.2	16.5	24.6	13										
Total Suspended Solids	g.m-3	4350	1070	15	12	7	8	11	20	21	21		100	50-470		35-286	8.0-26.0	2.0-95	1-1174	1-160	5-223
BTEX																					
Benzene	g.m-3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.95									
Toulene	g.m-3	< 0.001	0.005	< 0.001	< 0.001	0.002	0.001	< 0.001	< 0.001	0.001	0.003	ID									
Ethyl benzene	g.m-3	0.115	0.022	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.001	ID									
o-Xylene	g.m-3	0.121	0.034	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.002	0.35									
m & p-Xylene	g.m-3	**2.11**	**0.373**	< 0.002	0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.003	0.003	0.2									
Total Petroleum Hydrocarbons	g.m-3																				
C7-C9	g.m-3	2.78	0.6	< 0.03	< 0.03	< 0.03	< 0.03	< 0.05	< 0.05	< 0.05	< 0.05										
C10-C14	g.m-3	4.76	1.58	< 0.05	<0.05	< 0.05	< 0.05	< 0.1	< 0.1	< 0.1	< 0.1										
C15-C36	g.m-3	2	0.5	<0.1	<0.1	< 0.1	<0.1	< 0.3	< 0.3	< 0.3	< 0.3										
Total TPH	g.m-3	9.5	2.7	<0.2	<0.2	< 0.2	<0.2	< 0.4	< 0.4	< 0.4	< 0.4		15								
PAH																					
Acenaphthene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Acenaphthylene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Anthracene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0004									
Benzo[a]anthracene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001	0.0002									
Benzo[a]pyrene [BAP]	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001										
Benzo[b]fluoranthene	g.m-3	< 0.0001	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001										
Benzo[g,h,i]perylene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001										
Benzo[k]fluoranthene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Chrysene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Dibenzo[a,h]anthracene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Fluoranthene	g.m-3	< 0.0001	0.0006	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0003	< 0.0001	0.001									
Fluorene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Indeno[1,2,3-cd]pyrene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001										
Naphthalene	g.m-3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.016									
Phenanthrene	g.m-3	< 0.0001	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001	0.002									
Pyrene	g.m-3	0.0019	0.0003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0003	0.0002										

Notes:
(*1) Non-forecourt area manhole was a sewer/stormwater combined manhole. Samples were collected from the stormwater pipe avoiding the sewer line.

Key:

BOLD	Indicates that values exceeds ANZECC receiving fresh-water trigger value for 95% ecosystem protection
(light grey shading)	Indicates API Inlet exceeds control site lowest dissolved and total metal concentration
(dark grey shading)	Indicates API Outlet and NFA concentrations exceeds control site lowest dissolved and total metal concentration
Red	Dissolved metals reported as being at higher concentrations than total metals.
ID	Insufficent data

References:

1. ANZECC and ARMCANZ 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand
2. MfE (1998) Environmental Guidelines for Water Discharges from Petroluem Industry Sites in New Zealand (1998) Minstry for the Environment (recommended TPH and TSS values).
3. Williamson et al (1991) Urban Runoff Data Book. National Institute of Water and Atmospheric Research
4. American Petroleum Institute Publication (API 1669), December 1994
5. MfE (1998) Environmental Guidelines for Water Discharges from Petroluem Industry Sites in New Zealand.

Table 4-2: Surface Water Analytical Results for Site N

Sample Details and Analytical Results												Guidelines and Relevant Literature									
												ANZECC[1] Fresh Water 95% Level of Protection	MfE Environmental Guidelines for Water Discharges from Service Stations [2]	Data from Relevant Studies For Reference Only							
														Urban Road Runoff NZ [3]	API 1669 [4]						
URS Sample Reference		SWG282	SWG283	SWG284	SWG285	SWG289	SWG290	SWG280	SWG281	SWG286	SWG287										
Laboratory Sample Reference		434879-1	434879-2	434879-3	434879-4	434879-5	434879-6	422002-1	422002-2	422002-3	422002-4										
Date Sampled		9-Oct-06	9-Oct-06	9-Oct-06	9-Oct-06	9-Oct-06	9-Oct-06	12-Jun-06	12-Jun-06	12-Jun-06	12-Jun-06										
Time of Sampling		8.00pm	9.10pm	8.10pm	9.15pm	7.40pm	8.50pm	8.10am	9.50am	8.50am	10.05am										
Rainfall Information		**Field Observations:** Approximately 3-4mm over 3 hours. **Rainfall data:** No rainfall recorded for 4 days prior to sampling. Approximately 3 mm of rainfall was recorded between 7.00 and 10.00pm (sampling duration) and 3mm mm over the 24 hour period.						**Rainfall Data:** No rainfall recorded for 5 days prior to sampling. Approximately 15mm of rainfall was recorded between 8.33am -8.48am, with total of 66.8mm over the 24 hour period. Note however the rain-gauge at Auckland Airport only recorded 10.2 mm of rain during the 24 hour period.													
		Site N						**Contol Sites**													
Sampling Locations		**API Inlet(*1) First Flush**	**API Inlet Mid Storm**	**API Outlet (*2)First Flush**	**API Outlet Mid Storm**	**NFA First Flush**	**NFA Mid Storm**	**Control 1 First Flush**	**Control 1 Mid Storm**	**Control 2 First Flush**	**Control 2 Mid Storm**					Pananma Rd	Mobil Service Station	Pakuranga	Pacific Steel	Hayman Park	Unitec Sand Filter
Heavy Metals	**Units**																				
Dissolved Arsenic	g.m-3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	0.001	0.013									
Total Arsenic	g.m-3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.008	0.002				>0.01						
Dissolved Cadmium	g.m-3	< 0.00005	**0.00009**	**0.0002**	< 0.00005	**0.00038**	**0.00016**	0.00007	0.00006	< 0.00005	< 0.00005	0.0002									
Total Cadmium	g.m-3	0.00006	0.00011	0.00008	0.00008	0.00035	0.00042	< 0.00005	0.00008	0.00153	0.00006				>0.005						
Dissolved Chromium	g.m-3	0.0007	0.0007	**0.0013**	0.0009	0.0009	< 0.0005	0.001	0.0005	**0.0031**	**0.0015**	0.001									
Total Chromium	g.m-3	0.0024	0.0022	0.003	0.0018	0.0029	0.0077	0.0014	0.0027	0.017	0.0042				>0.005-0.011						
Dissolved Copper	g.m-3	0.006	**0.0062**	**0.0205**	0.009	**0.0193**	**0.0045**	**0.0129**	**0.0056**	**0.0698**	**0.0617**	0.0014		0.001							
Total Copper	g.m-3	0.02	0.017	0.0401	0.0157	0.0309	0.0327	0.0084	0.0202	0.197	0.0869			0.0009-0.0021	0.011-0.056	0.024-0.05	0.015-0.05	0.003-.050	0.01-2.42	0.02-0.07	0.002-0.077
Dissolved Nickel	g.m-3	< 0.0005	< 0.0005	0.0007	< 0.0005	0.001	< 0.0005	0.0007	< 0.0005	0.0006	< 0.0005	0.011									
Total Nickel	g.m-3	0.0019	0.0018	0.0028	0.0011	0.0025	0.0048	0.001	0.0018	0.0125	0.0012				>0.1						
Dissolved Lead	g.m-3	0.0003	0.0005	0.001	0.0006	0.0004	0.0004	0.001	0.0007	**0.0062**	**0.0052**	0.0034		0.00041							
Total Lead	g.m-3	0.0089	0.0081	0.012	0.0067	0.0119	0.0392	0.0068	0.0113	0.811	0.0258			0.0003-0.075	0.002-0.033	0.027-0.150	0.018-0.050	0.018-.050	0.017-1.660	0.021-1.51	0.005-0.094
Dissolved Zinc	g.m-3	0.007	**0.011**	**0.067**	**0.053**	**0.051**	**0.024**	**0.809**	**0.407**	**0.102**	**0.107**	0.008				0.03-0.129	0.01-0.150	0.028-0.321	0.005-.553	0.01-0.840	0.0080.022
Total Zinc	g.m-3	0.046	0.047	0.122	0.093	0.106	0.221	0.435	0.858	0.839	0.139			0.02-0.225	0.1-0.66	0.073-0.179	0.095-2.250	0.063-0.709	0.05-13.5	0.021-1.510	0.013-0.115
pH	pH Units	7.3	7.3	6.8	6.9	6.7	6.8	6.8	6.9	7.3	7.2										
Electrical Conductivity	mS/m	17.6	15.5	6.4	5	8.1	2.6	10.2	16.5	24.6	13										
Total Suspended Solids	g.m-3	43	34	35	25	69	62	11	20	21	21			50-470		35-286	8.0-26.0	2.0-95	1-1174	1-160	5-223
BTEX																					
Benzene	g.m-3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.95									
Toulene	g.m-3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.003	ID									
Ethyl benzene	g.m-3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.001	ID									
o-Xylene	g.m-3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.002	0.35									
m & p-Xylene	g.m-3	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.003	0.003	0.2									
Total Petroleum Hydrocarbons	g.m-3																				
C7-C9	g.m-3	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.05	< 0.05	< 0.05	< 0.05										
C10-C14	g.m-3	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.1	< 0.1	< 0.1										
C15-C36	g.m-3	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.3	< 0.3	< 0.3	< 0.3										
Total TPH	g.m-3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.4	< 0.4	< 0.4	< 0.4		15								
PAH																					
Acenaphthene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Acenaphthylene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Anthracene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0004									
Benzo[a]anthracene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001	0.0002									
Benzo[a]pyrene [BAP]	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001										
Benzo[b]fluoranthene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001										
Benzo[g,h,i]perylene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001										
Benzo[k]fluoranthene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Chrysene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Dibenzo[a,h]anthracene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Fluoranthene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0003	< 0.0001	0.001									
Fluorene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Indeno[1,2,3-cd]pyrene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001										
Naphthalene	g.m-3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.016									
Phenanthrene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001	0.002									
Pyrene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0003	0.0002										

Notes:

(*1) Sample collected from API inlet chamber (water was stagnant) when collected.

(*2) Sample colllected from manhole which also has other non-forecourt area discharging to it. See report for further details.

Key:

BOLD Indicates that values exceeds ANZECC receiving fresh-water trigger value for 95% ecosystem protection

(light grey shading) Indicates API Inlet exceeds control site lowest dissolved and total metal concentration

(dark grey shading) Indicates API Outlet and NFA concentrations exceeds control site lowest dissolved and total metal concentration

Red Dissolved metals reported as being at higher concentrations than total metals.

ID Insufficent data

References:

1. ANZECC and ARMCANZ 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand
2. MfE (1998) Environmental Guidelines for Water Discharges from Petroluem Industry Sites in New Zealand (1998) Minstry for the Environment (recommended TPH and TSS values).
3. Williamson et al (1991) Urban Runoff Data Book. National Institute of Water and Atmospheric Research
4. American Petroleum Institute Publication (API 1669), December 1994
5. MfE (1998) Environmental Guidelines for Water Discharges from Petroluem Industry Sites in New Zealand.

Table 4-3: Surface Water Analytical Results for Site U

Rainfall Information

Site U – **Field Observations:** Approximately 3-4mm over 3 hours

Rainfall data: No rainfall recorded for 5 days prior to sampling. Approximately 4 mm of rainfall was recorded between 6.00am and 11.00am and 9.8mm over the 24 hour period. A few showers (<1-2mm) occurred prior to sample collect ion at 9.00am.

Contol Sites – **Rainfall Data:** No rainfall recorded for 5 days prior to sampling. Approximately 15mm of rainfall was recorded between 8.33am -8.48am, with total of 66.8mm over the 24 hour period. Note however the rain-gauge at Auckland Airport only recorded 10.2 mm of rain during the 24 hour period.

Sample Details and Analytical Results		Site U						Contol Sites				Guidelines and Relevant Literature		Data from Relevant Studies For Reference Only							
URS Sample Reference		SWK673	SWK674	SWK675	SWK676	SWK671	SWK672	SWG280	SWG281	SWG286	SWG287	ANZECC[1] Fresh Water 95% Level of Protection	MfE Environmental Guidelines for Water Discharges from Service Stations [2]	Urban Road Runoff NZ [3]	API 1669 [4]						
Laboratory Sample Reference		435439-2	435439-3	435439-4	435439-5	435439-6	435439-1	422002-1	422002-2	422002-3	422002-4										
Date Sampled		16-Oct-06	16-Oct-06	16-Oct-06	16-Oct-06	16-Oct-06	16-Oct-06	12-Jun-06	12-Jun-06	12-Jun-06	12-Jun-06										
Time of Sampling		9.25am	10.00am	9.10am	10.10am	9.05am	9.50am	8.50am	9.50am	8.50am	10.05am										
Sampling Locations		**API Inlet First Flush**	**API Inlet Mid Storm**	**API Outlet First Flush**	**API Outlet Mid Storm**	**NFA First Flush**	**NFA Mid Storm**	**Control 1 First Flush**	**Control 1 Mid Storm**	**Control 2 First Flush**	**Control 2 Mid Storm**					Pananma Rd	Mobil Service Station	Pakuranga	Pacific Steel	Hayman Park	Unitec Sand Filter
Heavy Metals	**Units**																				
Dissolved Arsenic	g.m-3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	0.001	0.013									
Total Arsenic	g.m-3	0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001	0.008	0.002				>0.01						
Dissolved Cadmium	g.m-3	0.00008	< 0.00005	< 0.00005	< 0.00005	< 0.00005	0.00029	0.00007	0.00006	< 0.00005	< 0.00005	0.0002									
Total Cadmium	g.m-3	0.00029	0.00009	< 0.00005	< 0.00005	0.00008	0.00006	< 0.00005	0.00008	0.00153	0.00006				>0.005						
Dissolved Chromium	g.m-3	0.0006	< 0.0005	< 0.0005	< 0.0005	<0.0005	< 0.0005	0.001	0.0005	**0.0031**	**0.0015**	0.001									
Total Chromium	g.m-3	0.0036	0.0008	0.001	< 0.0005	0.0012	0.001	0.0014	0.0027	0.017	0.0042				>0.005-0.011						
Dissolved Copper	g.m-3	**0.0103**	**0.0023**	**0.0081**	**0.0017**	**0.0073**	**0.0082**	**0.0129**	**0.0056**	**0.0698**	**0.0617**	0.0014		0.001							
Total Copper	g.m-3	0.0282	0.0082	0.0105	0.0035	0.0157	0.0116	0.0084	0.0202	0.197	0.0869			0.0009-0.0021	0.011-0.056	0.024-0.05	0.015-0.05	0.003-.050	0.01-2.42	0.02-0.07	0.002-0.077
Dissolved Nickel	g.m-3	0.0007	< 0.0005	0.0006	< 0.0005	<0.0005	0.0007	0.0007	< 0.0005	0.0006	< 0.0005	0.011									
Total Nickel	g.m-3	0.003	0.0008	0.001	< 0.0005	0.0013	0.0008	0.001	0.0018	0.0125	0.0012				>0.1						
Dissolved Lead	g.m-3	0.0006	0.0001	0.0005	0.0001	0.0003	0.0005	0.001	0.0007	**0.0062**	**0.0052**	0.0034		0.00041							
Total Lead	g.m-3	0.0104	0.0036	0.0026	0.0012	0.0042	0.0037	0.0068	0.0113	0.811	0.0258			0.0003-0.075	0.002-0.033	0.027-0.150	0.018-0.050	0.018-.050	0.017-1.660	0.021-1.51	0.005-0.094
Dissolved Zinc	g.m-3	**0.064**	**0.029**	**0.047**	**0.017**	**0.59**	**0.627**	**0.809**	**0.407**	**0.102**	**0.107**	0.008				0.03-0.129	0.01-0.150	0.028-0.321	0.005-.553	0.01-0.840	0.0080.022
Total Zinc	g.m-3	0.234	0.1	0.102	0.039	0.455	0.783	0.435	0.858	0.839	0.139			0.02-0.225	0.1-0.66	0.073-0.179	0.095-2.250	0.063-0.709	0.05-13.5	0.021-1.510	0.013-0.115
pH	pH Units	7	7.2	7.1	7.2	7.2	7.1	6.8	6.9	7.3	7.2										
Electrical Conductivity	mS/m	14.6	6.2	23.1	7.7	20.6	14.6	10.2	16.5	24.6	13										
Total Suspended Solids	g.m-3	116	42	49	19	(*)	17	11	20	21	21			50-470		35-286	8.0-26.0	2.0-95	1-1174	1-160	5-223
BTEX																					
Benzene	g.m-3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.95									
Toulene	g.m-3	< 0.001	0.005	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.003	ID									
Ethyl benzene	g.m-3	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.001	ID									
o-Xylene	g.m-3	0.002	0.01	< 0.001	0.001	0.001	< 0.001	< 0.001	< 0.001	0.001	0.002	0.35									
m & p-Xylene	g.m-3	< 0.002	0.019	< 0.002	< 0.002	0.003	< 0.002	< 0.002	< 0.002	0.003	0.003	0.2									
Total Petroleum Hydrocarbons	g.m-3																				
C7-C9	g.m-3	0.41	0.05	0.03	< 0.03	< 0.03	< 0.03	< 0.05	< 0.05	< 0.05	< 0.05										
C10-C14	g.m-3	36.5	0.34	0.06	< 0.05	< 0.05	1.27	< 0.1	< 0.1	< 0.1	< 0.1										
C15-C36	g.m-3	527	10.8	7.9	0.2	0.2	13.9	< 0.3	< 0.3	< 0.3	< 0.3										
Total TPH	g.m-3	***564***	11.2	8	0.2	0.2	***15.2***	< 0.4	< 0.4	< 0.4	< 0.4		15								
PAH																					
Acenaphthene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Acenaphthylene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Anthracene	g.m-3	**0.0005**	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0004									
Benzo[a]anthracene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001	0.0002									
Benzo[a]pyrene [BAP]	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001										
Benzo[b]fluoranthene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001										
Benzo[g,h,i]perylene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001										
Benzo[k]fluoranthene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Chrysene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Dibenzo[a,h]anthracene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Fluoranthene	g.m-3	< 0.0001	0.0003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0003	< 0.0001	0.001									
Fluorene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Indeno[1,2,3-cd]pyrene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001										
Naphthalene	g.m-3	0.0006	< 0.0005	< 0.0005	< 0.0005	0.001	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.016									
Phenanthrene	g.m-3	**0.0048**	**0.0011**	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001	0.002									
Pyrene	g.m-3	0.0291	0.0035	0.0007	0.0002	< 0.0001	0.0008	< 0.0001	< 0.0001	0.0003	0.0002										

Notes:
(*) Lab Error (see Hills Laboratory Letter, Appendix D)

Key:

BOLD	Indicates that values exceeds ANZECC receiving fresh-water trigger value for 95% ecosystem protection
(light grey shading)	Indicates API Inlet exceeds control site lowest dissolved and total metal concentration
(dark grey shading)	Indicates API Outlet and NFA concentrations exceeds control site lowest dissolved and total metal concentration
Red	Dissolved metals reported as being at higher concentrations than total metals.
ID	Insufficent data

References:

1. ANZECC and ARMCANZ 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand
2. MfE (1998) Environmental Guidelines for Water Discharges from Petroluem Industry Sites in New Zealand (1998) Minstry for the Environment (recommended TPH and TSS values).
3. Williamson et al (1991) Urban Runoff Data Book. National Institute of Water and Atmospheric Research
4. American Petroleum Institute Publication (API 1669), December 1994
5. MfE (1998) Environmental Guidelines for Water Discharges from Petroluem Industry Sites in New Zealand.

Submission #44770

Table 4-4 : Surface Water Analytical Results for Site D

Sample Details and Analytical Results	Units	API Inlet First Flush	API Inlet Mid Storm	API Outlet First Flush	API Outlet Mid Storm	NFA First Flush	NFA Mid Storm	Control 1 First Flush	Control 1 Mid Storm	Control 2 First Flush	Control 2 Mid Storm	ANZECC[1] Fresh Water 95% Level of Protection	MfE Environmental Guidelines for Water Discharges from Service Stations [2]	Urban Road Runoff NZ [3]	API 1669 [4]	Pananma Rd	Mobil Service Station	Pakuranga	Pacific Steel	Hayman Park	Unitec Sand Filter
Sampling Locations		Site D						Contol Sites				Guidelines and Relevant Literature				Data from Relevant Studies For Reference Only					
URS Sample Reference		SWD 637	SWD 638	SWD 639	SWD 640	SWD 641	SWD 642	SWG280	SWG281	SWG286	SWG287										
Laboratory Sample Reference		448841/5	448841/6	448841/1	448841/2	448841/3	4488441/4	422002-1	422002-2	422002-3	422002-4										
Date Sampled		12-Mar-07	12-Mar-07	12-Mar-07	12-Mar-07	12-Mar-07	12-Mar-07	12-Jun-06	12-Jun-06	12-Jun-06	12-Jun-06										
Time of Sampling		5.00pm	7.00pm	5.10pm	7.10pm	5.20pm	7.20pm	8.50am	9.50am	8.50am	10.05am										
Rainfall Information		**Field Observations:** Approximately 2-3mm over 2 hours. **Rainfall data:** No rainfall recorded for 2 days prior to sampling. Approximately 3.6 mm of rainfall was recorded between 5.00pm and 8.00pm and 31mm over the 24 hour period.						**Rainfall Data:** No rainfall recorded for 5 days prior to sampling. Approximately 15mm of rainfall was recorded between 8.33am -8.48am, with total of 66.8mm over the 24 hour period. Note however the rain-gauge at Auckland Airport only recorded 10.2 mm of rain during the 24 hour period.													
Heavy Metals	Units																				
Dissolved Arsenic	g.m-3	0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	0.001	0.013									
Total Arsenic	g.m-3	0.002	0.002	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.008	0.002				>0.01						
Dissolved Cadmium	g.m-3	0.00005	< 0.00005	< 0.00005	< 0.00005	0.00007	0.00005	0.00007	0.00006	< 0.00005	< 0.00005	0.0002									
Total Cadmium	g.m-3	0.00015	0.00014	< 0.00005	0.00006	0.00007	0.00012	< 0.00005	0.00008	0.00153	0.00006				>0.005						
Dissolved Chromium	g.m-3	0.0009	0.0011	< 0.0005	0.0005	0.0006	0.0005	0.001	0.0005	**0.0031**	**0.0015**	0.001									
Total Chromium	g.m-3	0.0057	0.0042	0.0007	0.0016	0.0009	0.0039	0.0014	0.0027	0.017	0.0042				>0.005-0.011						
Dissolved Copper	g.m-3	**0.0122**	0.014	**0.0079**	**0.0111**	**0.0122**	**0.0086**	**0.0129**	**0.0056**	**0.0698**	**0.0617**	0.0014		0.001							
Total Copper	g.m-3	0.0309	0.0373	0.0064	0.0342	0.0104	0.0253	0.0084	0.0202	0.197	0.0869			0.0009-0.0021	0.011-0.056	0.024-0.05	0.015-0.05	0.003-.050	0.01-2.42	0.02-0.07	0.002-0.077
Dissolved Nickel	g.m-3	0.0018	0.0017	0.0014	0.0017	0.0015	0.001	0.0007	< 0.0005	0.0006	< 0.0005	0.011									
Total Nickel	g.m-3	0.0044	0.0046	0.0021	0.0029	0.002	0.0031	0.001	0.0018	0.0125	0.0012				>0.1						
Dissolved Lead	g.m-3	0.0034	0.014	0.0065	**0.0078**	0.0121	0.0033	0.001	0.0007	**0.0062**	**0.0052**	0.0034		0.00041							
Total Lead	g.m-3	0.0249	0.0232	0.0049	0.0194	0.0059	0.0179	0.0068	0.0113	0.811	0.0258			0.0003-0.075	0.002-0.033	0.027-0.150	0.018-0.050	0.018-.050	0.017-1.660	0.021-1.51	0.005-0.094
Dissolved Zinc	g.m-3	**0.167**	**0.124**	**0.424**	**0.495**	**0.282**	**0.137**	**0.809**	**0.407**	**0.102**	**0.107**	0.008				0.03-0.129	0.01-0.150	0.028-0.321	0.005-.553	0.01-0.840	0.0080.022
Total Zinc	g.m-3	0.48	0.302	0.716	0.898	0.495	0.53	0.435	0.858	0.839	0.139			0.02-0.225	0.1-0.66	0.073-0.179	0.095-2.250	0.063-0.709	0.05-13.5	0.021-1.510	0.013-0.115
pH	pH Units	6.4	6.7	7.3	7.3	7.2	7	6.8	6.9	7.3	7.2										
Electrical Conductivity	mS/m	29.9	15.2	33.5	34.9	20.8	8.6	10.2	16.5	24.6	13										
Total Suspended Solids	g.m-3	167	93	16	20	34	52	11	20	21	21			50-470		35-286	8.0-26.0	2.0-95	1-1174	1-160	5-223
BTEX																					
Benzene	g.m-3	< 0.001	< 0.001	0.006	0.014	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.95									
Toulene	g.m-3	0.041	0.008	0.075	0.205	< 0.001	0.006	< 0.001	< 0.001	0.001	0.003	ID									
Ethyl benzene	g.m-3	< 0.001	< 0.001	0.008	0.018	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.001	ID									
o-Xylene	g.m-3	< 0.001	< 0.001	0.017	0.034	0.003	< 0.001	< 0.001	< 0.001	0.001	0.002	0.35									
m & p-Xylene	g.m-3	< 0.002	< 0.002	0.031	0.072	< 0.002	< 0.002	< 0.002	< 0.002	0.003	0.003	0.2									
Total Petroleum Hydrocarbons	g.m-3																				
C7-C9	g.m-3	0.1	< 0.03	< 0.03	< 0.03	0.47	< 0.03	< 0.05	< 0.05	< 0.05	< 0.05										
C10-C14	g.m-3	< 0.05	< 0.05	< 0.05	< 0.05	0.14	< 0.05	< 0.1	< 0.1	< 0.1	< 0.1										
C15-C36	g.m-3	< 0.1	< 0.1	4.9	2.2	3.4	2.9	< 0.3	< 0.3	< 0.3	< 0.3										
Total TPH	g.m-3	< 0.2	< 0.2	5	2.2	4	2.9	< 0.4	< 0.4	< 0.4	< 0.4		15								
PAH																					
Acenaphthene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Acenaphthylene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Anthracene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0004									
Benzo[a]anthracene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001	0.0002									
Benzo[a]pyrene [BAP]	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001										
Benzo[b]fluoranthene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001										
Benzo[g,h,i]perylene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001										
Benzo[k]fluoranthene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Chrysene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Dibenzo[a,h]anthracene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Fluoranthene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0003	< 0.0001	0.001									
Fluorene	g.m-3	< 0.0001	< 0.0001	0.0003	0.0003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Indeno[1,2,3-cd]pyrene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001										
Naphthalene	g.m-3	< 0.0005	< 0.0005	0.0018	0.0025	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.016									
Phenanthrene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001	0.002									
Pyrene	g.m-3	< 0.0001	< 0.0001	0.0017	0.001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0003	0.0002										

Key:

BOLD	Indicates that values exceeds ANZECC receiving fresh-water trigger value for 95% ecosystem protection
(light grey shading)	Indicates API Inlet exceeds control site lowest dissolved and total metal concentration
(dark grey shading)	Indicates API Outlet and NFA concentrations exceeds control site lowest dissolved and total metal concentration
Red	Dissolved metals reported as being at higher concentrations than total metals.
ID	Insufficent data

References:

1. ANZECC and ARMCANZ 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand
2. MfE (1998) Environmental Guidelines for Water Discharges from Petroluem Industry Sites in New Zealand (1998) Minstry for the Environment (recommended TPH and TSS values).
3. Williamson et al (1991) Urban Runoff Data Book. National Institute of Water and Atmospheric Research
4. American Petroleum Institute Publication (API 1669), December 1994
5. MfE (1998) Environmental Guidelines for Water Discharges from Petroluem Industry Sites in New Zealand.

Table 4-5 : Surface Water Analytical Results for Site A

Sample Details and Analytical Results		Site A						Contol Sites				Guidelines and Relevant Literature									
												ANZECC[1] Fresh Water 95% Level of Protection	MfE Environmental Guidelines for Water Discharges from Service Stations [2]	Data from Relevant Studies For Reference Only							
														Urban Road Runoff NZ [3]	API 1669 [4]						
Sampling Locations		**API Inlet First Flush**	**API Inlet Mid Storm**	**API Outlet First Flush**	**API Outlet Mid Storm**	**NFA First Flush**	**NFA Mid Storm**	**Control 1 First Flush**	**Control 1 Mid Storm**	**Control 2 First Flush**	**Control 2 Mid Storm**					Pananma Rd	Mobil Service Station	Pakuranga	Pacific Steel	Hayman Park	Unitec Sand Filter
URS Sample Reference		SWL087	SWL088	SWL089	SWL090	SWL091	SWL092	SWG280	SWG281	SWG286	SWG287										
Laboratory Sample Reference		440410-1	440410-2	440410-3	440410-4	440410-5	440410-6	422002-1	422002-2	422002-3	422002-4										
Date Sampled		30-Nov-06	30-Nov-06	30-Nov-06	30-Nov-06	30-Nov-06	30-Nov-06	12-Jun-06	12-Jun-06	12-Jun-06	12-Jun-06										
Time of Sampling		10.05am	11.00am	10.20am	11.10am	9.50am	10.50am	8.50am	9.50am	8.50am	10.05am										
Rainfall Information		**Field Observations:** Approximately 5-6mm over a two hour period. **Rainfall data:** No rainfall recorded for 2 days prior to sampling. Approximately 8 mm of rainfall was recorded between 9.00am and 11.00am (sampling duration) and 12.6mm over the 24 hour period.						**Rainfall Data:** No rainfall recorded for 5 days prior to sampling. Approximately 15mm of rainfall was recorded between 8.33am -8.48am, with total of 66.8mm over the 24 hour period. Note however the rain-gauge at Auckland Airport only recorded 10.2 mm of rain during the 24 hour period.													
Heavy Metals	**Units**																				
Dissolved Arsenic	g.m-3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	0.001	0.013									
Total Arsenic	g.m-3	< 0.001	0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.008	0.002				>0.01						
Dissolved Cadmium	g.m-3	0.00008	< 0.00005	0.00005	< 0.00005	< 0.00005	0.00006	0.00007	0.00006	< 0.00005	< 0.00005	0.0002									
Total Cadmium	g.m-3	0.0001	0.00007	0.00008	0.00006	0.00007	0.0001	< 0.00005	0.00008	0.00153	0.00006				>0.005						
Dissolved Chromium	g.m-3	0.0009	< 0.0005	< 0.0005	0.0005	< 0.0005	< 0.0005	0.001	0.0005	**0.0031**	**0.0015**	0.001									
Total Chromium	g.m-3	0.0024	< 0.0005	< 0.0005	0.0033	< 0.0005	0.0005	0.0014	0.0027	0.017	0.0042				>0.005-0.011						
Dissolved Copper	g.m-3	**0.0131**	**0.0025**	**0.0043**	**0.0023**	**0.0028**	**0.004**	**0.0129**	**0.0056**	**0.0698**	**0.0617**	0.0014		0.001							
Total Copper	g.m-3	0.0189	0.004	0.0056	0.0089	0.0729	0.0059	0.0084	0.0202	0.197	0.0869			0.0009-0.0021	0.011-0.056	0.024-0.05	0.015-0.05	0.003-.050	0.01-2.42	0.02-0.07	0.002-0.077
Dissolved Nickel	g.m-3	**0.0012**	0.0008	0.0009	< 0.0005	0.0007	0.0008	0.0007	< 0.0005	0.0006	< 0.0005	0.011									
Total Nickel	g.m-3	0.0018	0.0009	0.001	0.001	0.0009	0.0012	0.001	0.0018	0.0125	0.0012				>0.1						
Dissolved Lead	g.m-3	0.0019	0.0006	0.0009	0.0004	0.0006	0.0008	0.001	0.0007	**0.0062**	**0.0052**	0.0034		0.00041							
Total Lead	g.m-3	0.0113	0.0012	0.0013	0.0152	0.001	0.0016	0.0068	0.0113	0.811	0.0258			0.0003-0.075	0.002-0.033	0.027-0.150	0.018-0.050	0.018-.050	0.017-1.660	0.021-1.51	0.005-0.094
Dissolved Zinc	g.m-3	**0.151**	**0.409**	**0.586**	**0.023**	**0.397**	**0.527**	**0.809**	**0.407**	**0.102**	**0.107**	0.008				0.03-0.129	0.01-0.150	0.028-0.321	0.005-.553	0.01-0.840	0.0080.022
Total Zinc	g.m-3	0.168	0.606	0.663	0.093	0.552	0.649	0.435	0.858	0.839	0.139			0.02-0.225	0.1-0.66	0.073-0.179	0.095-2.250	0.063-0.709	0.05-13.5	0.021-1.510	0.013-0.115
pH	pH Units	6.3	7.5	7.3	6.9	7.4	7.2	6.8	6.9	7.3	7.2										
Electrical Conductivity	mS/m	11.6	21.1	14.4	2.2	20.8	14.5	10.2	16.5	24.6	13										
Total Suspended Solids	g.m-3	20	3	5	30	4	12	11	20	21	21			50-470		35-286	8.0-26.0	2.0-95	1-1174	1-160	5-223
BTEX																					
Benzene	g.m-3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.95									
Toulene	g.m-3	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.003	ID									
Ethyl benzene	g.m-3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.001	ID									
o-Xylene	g.m-3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.002	0.35									
m & p-Xylene	g.m-3	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.003	0.003	0.2									
Total Petroleum Hydrocarbons	g.m-3																				
C7-C9	g.m-3	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.05	< 0.05	< 0.05	< 0.05										
C10-C14	g.m-3	< 0.05	< 0.05	0.97	< 0.05	< 0.05	1.04	< 0.1	< 0.1	< 0.1	< 0.1										
C15-C36	g.m-3	< 0.1	0.3	10.8	< 0.1	0.3	12.7	< 0.3	< 0.3	< 0.3	< 0.3										
Total TPH	g.m-3	< 0.2	0.3	11.8	< 0.2	0.4	13.8	< 0.4	< 0.4	< 0.4	< 0.4		15								
PAH																					
Acenaphthene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Acenaphthylene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Anthracene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0004									
Benzo[a]anthracene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001	0.0002									
Benzo[a]pyrene [BAP]	g.m-3	0.0003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001										
Benzo[b]fluoranthene	g.m-3	0.0007	< 0.0001	< 0.0001	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001										
Benzo[g,h,i]perylene	g.m-3	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001										
Benzo[k]fluoranthene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Chrysene	g.m-3	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Dibenzo[a,h]anthracene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Fluoranthene	g.m-3	0.0009	< 0.0001	< 0.0001	0.0006	< 0.0001	0.0001	< 0.0001	< 0.0001	0.0003	< 0.0001	0.001									
Fluorene	g.m-3	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001										
Indeno[1,2,3-cd]pyrene	g.m-3	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001										
Naphthalene	g.m-3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.016									
Phenanthrene	g.m-3	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0002	< 0.0001	0.002									
Pyrene	g.m-3	0.0006	0.0004	0.0019	0.0003	0.0008	0.0039	< 0.0001	< 0.0001	0.0003	0.0002										

Key:

BOLD	Indicates that values exceeds ANZECC receiving fresh-water trigger value for 95% ecosystem protection
(light grey shading)	Indicates API Inlet exceeds control site lowest dissolved and total metal concentration
(dark grey shading)	Indicates API Outlet and NFA concentrations exceeds control site lowest dissolved and total metal concentration
Red	Dissolved metals reported as being at higher concentrations than total metals.
ID	Insufficient data

References:

1. ANZECC and ARMCANZ 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand
2. MfE (1998) Environmental Guidelines for Water Discharges from Petroleum Industry Sites in New Zealand (1998) Minstry for the Environment (recommended TPH and TSS values).
3. Williamson et al (1991) Urban Runoff Data Book. National Institute of Water and Atmospheric Research
4. American Petroleum Institute Publication (API 1669), December 1994
5. MfE (1998) Environmental Guidelines for Water Discharges from Petroluem Industry Sites in New Zealand.

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OIEWG Sediment Sampling

Table 4-6: Sediment Analytical Results Compared to Sediment Quality Assessment Criteria

Sample Details and Analytical Results								Guidelines and Relevant Literature							
		Site N	Site U	Site J	Site A	Site D	Exposure Pathways Maintenance - Soil Ingestion and Dermal [4]	ANZECC[1] ISQG low	Data from Relevant Studies						
URS Sample Reference		SDG285	SWD 677	SWP 629	SDL 092	SWD 643									
Laboratory Sample Reference		434879-7	435436/1	440498/7	440410/7	448841/7									
Date Sampled		9-Oct-06	16-Oct-06	30-Nov-06	30-Nov-06	12-Mar-07			Data from TP10 [2].					Data from Dunedin [3]	
Sample Location		Sediment Samples													
		API Interceptor	API Interceptor	API Interceptor	API Interceptor	API Interceptor			Petrol Stations	Dairies	All day Parking lots	Streets	Residential Parking	Street dust	Sump Sediment
Heavy Metals	**Units**														
Total Arsenic	mg/kg	7	6	4	10	11	62	20							
Total Cadmium	mg/kg	0.4	0.5	0.3	0.2	0.2	183	1.5	35.6	17	13.2	13.6	13.5		
Total Chromium	mg/kg	99	30	188	43	37	> 10,000	80	350	233	258	291	323		
Total Copper	mg/kg	267	83	213	88	100	> 10,000	65	798	326	186	173	162	129 (145)	179 (145)
Total Nickel	mg/kg	157	21	135	77	35	838	21							
Total Lead	mg/kg	156	56	548	16	54.6	4610	50	1,183	677	309	544	180	289 (167)	262 (167)
Total Zinc	mg/kg	801	1,020	852	148	1400	> 10,000	200	6,785	4,025	1,580	1,800	878	528 (206)	424 (304)
Total Phosphorous	mg/kg	1,660	11,100	951	1,570	845			1,056	1,020	466	365	267		
Total Organic Carbon	g/100g	17.6	11.4	6.25	1.15	7.95			9.80	5.51	3.79	3.3	3.23		
Total Petroleum Hydrocarbons															
C7-C9	mg/kg	< 20	290	447	< 20	50	NA								
C10-C14	mg/kg	< 30	6,440	1,270	40	3,840	NA								
C15-C36	mg/kg	2,280	96,800	8,530	500	38,100	NA								
Total TPH	mg/kg	2,280	103,000	10,300	540	42,000			18,155	7,003	7,114	3,482	892		
PAH															
Acenaphthene	mg/kg	< 0.05	<0.09	< 0.05	< 0.06	< 0.1		16							
Acenaphthylene	mg/kg	< 0.05	<0.09	< 0.05	< 0.06	< 0.1		44							
Anthracene	mg/kg	< 0.05	<0.09	< 0.05	< 0.06	0.2		85							
Benzo[a]anthracene	mg/kg	0.12	0.42	0.46	0.51	< 0.1									
Benzo[a]pyrene [BAP]	mg/kg	0.3	0.33	0.28	0.53	< 0.1									
Benzo[b]fluoranthene	mg/kg	0.47	1.62	1.02	1.91	< 0.1									
Benzo[g,h,i]perylene	mg/kg	0.98	0.81	0.66	0.81	0.3									
Benzo[k]fluoranthene	mg/kg	0.21	0.69	0.22	0.78	< 0.1									
Chrysene	mg/kg	0.2	1.07	0.41	0.7	< 0.1									
Dibenzo[a,h]anthracene	mg/kg	< 0.05	<0.09	<0.05	< 0.06	< 0.1									
Fluoranthene	mg/kg	0.4	<0.09	0.74	2.13	0.7									
Fluorene	mg/kg	< 0.05	<0.09	<0.05	< 0.06	< 0.1		19							
Indeno[1,2,3-cd]pyrene	mg/kg	0.31	0.28	0.27	0.73	< 0.1									
Naphthalene	mg/kg	< 0.3	10.3	7.6	< 0.3	1.5	3,100	160							
Phenanthrene	mg/kg	0.18	12.3	<0.05	0.56	2.7		240							
Pyrene	mg/kg	0.77	31.1	3.32	1.75	9.8		665							
Benzo[a]pyrene [BAP] eq.	mg/kg	0.3941	0.5796	0.4613	0.8598	<0.1	25								

Notes: all concentrations are expressed on a dry weight basis

NA - indicates that contaminant not limiting as estimated health based criterion is signficantly higher than that likely to be encountered on site

References:

1. ANZECC and ARMCANZ 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand
2. ARC Technical Publication 10, 2003 (Table 10.1 page 10-4). These results show sediment quality found in oil/water separators relative to other land uses.
3. Brown & Peake 2005. Sources of heavy metals and PAHs in urban stormwater runoff (Data from Dunedine Studies)

Section 4 Results

Table 4-7 Range of Copper, Lead, Zinc, TSS and TPH in Service Station and Control Site Stormwater

Units: gm^3	API Inlet		API Outlet		NFA		Control sites		ANZECC Guidelines
	1st flush	Mid storm	1st flush	Mid storm	1st flush	Mid storm	1st flush	Mid Storm	
Dissolved Copper	0.0057-0.0131	0.0023-0.0145	0.0043-0.0205	0.0017-0.0111	0.0028-0.0193	0.004-0.0086	0.0129 – 0.0698	0.0056-0.0617	0.0008
Total Copper	0.0189-1.01	0.004-0.0889	0.0056-0.0401	0.0035-0.0342	0.0104-0.0729	0.0059 – 0.0327	0.0084-0.197	0.0202-0.0869	
Dissolved Lead	0.0003-0.0063	0.0001-0.014	0.0005-0.0065	0.0001-0.0078	0.0003-0.0121	0.0004-0.0033	0.001-0.0062	0.0007-0.0052	0.0008
Total Lead	0.0089-1.86	0.0012-0.148	0.0013-0.0131	0.0012-0.0194	0.001-0.0119	0.0016-0.0392	0.0068-0.811	0.0113-0.0258	
Dissolved Zinc	0.007-0.167	0.011-0.409	0.047-0.586	0.017-0.495	0.051-0.59	0.024-0.627	0.102-0.809	0.107-0.407	0.0008
Total Zinc	0.046-8.75	0.047-0.724	0.102-0.716	0.039-0.898	0.106-0.552	0.065-0.783	0.435-0.839	0.139-0.858	
Total Suspended Solids	20-4350	3-1070	5-49	12-30	4-69	8-62	11-21	20-21	
TPH	9.5-564	0.3-11.2	5-11.8	0.2-2.2	0.2-4	2.9-15.2	<0.4	<0.4	

4.4 Mass Load Data

A simple contaminant load calculation was undertaken using the API outlet and NFA monitoring data to estimate the total average annual contaminant load contribution from all service stations located in the Auckland Region. A similar calculation was undertaken for the two control sites monitored but using actual concentrations, as only one sample was collected from each control site.

In order to establish the estimated contaminant loads from all service stations in the Auckland Region and from the two control sites, the following assumptions were made:

- Average service station area: 0.22 hectares (based upon available industry data).
- There are currently in the order of 309 service stations in the Auckland Region (all brands, including independently operated sites) which equates to a total of approximately 68 hectares of land being occupied by service stations. The total approximate area of Auckland Region's mainland is approximately 451,800 hectares[3], with service stations occupying approximately 0.015% of this total area.
- Annual rainfall for the year (based on NIWA Data) for 2006 was 1,263mm.
- Control site 1 (Azda Plaza). Only one third of the total Azda Plaza car park area drains to the stormwater manhole sampled, equating to an area of approximately 1300m^2 (based on topographical information available for the Azda Plaza car park).
- Control site 2 (Auckland Museum Car park). Approximately 7900m^2 of the area around the Auckland Museum drains to the manhole from which stormwater samples were collected.

The number of service stations and average areas were provided by OIEWG members.

For comparison purposes, Table 4.8 and 4.9 presents the contaminant yields (i.e. the amount of contaminants produced per given source area in a given time (kga^{-1} ha^{-1})) calculated for service stations in the Auckland region and the two control sites. It should be noted that the mass loads/yields calculated from the OIEWG study are estimates and very conservative (i.e. likely to be higher than actual). The calculation of contaminant yield for each parameter is based on the average concentration found at each sample point across the five service stations. The contaminant yields calculated have been conservatively compared to available contaminant load information from the following ARC publications:

- ARC TP40104 – Sources and loads of metals in urban stormwater, June 2005. This technical report presents the mass loads and contaminant yields determined for three stormwater catchments in the Auckland area, namely Mission Bay (residential catchment), Auckland CBD (commercial catchment) and Mt Wellington (industrial catchment). It should be noted that this report does not specify whether predicted averages or actual averages from the monitoring data were used to determine the concentration yields.
- ARC Contaminant Load Model (ARC CLM, May 2006) – This spreadsheet model has been developed by ARC to calculate how much contaminants is produced in a given land area. Contaminant yields from this model have been used to provide some comparison for the OIEWG data. In particular, contaminant yields from model input categories: *paved surfaces other than roads* (i.e. commercial car parks and walkways); and *roads with traffic count of approximately 5000 -20,000 vehicles per day*. It should be noted that roof runoff in ARC model is a separate category. No information was available regarding how the yields were determined for the model.

[3] Source: ARC Growth Strategy, ARC website. Total urban Auckland area is 53,000 hectares.

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Table 4-8: Contaminant Yields for Service Stations in the Auckland Region and Control Sites - First Flush Scenaric

Contaminant Yields (kga⁻¹ha⁻¹)	Service Stations		Control Sites		ARC TP04104 – June 2005			ARC Contaminant Load Model May 06	
	API Outlet	NFA	Control Site 1	Control Site 2	Central Business District - Commercial (catchment area -30.1ha)	Mission Bay - Residential (catchment –area - 45.2 ha)	Mt Wellington - Industrial (catchment area - 34.0ha)	Commercial Paved Areas other than Roads or Roof (i.e. car parks, small driveways, walkways etc)	Roads – 5,000 to 20,000 vehicles/day (does not include roof runoff)
Copper	0.19	0.36	0.11	2.49	0.14	0.08	0.14	0.5	1.7
Lead	0.086	0.070	0.09	10.24	0.12	0.06	0.14	-	-
Zinc	4.53	4.34	5.49	10.60	1.63	0.57	5.2	0.5	5.4
TSS	303.12	359.96	138.93	265.23	310	620	252	1,000	1,500
TPH	63.15	12.12	-	-	-	-	-	-	26.8

Table 4-9: Contaminant Yields for Service Stations in the Auckland Region and Control Sites - Mid Storm Scenaric

Contaminant Yields (kga⁻¹ha⁻¹)	Service Stations		Control Sites		ARC TP04104 – June 2005			ARC Contaminant Load Model May 06	
	API Outlet	NFA	Control Site 1	Control Site 2	Central Business District - Commercial (catchment area -30.1ha)	Mission Bay - Residential (catchment –area - 45.2 ha)	Mt Wellington - Industrial (catchment area - 34.0ha)	Commercial Paved Areas other than Roads or Roof (i.e. car parks, small driveways, walkways etc)	Roads – 5,000 to 20,000 vehicles/day (does not include roof runoff)
Copper	0.17	0.21	0.26	1.10	0.14	0.08	0.14	0.5	1.7
Lead	0.115	0.166	0.14	0.33	0.12	0.06	0.14	-	-
Zinc	3.15	5.68	10.84	1.76	1.63	0.57	5.2	0.5	5.4
TSS	267.76	381.43	252.60	265.23	310	620	252	1,000	1,500
TPH	8.21	81.08	-	-	-	-	-	-	26.8

Notes for Table 4-8 and Table 4-9

1) Control Site 1: Azda Plaza car park site, approximately 1300m^2 of the total Azda Plaza car park discharges to the stormwater manhole monitored.

2) Control Site 2: car park around the Auckland Museum building, equating to approximately 7900m2 draining to stormwater manhole monitored.

References:

1) ARC TP04104. Sources and loads of metals in urban stormwater. ARC Technical Publication 04104, June 2005

Note that it is unclear whether contaminant yields are calculated using predicted averages or actual concentrations from study.

2) ARC Contaminant Load Model (CLM), May 2006 - Contaminant Yields

Note that the ARC CLM does not specify how the contaminant yields were calculated for the model.

Section 4 Results

Comparison of contaminant yields for all service stations in the Auckland Region with control sites and published data indicates the following:

Based on average first flush concentrations

- The estimated Cu and Pb yields from service stations in the Auckland Region (both API outlet and NFA) are within the range of Cu and Pb yields for the two control sites, and in the same order as the ranges presented in TP40104 and data representing commercial paved areas and roads in the ARC CLM (for Cu only).
- The estimated Zn yield from service stations in the Auckland Region (both API outlet and NFA) is less than the Zn yield calculated for the two control sites, and within the ranges presented in TP04104 and data representing road runoff in the ARC CLM.
- The estimated TSS yield from service stations in the Auckland Region (both API outlet and NFA) is greater (303 – 360kga^{-1} ha^{-1}) than the TSS yield for the two control sites (138 – 265kga^{-1} ha^{-1}) but within the ranges presented in the ARC TP04104 and significantly less than commercial paved areas other than roads or roof (1000kga^{-1} ha^{-1}) and roads (1500kga^{-1} ha^{-1}) in the ARC CLM model.

Based on average mid storm concentrations

- The estimated Cu yield from service stations in the Auckland Region (both API outlet and NFA) is less than the Cu yield for the two control sites, and less than commercial paved areas and roads in the ARC CLM.
- The estimated Pb and Zn yields from service stations in the Auckland Region (both API outlet and NFA) are comparable with Pb and Zn yields for the two control sites, and within the ranges presented in TP40104 and ARC CLM.
- The estimated TSS yield from service stations in the Auckland Region (both API outlet and NFA) is slightly greater (268 – 381 kga^{-1} ha^{-1}) than the TSS yield for the two control sites (252 -565 kga^{-1} ha^{-1}) but within the ranges presented in ARC TP04104 (252 – 620 kga^{-1} ha^{-1}), and significantly less than commercial paved areas other than roads or roof (1000kga^{-1} ha^{-1}) and roads (1500kga^{-1} ha^{-1}) in the ARC CLM model.

4.5 Other Matters

Table 4.10 provides a summary of Regional stormwater rules and/or standards for TSS management in the Regional plans which are applied by other Regional Councils throughout New Zealand[4]. The comments column provides a general overview of what the standards would mean for service station sites. The range of TSS concentrations measured in discharges from the non forecourt and forecourt areas of the five service station sites in this study are as follows:

- API outlet (5-49 gm^{-3})
- NFA (4 - 69 gm^{-3})

Table 4-10 Stormwater Rules/Standards for TSS

Council	Stormwater Rule /Standard for TSS	Comments
Northland Operative Regional Water and Soil Plan	Permitted stormwater 21.1.2 (e) (v) 100 gm^{-3} TSS	No treatment required if achieving the standard. Council does not control inputs to reticulated systems.
Auckland PARP: ALW	Treatment to achieve 75% reduction in TSS.	Treatment devices in accordance with ARC TP10 required in all circumstances.
Environment Waikato Proposed Regional Plan.	Rule 3.5.11.4 (Permitted into water). Required to meet TSS standards (in Rule 3.2.4.6) which stipulates that an increase in level by 10% or 100gm^{-3} or breach certain receiving water standards requires treatment.	Deemed to comply if discharge meets MfE Guideline. Environment Waikato does not regulate inputs to reticulated systems.
Environment BOP Proposed Regional Land and Water Plan	Rule 30 stormwater to surface. TSS standard either 150 gm^{-3}or more than 80gm^{-3} in the receiving environment.	EBOP does not regulate inputs to reticulated systems.
Taranaki Regional Freshwater Plan	Rule 23 Stormwater into land or water : TSS is 100gm^{-3}	Provisions do not distinguish between inputs to infrastructure as Council wishes to retain ability to control inappropriate inputs, however general practice is not to regulate for inputs into infrastructure.
Gisborne Regional Regional Discharges Plan	Rule 7.3.2. Stormwater no more than 25mg/l above receiving environment. Rule 7.3.2. A (for road construction and maintenance): 200 gm^{-3}or no more than 50 gm^{-3} above receiving environment standard.	Provisions unclear about inputs into reticulated systems, practice is more focused on end of pipe discharges.
Hawkes Bay Resource Management Plan	Rule 42: No permitted TSS standards. Excludes hazardous substance storage. Hazardous substances storage areas area controlled activity.	Council does not control inputs into infrastructure. Hazard substance storage areas are a controlled activity where directly discharging to water. Matters for control do not

[4] Source: Burton Consultants Limited

Section 4 Results

Council	Stormwater Rule /Standard for TSS	Comments
		include treatment devices.
Horizons Land and Water Plan	Rule DSW 3. Notes change in visibility by more than 30% in receiving environment.	Not Council practice to control inputs into infrastructure. Industrial and trade premises with Hazardous substance areas need interceptor systems. Excludes Manawatu Catchment where any discharge from industrial and trade is a controlled activity and needs to meet the 30% visibility standard.
Greater Wellington Freshwater Plan	Rule 2 stormwater to surface water is permitted provided no conspicuous change in colour or visual clarity.	Rule 3 of Discharge to Land Plan permits discharges into infrastructure (includes no TSS standard). Both plans allow hazardous substance storage premises provided interceptor in place.
Tasman Tasman Resource Management plan	Rule 36.4.2 (permitted) and 36.4.3A (Controlled) No specific TSS standard.	Council does control inputs into infrastructure.
Nelson Freshwater	FWr 21. Stormwater permitted TSS 100 gm^{-3}.	Inputs controlled by bylaw (which includes refs to MfE Guidelines).
Marlborough Marlborough Sounds MP Wairau Awatere	No specific TSS standard although for discharges from water supply systems must meet 50 gm^{-3} for TSS in 1.11.1 (Wairau Plan)	Inputs not controlled in either plan.
West Coast Water Plan	Rule 12.5.1 No conspicuous change in visual clarity.	Discharge is from reticulated networks. Council does not control inputs into infrastructure.
ECAN Natural resources Plan	Rule 5 and 6. Includes 75% TSS treatment for new areas $500m^2$ to 2 ha in a specific BP zone or unprotected areas of ground disturbance for more than 3 months or an area between 2 and 4 hectares elsewhere in the region.	Council does not control inputs into existing infrastructure. Focuses on extension of development. And effectively land development activities
Otago Water Plan	Rule 12.4. Permitted (from a reticulated system) no TSS standard, only visual clarity.	Council practice is not to seek inputs for inputs into infrastructure.
Southland	Permitted in Rule12 and 13 (no TSS standard) although have to meet WQ standards which includes various clarity standards.	Council does not control inputs into infrastructure systems.

The review of statutory rules and regulations conducted by Burton Consultants Limited shows that the concentrations of TSS measured in the API outlet and NFA samples for all five of the sites sampled would be permitted in almost all jurisdictions within New Zealand.

Section 5 Conclusions

The purpose of the study that forms the basis of this report was to investigate and assess the quality of stormwater and sediment at OIEWG company-operated service stations in Auckland Region. At each of five service stations, samples were taken to investigate the quality of:

- stormwater entering the American Petroleum Institute (API) separator;
- treated stormwater discharging from the API separator;
- stormwater discharging from non-forecourt areas of service station sites;
- stormwater discharging from typical public/commercial car parks in the Auckland area; and
- sediment retained in the API device.

Stormwater quality samples were also taken at two control sites.

A single round of stormwater and sediment sampling was conducted at each of the five service station sites and control sites between 12 June 2006 and 12 March 2007.

The following key findings were noted:

Water Quality

The water quality discharging from most of the five service stations monitored exceeded the ANZECC water quality standards for dissolved Zn and dissolved Cu. However, the monitoring results show that the water quality discharging from the API outlet (FF and MS) and NFA (FF and MS) is generally comparable and within the range discharging from the two control sites.

BTEX and PAH concentrations measured in the stormwater samples at all five service stations were either below the analytical laboratory detection limit and/or within the ANZECC water quality standard. The TPH concentrations measured in stormwater samples collected from most sites were below the MfE 1998 criterion of 15 gm^{-3}. A TPH concentration of 15.2 gm^{-3} was measured in the NFA MS sample at Site U. This result is considered to be anomalous, linked to the presence of drainage that is partially non-compliant with the MfE Guidelines.

The TSS concentrations measured in the samples collected from the API inlet and API outlet (both FF and MS) at all five service stations clearly demonstrate the efficiency of the API separator with respect to these contaminants. The TSS concentrations measured for API inlet samples (both FF and MS) were generally a magnitude higher than the TSS concentrations measured at the API outlet.

The TSS concentrations discharging from the API outlet (both FF and MS) at all five service stations were less than the MfE 1998 criterion of 100gm^{-3}. Furthermore, the TSS concentrations measured in samples from all sites were also less than, or within the range for, TSS concentrations measured at the two control sites, and data representing urban road runoff and car parks in New Zealand.

The effectiveness of the API for TSS treatment was not only demonstrated by the TSS concentrations, but also by the heavy metal concentrations within sediment captured by the API (refer to API inlet results) compared with the concentration of metals exiting the API (API outlet sample). ARC TP10 indicates that API separators are not designed to remove TSS, therefore additional treatment devices would be required (i.e. sandfilters). However, the water and sediment quality data from the five service stations investigated suggests that APIs are effective in trapping TSS (including heavy metals) in the API chamber.

The TSS concentrations discharging from the NFA (both FF and MS) at all five service stations were less than the MfE 1998 criterion of 100gm^{-3} and within the range representing urban road runoff and car parks in New Zealand. The review of statutory rules and regulations also indicates that the level of TSS found in the API outlet and NFA samples would be permitted in almost all other jurisdictions within New Zealand.

Section 5 Conclusions

The water quality discharging into the API from most of the five service stations, when compared with the concentrations recorded discharging from NFA's, confirms that the 'high risk activity areas' (i.e. where stormwater containing potentially environmentally hazardous substances are generated) are in fact the forecourt areas of the service station which are serviced by an API at MfE compliant service stations. The sample results for API outlets show that the APIs are effective in reducing concentrations of contaminants to levels that are unlikely to have more than minor effects on the environment.

Sediment Quality

The sediment quality data for all five service station sites shows that all heavy metal and organic (PAH) concentrations were several times lower than those reported for service stations in the ARC TP10 publication (i.e. Table 10.1 which presents sediment quality data found in oil and water separators at U.S. petrol stations relative to other land uses).

Except for Sites U and D, the TPH concentrations measured were within the range presented for service stations in the ARC TP10 publication.

The TPH concentration in API sediments at Site U was higher than those reported for service stations in the ARC TP10 publication. Given that the samples were collected very near the end of the scheduled maintenance interval, the results are considered to reflect the late stage of the cleaning cycle. More importantly, the API outlet stormwater results demonstrate that the API interceptor is effective in containing TPH contaminated sediments.

The sediment sample at Site D was collected approximately one month after the API cleanout. Although the TPH concentration in sediment is elevated, the TPH concentration measured in the API outlet stormwater sample is within the 15 gm^{-3} criterion of MfE 1998, demonstrating the effectiveness of the API in capturing TPH-impacted sediment.

Therefore, regardless of the stage of the cleaning cycle, the API remains effective at capturing TPH contaminated sediments from the forecourt areas of service station sites.

Other Matters

1) Compliance with MfE Site Drainage Requirements

Based on as-built drawings and preliminary site walkovers, site drainage at all five service station sites, appeared to be compliant with Categories 1 to 4 of the MfE service station drainage criteria. However, during sampling and assessment of analysis results, it became apparent that arrangements at two service stations – Sites A and U – deviated to some extent from MfE guideline compliance. It is considered that these non-compliant elements were responsible for elevated stormwater TPH results from the NFAs at both sites.

5) API maintenance and cleaning

API maintenance/cleaning for each of the four OIEWG companies are conducted by Site Care, an independent contractor. The API separators are monitored and cleaned by Site Care following each of the oil company-specific management plans. In general, the API separators are monitored and cleaned every six months. Vacuum tankers are used to remove the sediment build up in the API separators.

6) Annual Estimated Mass Loads from service stations in the Auckland Region.

In general, the estimated metal yields (i.e. Cu, Pb and Zn) from service stations in the Auckland Region (for FF and MS scenario) are comparable with metal yields from the two control sites and yields presented in the ARC publications.

The estimated TSS yields from service stations in the Auckland Region (API outlet & NFA, and FF & MS) are slightly greater than the TSS yield for the two control sites but are within the ranges presented in ARC TP04104 (252 – 620 kga^{-1} ha^{-1}), and significantly less than commercial paved areas other than roads or roof (1000kga^{-1} ha^{-1}) and roads (1500kga^{-1} ha^{-1}) in the ARC CLM model.

Section 5 Conclusions

This report has been prepared by URS New Zealand Limited (URS) on behalf of the Oil Industry Environmental Working Group (OIEWG) and presents the findings of the stormwater and sediment quality monitoring conducted at five service stations (referred to as Site J, Site N, Site U, Site D, Site A) and two control sites (Azda Plaza, Auckland Museum car parks). URS understands that the OIEWG wishes to use the findings of this investigation to review the manner in which Auckland Regional Council (ARC) proposes to regulate service station sites in the Auckland region..

With reference to the Project Background set out in section 1.1 of this report, a number of observations can be made from the investigations carried out by URS. It should be noted that these observations are based on a limited number of samples and are applicable to service stations that are designed, constructed and operated in accordance with the relevant MfE Guideline.

- Physical segregation of forecourt and non-forecourt areas of service stations – Observations made during this investigation confirmed that to a large extent, there is good segregation between forecourt and non-forecourt areas of service stations. These observations were supported by clear differences in analytical quality data for stormwater samples taken from the two types of area, with contaminant loads being significantly higher at the inlet to separators serving forecourt areas than in discharges from non-forecourt areas.
- Quality of stormwater discharges from non-forecourt areas – Results of analysis show that contaminant concentrations - particularly TSS and TPH - in stormwater discharges from non-forecourt areas are similar to concentrations in stormwater discharged from public car parks. Sample results are also in line with the reported ranges contaminant concentrations in urban road runoff in New Zealand. These findings are consistent with observations regarding segregation of forecourt and non-forecourt areas, and with anecdotal evidence suggesting that non-forecourt areas are used predominantly for parking of vehicles rather than for activities with higher associated risk, such as servicing, oil changes etc.
- Capability of API Interceptors to Reduce Contaminant Loads – Analysis results for stormwater and sediment show very clearly that API interceptors installed and maintained in accordance with MfE Guidelines are capable of reducing significantly, concentrations of TSS, hydrocarbon and heavy metal contaminant concentrations in stormwater. Reductions have been found to levels that (i) meet the relevant MfE quality criteria,(ii) are in line with reported figures for urban road runoff, and (iii) in many cases, are lower than the relevant ANZECC guideline concentrations.

  Analysis of sediments from API interceptors indicates that the devices are capable of retaining suspended solids, metals and hydrocarbons to a much greater extent than indicated in ARC Technical Publication 10.

  Observations made during site visits confirmed that API interceptors are being maintained regularly and that this maintenance is critical to efficient retention of contaminants in the contained water and sediment.

From these observations, two key conclusions can be drawn:

Conclusion 1 – Non-forecourt areas of service stations are relatively ‘low risk’ in terms of stormwater contaminant generation, presenting no more risk to stormwater than typical public car parks or urban roads. Consequently, the oil industries focus on segregation of forecourt and non-forecourt areas, and on providing treatment only for discharges from forecourt areas, is appropriate.

Conclusion 2 - API interceptors that are designed, installed and maintained in accordance with MfE Guidelines provide appropriate treatment for forecourt stormwater runoff, reducing contaminant concentrations to levels that meet relevant criteria and are consistent with concentrations in public car parks and urban road runoff

Section 6 References

ANZECC, 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand and Conservation Council (ANZECC), October 2000.

ANZECC and ARMCANZ, 2000. *Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand* (ANZECC and ARMCANZ.

American Petroleum Institute Publication, 1994. *Results of a Retail Gasoline Outlet and Commercial Parking Lot Stormwater Runoff*. API Publication 1669.

ARC, 2006. Contaminant Load Model. May 2006
Source: http://www.arc.govt.nz/arc/environment/water/stormwater/stormwater_home.cfm

ARC, 2005. Sources and loads of metals in urban stormwater. ARC Technical Publication 04104.

ARC, 2003. *Stormwater Treatment Devices: Design Guideline Manual.* ARC Technical Publication 10.

J.N Brown, B.M Peake, 2005. Sources of heavy metals and PAH's in urban stormwater runoff (data from Dunedin studies). Science of the Total Environment.

MfE, 1988. *Guidelines for Water Discharges from Petroleum Industry Site in New Zealand.* Report prepared by a Joint Working Group of the Ministry for the Environment, local authorities and petroleum marketing companies.

MfE and MOH, 1997*. Health and Environment Guidelines for Selected Timber Treatment Chemicals.* Published by the Ministry for the Environment and Ministry of Health.

MfE, 1999. Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand. Report Published by the Ministry for the Environment.

US EPA, 1991. Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses.

Williamson et al, 1991. Urban Runoff Data Book

Section 7 Limitations

URS New Zealand Limited (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Oil Industry Environmental Working Group and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in proposal dated 17 November 2005 (stormwater component) and 8 February 2006 (sediment sampling component).

The sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between November 2005 and February 2008 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

The following specific project limitations are noted:

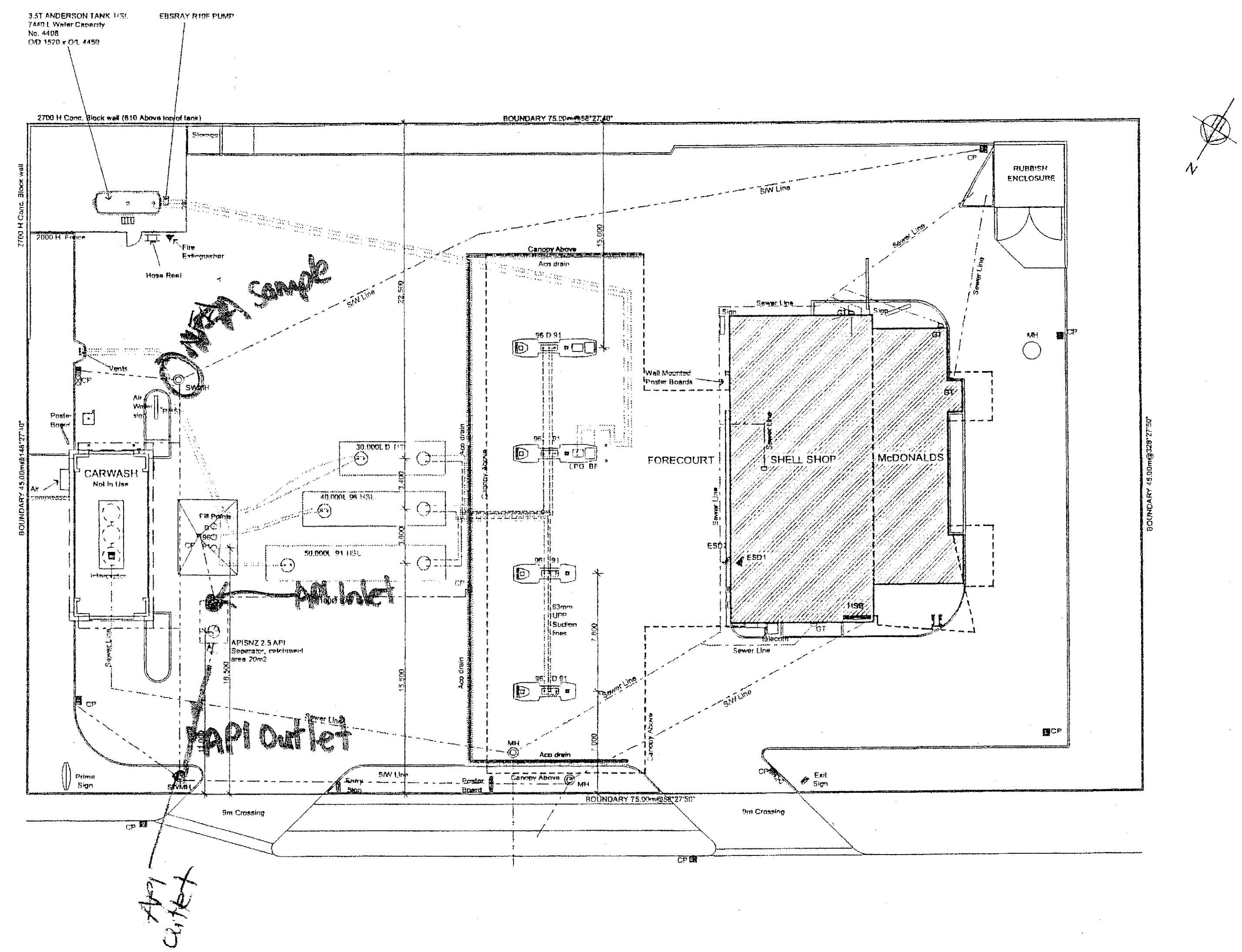
- Only one set of samples was collected from each service station and control sites - A greater number of samples at each site would enable further statistical analysis and understanding of sample variability to be determined.
- Control site and service station samples were collected on different days under different storm events which means that contaminant concentrations are likely to vary depending on the scale of storm event, therefore results are tentatively comparable.
- Control site drainage areas are significantly greater than the service station site non-forecourt drainage areas and total service station areas. Therefore, the mass load of contaminants draining from the control sites will be greater over the same rainfall period.

Submission #44770

Appendix A Stormwater and Sediment Sampling Protocol

Appendix B As-buit Plans for Selected Sites

Submission #44770



REFERENCE DRAWINGS

DWG NO	DRAWING TITLE
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Z02	1_105144_05_Z_SHA_02

GENERAL NOTES

- Contractor shall verify all data on site prior to commencing any work.
- Do not reproduce any standard drawing before checking latest drawing revision with Shell H.O. engineering division.
- All underground plant shown assumed position only. Location should be determined on site.
- Boundaries unless specified with bearing and dimension are best approximation from current known information for HSNO purposes only.
- This drawing has been produced for the "Hazardous Substances & New Organisms Act 1996" and includes all relevant documents and supersedes drawing 1_105144_04_U_JCY_01, 1_105144_01_D_SNZ_01
- Site checked Don Robertson , 05/05/05

LEGEND:

TANKAGE AND PIPING TABLE

TANK TYPE	TANK CAPACITY AND PRODUCT	DATE	TANK DEPTH	FILL	SPILL CONTAINER	OVERFILL VALVES	CATHODIC PROTECTION		ISO VALVE AT TANK	SAFE SUCTION	FILL LINES		SUCTION LINES		VENT LINES		PUMP SUMP
							INSTALLED	TYPE			MATERIAL	DATE	MATERIAL	DATE	MATERIAL	DATE	
Steel	50,000ltr 91	1992		Remote 03	Yes	Yes	Yes	Sacrificial Anode	Yes	Yes	UPP	2003	UPP	2003	UPP	2003	Yes
Steel	40,000ltr 91	1992		Remote 03	Yes	Yes	Yes	Sacrificial Anode	Yes	Yes	UPP	2003	UPP	2003	UPP	2003	Yes
Steel	30,000ltr 96	1992		Remote 03	Yes	Yes	Yes	Sacrificial Anode	Yes	Yes	UPP	2003	UPP	2003	UPP	2003	Yes

SHA ARCHITECTURE

SHELL NEW ZEALAND LTD
3 QUEENS WHARF, PO BOX 2091
WELLINGTON, NEW ZEALAND
TELEPHONE: 0800 474 355

drawn: J. Lee | date: March 2005
checked: M. Finlay | scale: 1:150 @ A1, 1:300 @ A3

Site A

shell ref: 1_105144_05_U_SHA_01
SHA Ref: 04044
sheet: U01
revision: A

NOTES

1. CO-ORDINATES ARE IN TERMS OF MT EDEN GEODETIC DATUM 1949 - 300,000mE 700,000mN. LEVELS ARE IN TERMS OF LINZ SURVEY DATUM.
2. REFER TO DWG NZL01-012050-C01 FOR SITE SERVICES PLAN.
3. REFER TO DWG NZL01-012050-C03 FOR GRADING PLAN.
4. REFER TO DWG NZL01-012050-C07 FOR DRAINAGE LONGSECTIONS.
5. REFER TO DRG-STD-NZL-C001 AND C002 FOR API SEPARATOR DETAILS
6. REFER TO DRG-STD-NZL-C009 FOR CESSPIT, PIPE AND MANHOLE DETAILS
7. ALL uPVC PIPES TO BE CLASS 'C'
8. ALL DISUSED PIPE CONNECTIONS HAVE BE SEALED OFF AT EXISTING MANHOLES.
9. NEW 1050Ø CONCRETE MANHOLE CHAMBER WITH HEAVY DUTY LID AND FRAME LID LEVEL TO MATCH FINISHED GROUND LEVEL INLET SOFFIT 75mm ABOVE OUTLET SOFFIT. OUTLET SOFFIT TO MATCH EXISTING WHERE APPLICABLE.
10. ALL 160Ø uPVC SANITARY SEWER PIPES ARE LAID AT A MINIMUM OF 1.0% GRADE.
11. ALL 110Ø uPP PIPES ARE LAID AT A MINIMUM OF 1.2% GRADE.
12. ALL 110Ø uPVC SW PIPES ARE LAID AT A MINIMUM OF 1.2% GRADE
13. ALL 160Ø uPVC SW PIPES ARE LAID AT A MINIMUM OF 1.0% GRADE.
14. ALL 225Ø uPVC SW PIPES ARE LAID AT A MINIMUM OF 1.0% GRADE.
15. ALL CESSPITS ARE 675x450 CONCRETE PRECAST UNITS WITH HEAVY DUTY FRAME AND GRATE. (REFER TO DWG-STD-NZL-009)
16. SAND FILTER IS APPROVED BY ARC AND COMPLIES WITH TP10 STANDARD. SIZE OF SAND FILTER CATCHMENT IS APPROX. 0.15Ha. EQUIVALENT TO 31.5m WQV. TWL=81.4mAD MAX. AVAILABLE HYDRAULIC HEAD=1.5m.
17. ALL PIPEWORK OVER 200ΦID ARE RCRRJ CLASS 2 PIPES.

SERVICES DISCLAIMER

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LEGEND

- EX STORMWATER
- EX PUBLIC STORMWATER
- EX SANITARY SEWER
- EX PUBLIC SANITARY SEWER
- MANHOLE
- CESSPIT

CATCHMENT AREA	
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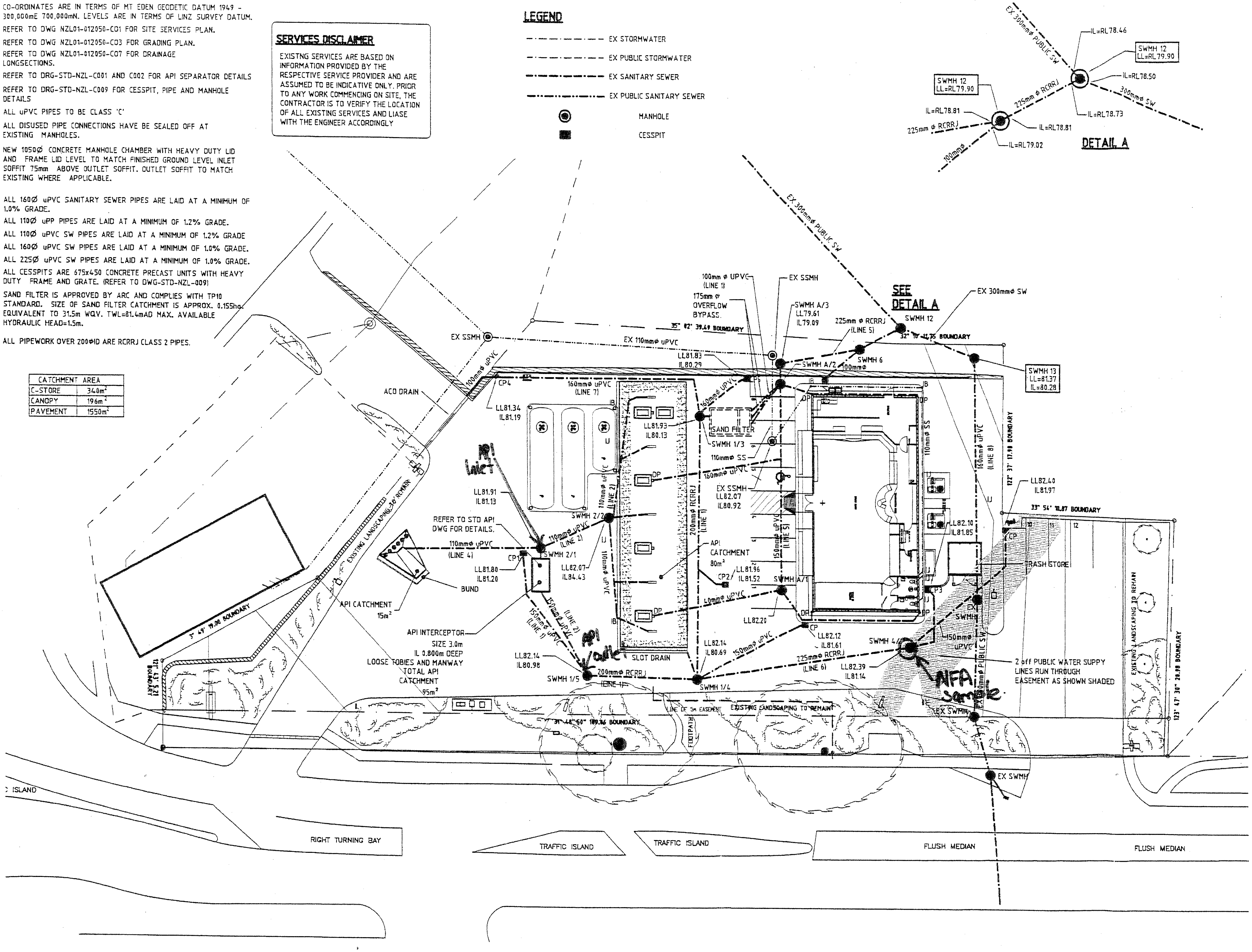
CANOPY	196m²
PAVEMENT	1550m²



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5	01.07.05	AS BUILT DRAWING	TJ
4	01.06.05	ISSUED FOR CONSTRUCTION	TJ
3	25.04.05	SAND FILTER MODS	TJ
2	14.04.05	ISSUED FOR CONSTRUCTION	TJ
1	04.04.05	ISSUED FOR CONSTRUCTION	TJ
0	01.04.05	ISSUED FOR CONSTRUCTION	TJ
A	18.03.05	ISSUED FOR RESOURCE CONSENT	TJ

Revision

Mobil Oil New Zealand Limited

Building Certifications: "I HEREBY CERTIFY THAT THIS WORK HAS BEEN REVIEWED BY ME IN ACCORDANCE WITH SOUND ENGINEERING PRACTICE AND LOCAL REGULATORY REQUIREMENTS.

CONSULTANT SIGNATURE

SINCLAIR KNIGHT MERZ
SKM

Country: NEW ZEALAND

Site D

Site Address:

Building Type: 2900/2005

NORTH

Drawing Title: DRAINAGE LAYOUT PLAN

ISSUED FOR: AS BUILT

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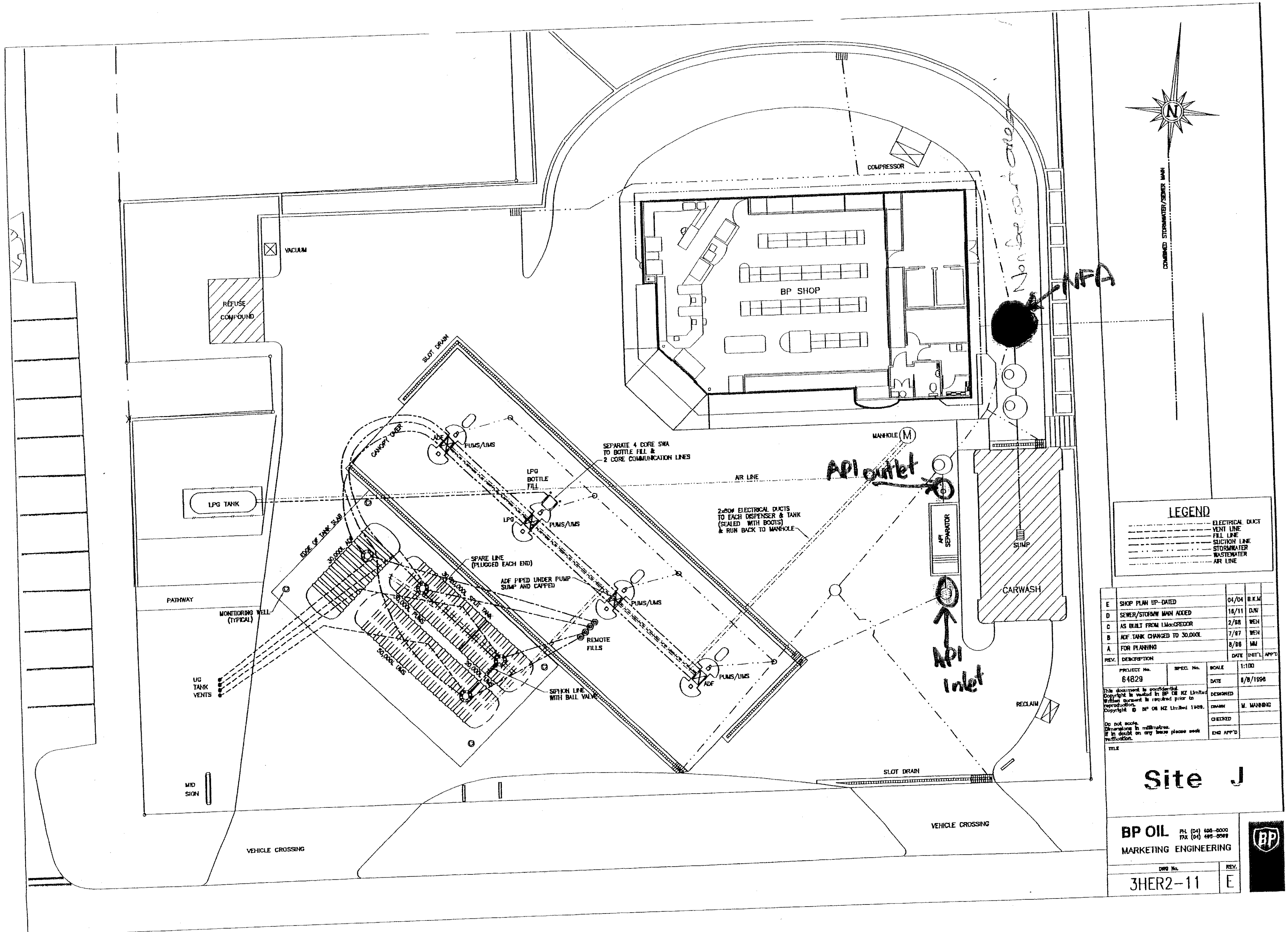
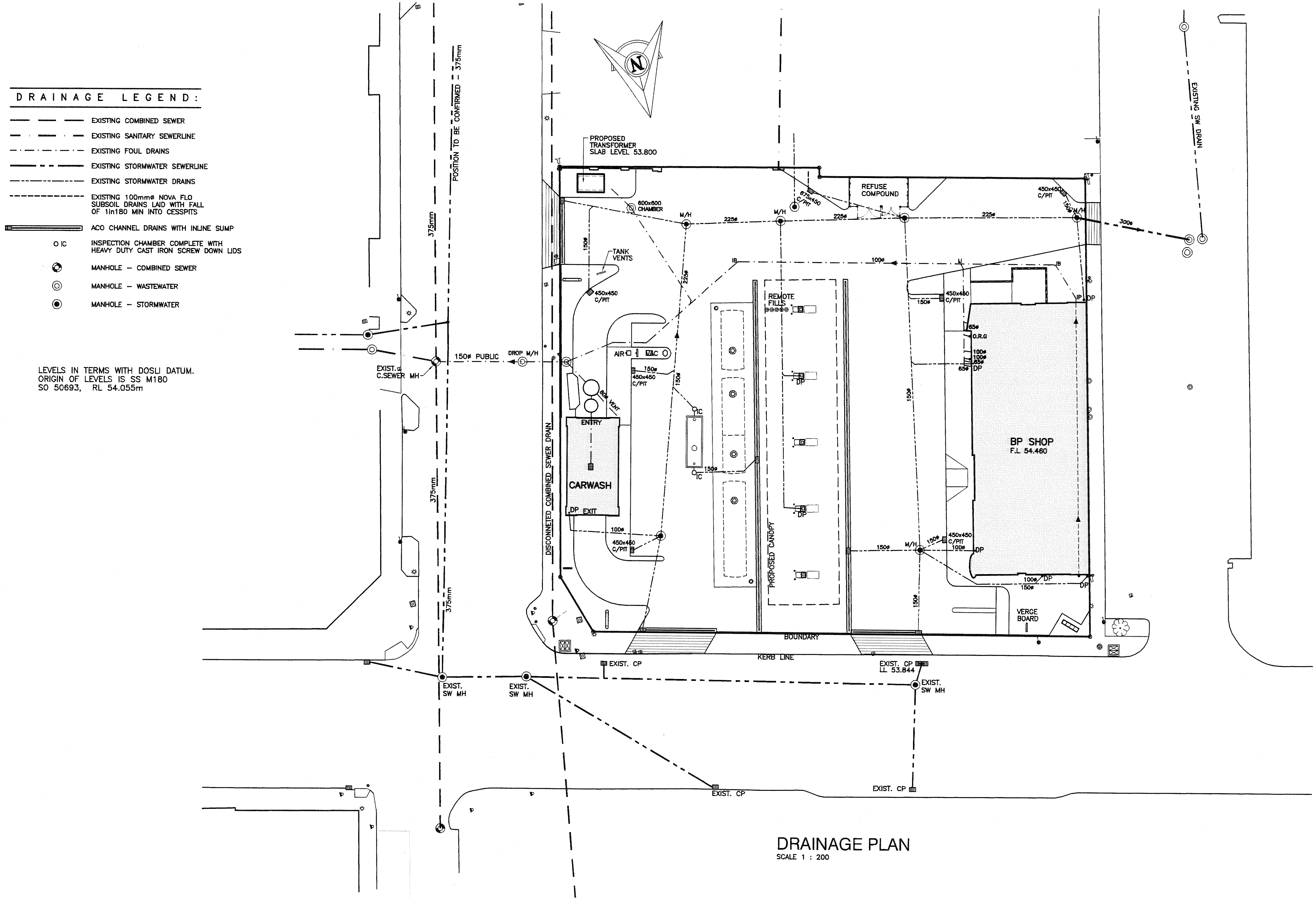
DRAWN BY	GARY HO
CHECKED BY	SIMON
DESIGNED BY	SIMON
DESIGN CHECKED BY	SIMON
CDO MANAGER	TJ

DRAWING NO.: DRG-DES-NZ01-002077-C16 REV. NO.: 5

Submission #44770



Submission #44770



5 0 5 10 15

SCALE 1:200

Rev:	Description:	Date:
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BP Oil NZ Limited Ref No.: 3NM2-111-A

DO NOT SCALE. DIMENSIONS IN MILLIMETRES. IF IN DOUBT ON ANY ISSUE PLEASE SEEK VERIFICATION

Scale:	1:200 1:100
Date:	24/05/01
Designed:	M.T.KEOGH
Drawn:	L.N.MEIKLEJOHN
Checked:	
Plot Scale:	A1–1:1 A3–1:2

Project Title: Site N

Drawing Title:

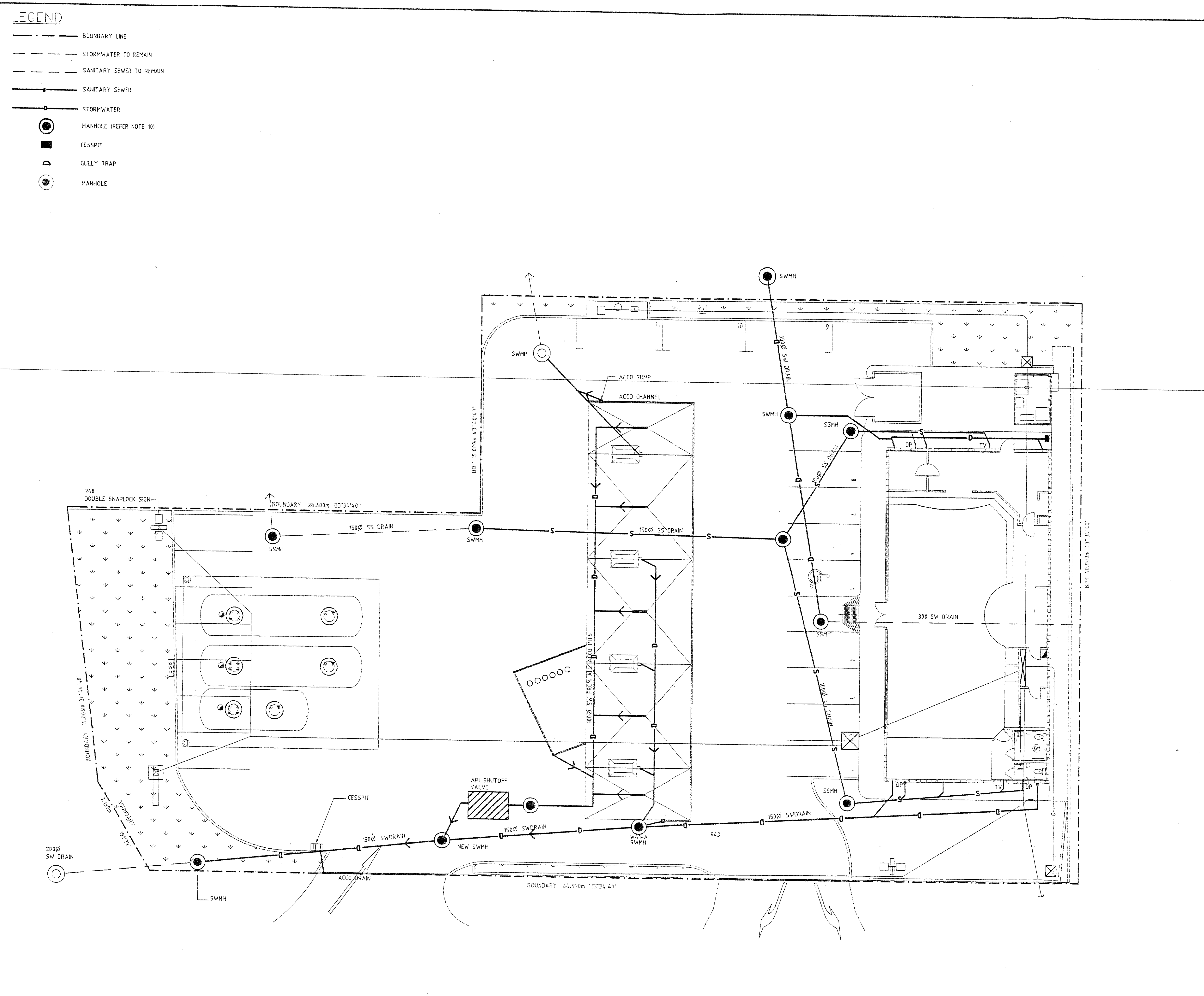
Drawing prepared by: TECHNITRADES LIMITED
12 BEN LOMOND CRES. PAKURANGA, AUCKLAND PH/FAX (09) 576-7166
on behalf of: BP OIL MARKETING ENGINEERING
PO BOX 892, WGTN PH. (04) 495-5000 FAX (04) 495-5599

Technitrades Drawing No.: 1 OF 1 1819-Asb-Dr

Rev No.: A

bp

Submission #44770



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2	22.02.05	ISSUED ASBUILT	TJ
1	10.09.04	ISSUED FOR CONSTRUCTION	TJ
0	03.09.04	ISSUED FOR CONSTRUCTION	TJ
A	APRIL 04	ISSUED FOR BUILDING CONSENT	TJ

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Mobil Oil New Zealand Limited

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CONSULTANT SIGNATURE

SINCLAIR KNIGHT MERZ
SKM
SUITE E-15-02, LEVEL 15, BLOCK E,
PLAZA MONT' KIARA, NO. 2, JALAN KIARA,
MONT' KIARA, 50480 KUALA LUMPUR.
TEL : +603-6204 6688
FAX : +603-6204 6772

Country :

NEW ZEALAND

Site R

Building Type :

2900/2004

NORTH

Drawing Title :

DRAINAGE PLAN

ISSUED FOR	AS BUILT
SCALE	1:250 (A3) & 1:125 (A1)
DRAWN BY	GARY HO
CHECKED BY	TLH
DESIGNED BY	TLH
DESIGN CHECKED BY	
CDD MANAGER	TJ
DRAWING NO.	REV. NO.
DRG-DES-NZ01-002030-C05	3

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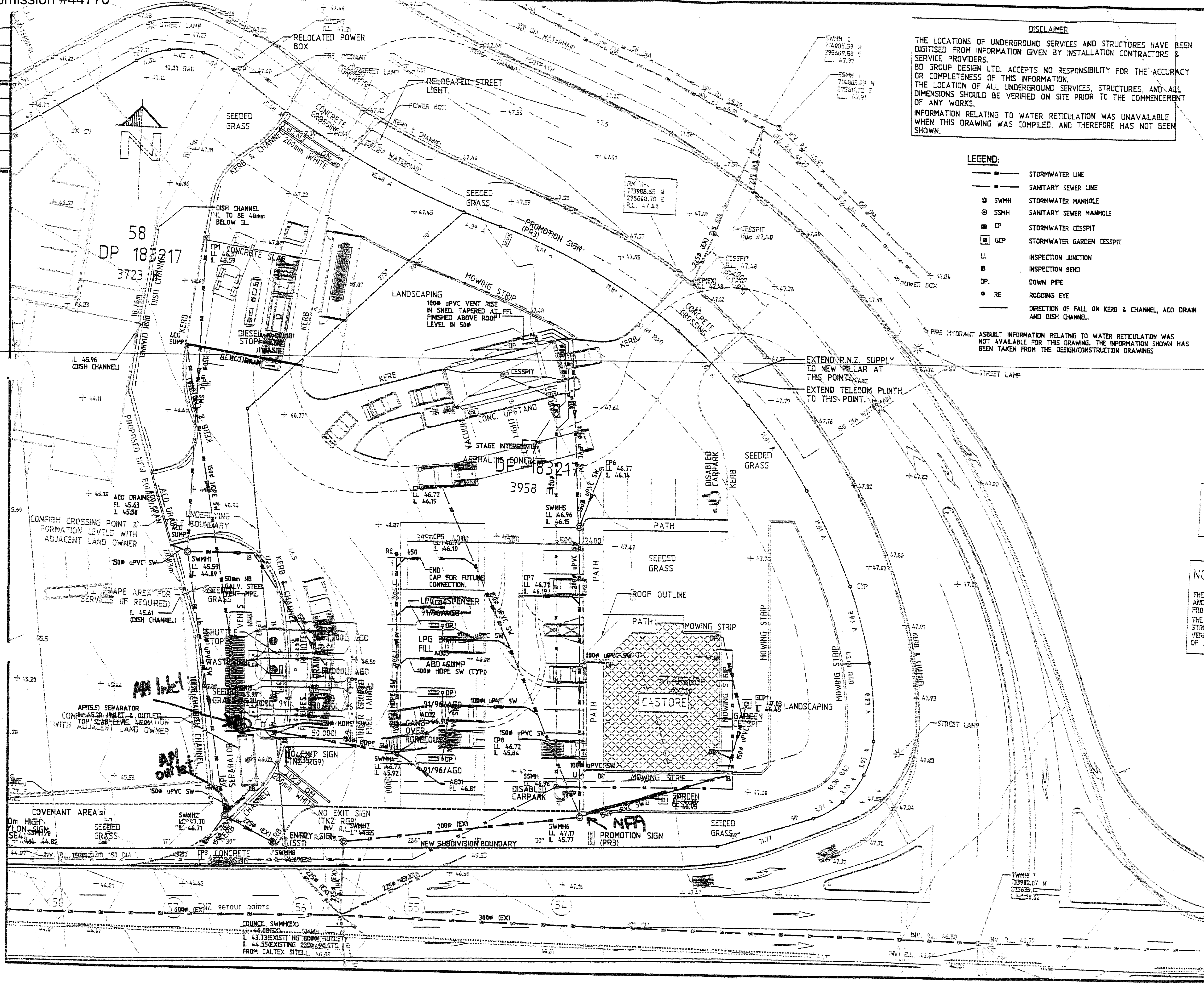
Submission #44770



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CALTEX

BD GROUP DESIGN LIMITED
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Mt. Eden, Auckland
Tel 64 09 638 7766
Fax 64 09 638 7766
dave@bdgroup.co.nz

APPROVALS	INITIALS	DATE
CRC		

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Site U

ASBUILT SITE SERVICES LAYOUT PLAN

DRAWN	DATE	DESIGNED	DATE
N.E.B.	11/2001		
CHECKED	DATE	APPROVED	DATE

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JOB No.	DRAWING No.	REV.
1508	1508ABS02	A

Submission #44770

Appendix C Field Sheets

Appendix D Laboratory Analytical Results

Submission #44770

Auckland Wellington Christchurch

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Stormwater Treatment Devices Monitoring at Representative Z Service Stations in the Auckland Region

Z Energy Limited

***solutions** for your environment*

Submission #44770

Stormwater Treatment Devices Monitoring at Representative Z Service Stations in the Auckland Region

Prepared for

Z Energy Limited

October 2013

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Quality Control Sheet

TITLE	**Stormwater Treatment Devices Monitoring at Representative Z Service Stations in the Auckland Region**
CLIENT	Z Energy Limited
VERSION	Final
DATE	25 October 2013
JOB REFERENCE	A02579800
SOURCE FILE(S)	A02579800_R001

DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Hayden Easton

Reviewed by

SIGNATURE

Roger Seyb

Approved by

Keith Delamore

Limitations:

This report has been prepared on the basis of information provided by Z Energy. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information. This report has been prepared by PDP on the specific instructions of Z Energy for the limited purposes described in the report. PDP accepts no liability to any other person for their use of or reliance on this report, and any such use or reliance will be solely at their own risk.

Sampling of water and sediment has been carried out under existing conditions at several service stations under synthetic rainfall conditions modelled using water sprinklers. The results obtained are based on these conditions and could change under different conditions in the treatment devices or under natural rainfall.

The laboratory test results provide an approximation of the concentration of petroleum hydrocarbon compounds and geochemical parameters and are subject to the inherent limitations of the laboratory techniques used for the tests.

PDP has sampled and tested only for those chemicals that are described in this report. The presence or absence of other chemicals at the site is not considered in this report.

Executive Summary

Z Energy service stations have a variety of stormwater treatment devices, ranging from American Petroleum Institute oil-water separators (API), to three and two stage oil-water interceptors. The principal purpose of these installed stormwater treatment devices is to treat stormwater discharges to minimise the potential discharge of contaminants to the environment. The purpose of this project was to determine the typical sediment and water quality performance achieved by these devices. Five Z Energy service stations and two high use commercial/recreational car parks (control sites) were used in this study.

The project methodology was carried out using methods that are in accordance with the Auckland Council's Proprietary Device Evaluation Protocol (Wong *et al*, 2012) and stormwater device technical specifications (Humes, 2006).

Sediment samples were obtained and analysed for the following parameters: heavy metals, polycyclic aromatic hydrocarbons, BTEX, and total hydrocarbons. Water quality samples were obtained and analysed for the following parameters: heavy metals, polycyclic aromatic hydrocarbons, BTEX, total suspended solids (TSS) and total hydrocarbons. In addition, water quality was also analysed with a handheld water quality meter for the following parameters: temperature, dissolved oxygen, pH, electrical conductivity, and oxygen reduction potential. The above analysed contaminant suite is considered appropriate given the vehicle related activities that occur at the Z service stations.

In general, for the sampling events carried out, water quality results identified that the stormwater treatment devices are achieving the effluent discharge requirements of water quality guidelines i.e. Auckland Regional Council Technical Publication 10 (ARC, 2003), and the Ministry for the Environment publication 'Guidelines for Water Discharges from Petroleum Industry Site in New Zealand' (MfE, 1998).

Sediment sampling was carried out in the primary catch pit to the stormwater network, or the primary chamber of the treatment device at each site. All rainfall events used in this project were synthetically generated. Rainfall was produced by applying water (sourced from a fire hydrant) via sprinkler across the sample drainage area. The rainfall intensity applied at each site depended upon the type and size of the device present. Water quality sampling involved the collection of first flush water and discharges at intervals of 10 and 30 minutes after the collection of the first flush sample.

A key driver of the quantity of sediment captured is the extent of landscaped areas adjacent to and within the service stations. Catch pits and oil water separators/interceptors are capturing high concentrations of these contaminants.

Contaminant concentrations obtained from within forecourt drainage areas, were commonly greater than non-forecourt drainage areas. Removal of accumulated sediments within catch pits/treatment devices should be based on the rate at which the potential contaminant load is produced within the site.

Oil water separators (API's) achieved a TSS removal performance of between 72% and 42% for the events sampled. The three stage oil water interceptor produced a TSS removal performance of 54% for the event sampled. All sites complied with MfE (1998) guidelines by achieving an average effluent discharge of 100 mg/L TSS for the duration of the design storm.

It is important to recognise that the actual TSS loads discharging into the devices were low. Similar studies on treatment devices such as Upflo filters show comparable performance at low sediment loads.

All stormwater discharges from the service stations that were assessed had TPH concentrations less than the required MfE (1998) discharge standard (15 mg/L).

The site effluent discharge concentrations of copper, zinc, and chromium in the water column often exceeded ANZECC (2000) 95% protection level triggers. Copper and zinc protection levels were commonly exceeded in both control car parks also. This result is expected due to the vehicular activities present at the sites. For the events monitored, dissolved heavy metal concentrations are greatest in non-forecourt areas.

In comparison to other similar studies (URS, 2008), mass loads obtained in this project were considered to be similar.

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Appendices

1.0 Introduction

Z Energy Limited (Z) has engaged Pattle Delamore Partners Limited (PDP) to obtain information to define the stormwater discharge quality from forecourt and non-forecourt areas of Z service stations.

Z service stations have a variety of stormwater treatment devices, ranging from American Petroleum Institute oil-water separators (API), to three and two stage oil-water interceptors. The principal purpose of these installed stormwater treatment devices is to minimise the discharge of separate phase hydrocarbons arising from fuel spillage on the forecourt. A secondary beneficial effect of the interceptors is the capture of sediment run-off from the forecourt areas. The devices are also required to meet water quality requirements set out in resource consents and regional plans. Typically this means meeting discharge quality criteria as described by Auckland Regional Council Technical Publication 10 (ARC, 2003), and the Ministry for the Environment publication 'Guidelines for Water Discharges from Petroleum Industry Sites in New Zealand' (MfE, 1998).

1.1 Project Objectives

The objectives of this project are to understand:

- The design, operation, performance and achievable water quality discharge from the various types of stormwater treatment devices (oil-water separators/interceptors) located at Z service stations;
- The physical segregation of forecourt (areas that provide for the dispensing of petroleum products) and non-forecourt areas (areas that do not provide for the dispensing of petroleum product) of service stations;
- The activities that take place in non-forecourt areas of Z service stations;
- The quality of stormwater discharges from non-forecourt areas of service stations; and
- The quality of stormwater discharges from representative control drainage areas, so to allow comparative assessments to be made with Z service stations.

1.2 Project Scope of Works

In order to achieve the above project objectives, the following project scope of works were carried out:

- Identification of five Z service stations that are regarded as 'typical' in the Auckland region. In this context, 'typical' relates to the size of the service station, the traffic volume through the station, and the potential generation of stormwater and sediment contaminants.
- Collection of stormwater samples from the selected five service station sites, which demonstrate the quality of:
    - stormwater influent entering the stormwater treatment device;
    - treated stormwater effluent discharging from the stormwater treatment device; and

  - stormwater discharging from non-forecourt areas at each of the five service stations.
- Collection of stormwater samples from two control sites, where control sites represent typical public/commercial car parks.
- Collection of sediment samples from the primary treatment device chamber (either a pre-treatment catchpit, or the primary chamber of the stormwater treatment device) at each of the selected service stations to determine the quality of sediment retained within the footprint of Z service stations.
- Collection of sediment samples from non-forecourt areas at each of the five service stations.
- Collection of sediment samples from two control sites, where control sites represent typical public/commercial car parks.
- Assessments of each of the selected service station sites to determine, to the extent necessary, whether on site drainage systems comply with the 'Guidelines for Water Discharges from Petroleum Industry Site in New Zealand, Ministry for the Environment, 1998' (the MfE Guidelines).
- Calculation of the total approximate annual contaminant yield from the monitored Z service stations.
- Preparation of a report detailing the findings of the investigation.

1.3 Report Structure

The following report has been structured in the following key sections:

- Introduction; a brief summary of the project purpose.
- Relevant guidelines; an assessment of relevant local and national guidelines that are relevant to this project.
- Site selection; a discussion on the sites used in this project and the process as to how they were selected.
- Sampling methodology; a step by step discussion on the methodology used to obtain the relevant datasets.
- Results; detail on the results obtained during the project.
- Discussion; an analytical discussion on the results obtained, and what they imply.
- Conclusion; a summation of key project findings.

2.0 Consenting Framework and Relevant Guidelines

The following section provides a discussion on the consenting framework by which Z service stations (or any service station) are assessed. Also discussed, are the relevant guidelines to which Z service stations are required to comply, to meet the given consenting framework. Information is given regarding the individual standards and how these standards are to be monitored.

2.1 Consenting Framework

The consenting framework for stormwater discharges which Auckland service stations are required to achieve is a combination of industrial trade activity rules (Rules 5.5.14 to 5.5.19 of the Auckland Council Plan: Air, Land, and Water) and stormwater discharge rules (Rules 5.5.1 to 5.5.5 of the Auckland Council Plan: Air, Land, and Water and Chapter H (Natural Resources) Rules 4.8 of the proposed Auckland Unitary Plan). The relevant rules differ in relation to the differing activities that occur within the forecourt (an industrial trade activity area) and the non-forecourt (stormwater discharge area).

The differing rules associated with the various areas within a service station leads also to differing discharge standards. For the forecourt area (the industrial trade activity area) stormwater discharges are commonly required to meet the standards provided by MfE (1998). The non-forecourt area however, is commonly required to meet the discharge standard defined within Auckland Council Technical Publication 10.

Discussion of each of these documents, as well as other relevant documents that are also commonly referenced, is provided in the following sections.

2.2 Ministry for the Environment

The Ministry for the Environment publication ‘Guidelines for Water Discharges from Petroleum Industry Site in New Zealand’ (MfE, 1998) provides guidelines to assist petroleum industry site owners to ensure water discharges from their sites meet the water quality objectives in regional policy statements and plans.

The two key objectives that stormwater discharge effluent quality is required to achieve are:

- An average 100 mg/L Total Suspended Solids for the duration of the design storm.
- An average 15 mg/L Total Petroleum Hydrocarbons for the duration of the design storm.

2.3 Auckland Council

2.3.1 Technical Publication 10 (TP10)

Technical Publication 10 (TP10) is the Auckland Council’s guidance manual for the design of stormwater treatment devices within the Auckland region. Chapter 13 of TP10 provides specific guidance for the design and management of oil-water separators.

The key design criterion of TP10 for discharge quality from oil-water separators is the removal of oil and grease down to 15 mg/L using a 15 mm/hr rainfall intensity.

2.3.2 Proprietary Device Evaluation Protocol (PDEP)

The Proprietary Device Evaluation Protocol (PDEP) (Wong *et al.*, 2012) provides guidance to local and international proprietary device manufactures on how stormwater proprietary devices may become Auckland Council verified. A verified device may then be used by consent holders as a device that meets TP10 water quality objectives, i.e. by utilising a verified stormwater treatment device for an activity that requires consenting, the Auckland Council will have confidence/knowledge of the discharge quality that can be achieved.

Whilst Z are not seeking to achieve verification of the stormwater treatment devices that are present at their service stations, the PDEP however does provide discussion on the stormwater monitoring methodologies that may be used to assess the performance of proprietary devices, e.g. synthetic storm generation, manual grab sampling techniques, and laboratory analysis methods and these have been considered in this study.

2.4 Australia New Zealand Environment and Conservation Council (ANZECC)

The Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000) provide discharge water quality trigger values for both freshwater and marine receiving environments. ANZECC (2000) also provides sediment quality guidelines.

For each receiving environment (be it freshwater or marine), ANZECC (2000) provides a range of different water quality trigger values for a level of protection that must be observed within the given receiving environment e.g. a 99% protection level is for a unmodified receiving environment with high conservation/ecological value, 95% or 90% protection is given for receiving environments with slightly to moderately disturbed systems where aquatic diversity may have been adversely affected, whilst a 80% protection level is provided for highly disturbed receiving environment of low ecological value. For the purposes of this project, monitoring results will be compared to the 95% level of protection, as well as the 80% level of protection. The former has also been selected to be consistent with similar service station assessments that have previously been carried out (URS, 2008)

Table 1 below presents the 95% and 80% level of protection trigger values (for freshwater receiving environments) for the parameters that were assessed in this project.

Table 1: ANZECC (2000) 95% and 80% Protection Level trigger values for Freshwater Receiving Environments

Parameter	Units	ANZECC (2000) 95% Protection trigger value	ANZECC (2000) 80% Protection trigger value
Naphthalene	g/m^3	0.016	0.085
Dissolved Arsenic	g/m^3	0.013	0.140
Dissolved Cadmium	g/m^3	0.0002	0.0008
Dissolved Chromium	g/m^3	0.001	0.040
Dissolved Copper	g/m^3	0.0014	0.0025
Dissolved Lead	g/m^3	0.0034	0.094
Dissolved Nickel	g/m^3	0.011	0.017
Dissolved Zinc	g/m^3	0.008	0.031
Benzene	g/m^3	0.95	2.00
m&p-Xylene	g/m^3	0.2	0.340
o-Xylene	g/m^3	0.35	0.640

It must be recognised that the standards provided in Table 1 are based on a discharge that has undergone reasonable mixing processes within the receiving environment. Due to the discharges being monitored directly at the influent and effluent of a stormwater treatment device or catch pit, comparison of results to the ANZECC (2000) must be considered as being conservative, i.e. the results could be higher and still meet ANZECC (2000) triggers at the receiving environment due to dilution and mixing effects.

The above trigger values presented in Table 1 are not regulatory standards. ANZECC (2000) notes that the interpretations of the trigger values are primarily for the initiation of management responses, i.e. they may trigger an investigation. ANZECC (2000) quotes the following:

'If a trigger value listed is exceeded at a site, further action results. The action can be:

- *Incorporation of additional information or further site-specific investigation to determine whether or not the chemical is posing a real risk to the environment. The investigation may determine the fraction of the chemical in the water that organisms can take up (the bioavailable fraction) to use for comparing with the trigger value. The investigation and/or regular monitoring may also result in refinement of the guideline figure to suit regional or local water quality parameters and other conditions. Such refinement would occur where exceedance of the trigger value was shown to have no adverse effects upon the ecosystem; alternatively*

- *Accept the trigger value without change as a guideline applying to that site and initiate management action or remediation.'*

Furthermore, ANZECC (2000) notes '*These trigger values should not be considered as blanket guidelines for national water quality, because ecosystem types vary so widely throughout Australia and New Zealand. Such variations, even on a smaller scale, can have marked effects on the bioavailability, transport and degradation of chemicals, and on their toxicity.'*

The above ANZECC (2000) statement implies that even if a trigger value is exceeded, it may not necessarily need a management approach, as the quality of the discharge needs to be placed in context with the receiving environment in which it is discharged.

Similar to water quality, ANZECC (2000) provides multiple sediment quality trigger values for differing levels of protection. Interim Sediment Quality Guideline-Low (ISQG-Low) and Interim Sediment Quality Guideline-High (ISQG-High) are based from the US National Oceanic and Atmospheric Administration (NOAA) listings, which ANZECC corresponds to the effects range-low and effects range-median, respectively (ANZECC, 2000). These guideline values are however, not appropriate for assessing the sediment quality from the Z service stations. Sediment collected from the Z service stations is from stormwater treatment devices, where a high proportion of the sediment load discharging from the site is expected to be retained, whereas the ISQG trigger values are based on sediment in the receiving environment where any untreated sediment load from the service station is likely to be a very small proportion of the total stream sediment load.

2.5 Auckland Regional Council Technical Publication 153

Auckland Regional Council Technical Publication 153 'Background Concentrations of Inorganic Elements in Soils from the Auckland Region' (ARC, 2001) presents ranges of background concentrations of trace elements in Auckland soils. Ranges are presented for non-volcanic and volcanic soils, where applicable.

The purpose of presenting this information is to identify if measured concentrations from the sample sites contain heavy metal concentrations that are attributable to the sediment sources that are tracked on to or derived from the area surrounding the service stations (i.e. landscaping).

Table 2 below presents the background concentrations of trace element in Auckland soils that are specific to this project.

Table 2: Background Ranges of Trace Elements in Auckland Soils (ARC, 2001)

Element (Total Recoverable)	Non-Volcanic Range	Volcanic Range
Arsenic	0.4-12	
Cadmium	<0.1-0.65	
Chromium	2-55	3-125
Copper	1-45	20-90
Lead	<1.5-65	
Nickel	0.9-35	4-320
Zinc	9-180	54-1160

Notes: 1. All values are presented as (mg/Kg).
2. Table only presents elements that are measured in this project.

All service stations monitored in this project (discussed in Section 3) are located on soils with a volcanic origin. The highest concentrations presented in Table 2 are therefore used as indicators for the service station contributions of heavy metals.

3.0 Site Selection

The five Z service stations selected for this project were:

- Z Browns Road; located in Wiri in an industrial/residential area.
- Z Highbrook; located in Highbrook in an industrial catchment.
- Z Hunters Corner; located in Papatoetoe in a commercial/residential area.
- Z Lakeside; located in Takapuna in a commercial/residential area.
- Z Sylvia Park; located south of Mt Wellington in an industrial area.

For the purposes of confidentiality, the two control sites used in this project are not named in this report. Both sites however, are described as 'high use' car parks relating to commercial/recreational activity (based on a qualitative assessment of relative use). Control Site A resides in a predominantly residential catchment, whilst Control Site B is based within a predominantly mixed use residential/commercial catchment. Further discussion on both sites is provided in Section 3.4.

To achieve the objectives of this project, the Z sites selected had to achieve a specific set of criteria:

- Be representative of the average stormwater treatment provided by Z service stations;
- Have drainage area characteristics that are common for Z service stations; and
- Have traffic volumes that are common for the majority of Z service stations.

Using the above criteria, sites were selected using a two stage process. Stage one involved a desktop review of all Auckland Z services station drainage plans to determine the characteristics of the stormwater network and associated stormwater treatment devices. Once a list of potential sites was identified, an on-site inspection was undertaken (stage two), to assess the ease of monitoring and the prospects of achieving successful monitoring outcomes.

3.1 Stormwater Treatment Devices

A range of stormwater treatment devices are present across Z service stations in the Auckland region. Devices range from:

- API oil-water separators (of various sizes);
- Three stage oil-water interceptors; and
- Two stage oil-water interceptors.

API oil-water separators are the most common and therefore in this project, have been given a greater priority in site selection.

For this project, the selected sites have the following stormwater treatment devices:

- Z Browns Road: Three Stage oil-water interceptor.
- Z Highbrook: Humes API oil-water separator (model 5500).
- Z Hunters Corner: Humes API oil-water separator (model 3000).
- Z Lakeside: Two Stage oil-water interceptor.
- Z Sylvia Park: Humes API oil-water separator (model 3500).

3.2 Design of the Monitored Stormwater Treatment Devices

The following section discusses the design of the various stormwater treatment devices monitored in this project.

3.2.1 Two Stage Interceptor

The two stage interceptor located at Z Lakeside is comprised of two cesspits in series.

The system has an estimated 0.2 m^3 of available detention, with an estimated 0.07 m^3 available for floatable hydrocarbon retention (i.e. the live storage volume). Note this site has been programmed for a drainage upgrade.

3.2.2 Three Stage Interceptor

The three stage interceptor is a series of three manhole systems comprising manhole risers, bases, lids, and covers. An estimated 3.1 m^3 of detention is provided by this interceptor, with an estimated 0.5 m^3 available for floatable hydrocarbon retention (live storage volume). As an additional component of the three stage interceptor, Z has installed a ball valve. The purpose of this valve is to allow for the disconnection of the stormwater discharge from the public stormwater network in the instance of a spill event occurring.

3.2.3 API Oil-Water Separators

The API oil-water separator provides separation of oil and water runoff from a range of land uses that involve hydrocarbon products. The API unit comes in a range of sizes to accommodate differing catchment areas. Depending on size, an API unit may have two to four independent chambers to manage runoff. These chambers are divided by a single grill and baffle(s) to allow oil droplets to float while stormwater can pass beneath. The grill is made from galvanised steel, whilst all other components are pre-cast concrete.

All API units also have an emergency shut-off valve to allow for the containment of any excessive accidental spills.

API units have been tested by various distributors within New Zealand (Humes and Hynds Environmental). Both distributors state that API units can achieve the requirements of ARC TP10 (2003) and MFE (1998) by being able to:

- Retain at least 2500 litres of petroleum spill; and
- Discharge less than 15 parts/million total petroleum hydrocarbons dissolved in the stormwater effluent.

MfE (1998) includes a simulated spill event where the API was filled with product and the effluent was sampled. This demonstrated that an API can achieve a discharge with less than 15 mg/L of TPH whilst retaining a large volume of product. In practice this is an overly conservative scenario. As such, a spill event can only occur during filling when a trained tanker driver will be present to turn off the API separator’s emergency shut off valve (preventing through-flow) and arrange an immediate pump out of the interceptor by a contractor. The study does however demonstrate that the API a robust device with respect to minimising off-site hydrocarbon discharges.

The other aspect of service station run-off that has come into focus is the potential for elevated levels of heavy metals in run-off. The API separator was not designed to address sediments but the retention times required to fulfil its primary purpose of hydrocarbon treatment result in a sediment control function.

Table 3 provides specific specification details for the various API monitored. Information is provided by Humes (Humes, 2006).

Table 3: API Specification Details (Humes, 2006)

Model Reference	**API3000**	**API3500**	**API4000**	**API4500**	**API5000**	**API5500**
Capacity for petroleum product (m^3)	3.0	3.63	4.25	4.88	5.5	6.13
Design Flow (m^3/hour)	2.45	2.95	3.45	3.95	4.35	4.80
ARC (2003) design criteria						
Design flow (m^3/hour)	1.75	2.10	2.40	2.75	3.05	3.40
Orifice size diameter (mm)	21	23	25	27	28	30
Catchment area (m^2)with 15 mm/hour rainfall event	117	140	160	183	203	227

3.3 Forecourt and Non-Forecourt Areas

Sampling was required in both the forecourt (within the refuelling bays) and non-forecourt areas (commonly the ingress or egress areas to the service station). When selecting the forecourt and non-forecourt areas for each monitored site, the following considerations were made:

- Whether the stormwater runoff would contain sufficient contaminant load to meet laboratory levels of detection when analysed, i.e. the drainage area had to be of sufficient size to allow a required minimum contaminant concentration to be mobilised.
- In contrast however, the area cannot be too large as it would change:
  - The intensity of rainfall applied across the drainage area, i.e. all stormwater treatment devices monitored are designed by flow rates, therefore the design rate at which rainfall is to be applied to a drainage area (to meet 100% performance of a device) does not alter. If therefore, the drainage area was too large, a lower rainfall intensity would have to be applied, which may limit the mobilisation of contaminants.

- The operation of the service station. The project requires shutting down an area of the service station; if the drainage area is too large, this excluded area would affect the operation of the site.

It is recognised that by not applying simulated rainfall (discussed in Section 4.1) across the entire forecourt area that drains to the stormwater treatment device, this may not reflect the true potential contaminant load that may enter the device. This however, can be compensated for by the following;

- In a 'normal' situation, the entire forecourt drainage area does not provide stormwater runoff to the device, due to the drainage area being roofed via a canopy. Rainfall can only enter a forecourt via rainfall blown by the wind on to the forecourt, or by vehicle tracking.

In addition to the above considerations when selecting forecourt and non-forecourt drainage areas, the following assumptions were made:

- Within the forecourt drainage area at each site, the dispensers directly in front of the retail shop entrance were always included in the sampled drainage area. We assume that these dispensers are the ones most frequently used by patrons.
- The quantity of hydrocarbon staining within a forecourt provides a visual indication on the potential hydrocarbon load present within the drainage area. If a large area of hydrocarbon staining was observed, it was deemed appropriate that the sampled drainage area be reduced (as the load was anticipated to be sufficiently high to achieve the sampling objectives).

Using the above methodology to determine appropriate forecourt and non-forecourt sampling areas, we consider that the catchments selected are generally representative of each site.

3.3.1 Ministry for the Environment Classification

MfE (1998) provides guidance and specifications to allow for the classification of drainage areas within service stations. This classification was used to ensure that specific activities were carried out in selected Z service stations. The MfE (1998) guidance provides four categories, these are:

Category 1 - Drainage systems are dedicated to capture and dispose of stormwater from roof areas, paved open areas and unpaved areas.

Category 2 - Drainage systems are dedicated to capture and dispose of stormwater and product spills from beneath the canopy where vehicle fuelling takes place, and from the slab around the remote fill points.

Category 3 – Drainage systems on site are dedicated to the capture of wastes from car washes, toilets, ablutions and kitchens and similar wastes for disposal to sewers.

Category 4 - Drainage systems are dedicated to the capture of washings and waste from workshops.

Table 4 presents the categories that are present at each service station selected for this project.

Table 4: MfE Drainage Classification Present at Sample Sites (MfE, 1998)

Site	Category 1			Category 2			Category 3			Category 4			Comments
	Y	N	N/A	Y	N	N/A	Y	N	N/A	Y	N	N/A	
Z Browns Road	√			√			√					√	Car wash now decommissioned
Z Highbrook	√			√			√					√	Includes a truck refuelling station
Z Hunters Corner	√			√			√					√	
Z Lakeside	√			√			√					√	
Z Sylvia Park	√			√			√					√	

For the purposes of this project, and to ensure no cross contamination could occur from the individual drainage networks, all selected sites had separate drainage networks for categories 1 to 3.

3.4 Control Sites

Two control sites (two ‘high use’ uncovered car parks) were used in this project. The objective of the control sites was to determine what is the ‘typical’ stormwater quality discharged from sites with a similar traffic volume. These results can then be used for comparison purposes against a service station, but without vehicle refuelling activities present.

Whilst no traffic counts have been made, vehicles that enter these two car parks range from standard passenger vehicles, to commercial buses. The two car parks service recreational and commercial Auckland facilities that have approximately 850,000 and 950,000 visitors on an annual basis, respectively.

4.0 Monitoring Methodology

The following section describes the methodology used to assess the average performance of the stormwater treatment devices.

The methodology was developed in accordance with guidance presented in Wong *et al.* (2012), ‘Proprietary Devices Evaluation Protocol (PDEP) for Stormwater Quality Treatment Devices’, and technical specifications for the treatment devices (Humes, 2006).

The monitoring and sampling methodology was discussed with Auckland Council officers to allow opportunity for Council to provide input. Where feedback was provided (as discussed in section 4.6), this was incorporated into the sampling methodology.

4.1 Synthetic Rainfall

All rainfall events used in this project were synthetically generated. Rainfall was produced by applying water (sourced from a fire hydrant) across the sample drainage area via an array of up to eight sprinklers.

Sprinklers used in this project were selectively chosen to ensure that droplets were produced, rather than a mist. This was to ensure the characteristics of natural rainfall are achieved.

Each sample drainage area assessed (forecourt, non-forecourt, or control) had sprinklers arranged so an even distribution of rainfall was applied. Field notes were made describing the extent of the synthetic rainfall achieved during each assessment.

4.1.1 Rainfall Intensity and Flow Rate Calculations

Synthetic rainfall was applied across drainage areas at pre-determined flow rates. For each drainage area, flow rates and rainfall intensities were calculated using the following key principles:

1. For forecourt drainage areas that are treated by API oil-water separators, the peak design flow rate for the device (that drains the subject forecourt drainage area) was used, i.e. the applied rainfall intensity was determined from the maximum flow rate that the device can provide stormwater treatment for, before the emergency bypass structures are enabled.
2. For forecourt drainage areas that are treated by two or three stage interceptors, the rainfall intensity was determined by what was equivalent (in respect to drainage area) to the API model 5500 peak design flow rate. The key rationale for this methodology was to ensure that all sites could be compared, given that the maximum flow rate which an interceptor device can receive is much greater than an API separator i.e. the maximum design flow of an interceptor is defined by the effluent pipe (commonly a 150 mm dia. pipe) from the separator.
3. All rainfall intensities applied to control sites followed the same assumptions as above (principle 2).
4. For non-forecourt drainage areas, the same rainfall intensity as that applied to the site's respective forecourt drainage area was used. This was to ensure a comparison between the two drainage areas could be carried out.

In regards to principle 1 above, the peak flow rate for each API oil-water separator model was sourced from the Humes website (www.humes.co.nz).

Table 5 below presents the drainage areas irrigated, the predetermined flow rates and their respective equivalent rainfall intensities that were applied to drainage areas with oil-water separators/interceptors.

Table 5: Flow Rates and Equivalent Rainfall Intensities applied to Sampled Drainage Areas

Site Reference	Stormwater Treatment Device	Drainage Area (m^2)	Determined Flow Rate (L/s)	Equivalent Rainfall Intensity (mm/hour)
Z Browns Road	Three Stage oil-water interceptor	131	1.3	40
Z Highbrook	API oil-water separator (model 5500)	99	1.36	49
Z Hunters Corner	API oil-water separator (model 3000)	62	0.69	40
Z Lakeside	Two Stage oil-water interceptor	118	1.5	34
Z Sylvia Park	API oil-water separator (model 3500)	115	0.8	26
Control Site A	Nil	155	1.3	31
Control Site B	Nil	152	1.3	32

Device information sourced from the Humes website includes design drainage areas for respective design rainfall intensities. To ensure and verify that the above proposed rainfall intensities/flow rates (as provided in Table 4) are consistent with the API's devices design specifications, an assessment of the pre-determined flow rates and equivalent rainfall intensities was carried out. Graphical information that illustrates this assessment is provided in Appendix B.

Results from this assessment indicate that the determined flow rates are consistent with design specifications provided by Humes.

4.1.2 Applying Determined Flow Rate

To ensure that the determined flow rates are correctly applied to the respective drainage areas, flow rates were calibrated in the field using two methods:

1. Using the flow meter included with the fire hydrant standpipe; and
2. By carrying out volumetric assessments.

For the volumetric assessments, the following procedures were carried out:

- Water discharged from sprinklers was placed within a 20 L container;
- The time to fill the 20 L container was measured;
- The flow rate was then either adjusted or further sprinklers were included/removed (if required), with the above steps repeated to achieve the desired flow rate.

4.2 Site Maintenance Pre Sampling

During site reconnaissance (prior to sampling) PDP staff observed, for most service station sites, stormwater drainage (commonly catch pits or ACO drains) to the treatment devices was impaired by organic matter. In most instances, the organic matter was vegetation from nearby landscaped areas. This would limit the stormwater entering the stormwater treatment device. Site maintenance was therefore necessary to ensure the project objectives were achieved. Organic matter within the stormwater treatment devices and stormwater catch pits was not removed.

The accumulation of sediment in these stormwater devices indicates that they reduce sediment run-off from the sites. The methodology does not allow an assessment of the primary sedimentation occurring in these systems as the sampling of device influent occurs after the ACO drains.

Once site maintenance was carried out, all water quality assessments were carried out as soon as practicably possible.

4.3 Sediment Sampling Methodology

The following section describes the sediment sampling methodology.

All sediment sampling was carried out prior to any maintenance actions (as described in Section 4.2 above) were undertaken.

4.3.1 Sample Locations

Sediment samples were collected at the following locations:

- For forecourt drainage areas, sediment samples were obtained from either the first catch pit (pre-treatment catch pit) in the stormwater reticulation that collects water from the forecourt, or if no pre-treatment catch pit was present, the sample was collected from the primary chamber of the stormwater treatment device.
- For non-forecourt and control site drainage areas, the sediment sample was obtained from the stormwater catch pit that drains the subject sample drainage area.

4.3.2 Sample Collection

All samples were collected using manual grab methods i.e. via a collection container attached to mighty grippers. All sampling equipment was washed with Decon 90 detergent between sites to ensure no cross contamination could occur.

All sediment samples collected were placed on ice and stored in chilly bins to minimise the possibility of samples undergoing thermal and/or photo degradation. Sediment samples were then couriered to Hills Laboratories (IANZ Accredited) for analysis within 24 hours of collection. All sediment samples were analysed at screen levels of detection.

4.3.3 Contaminants of Concern

Sediment samples were assessed for the following suite of contaminants, which are considered to be typical of the metal and petroleum compounds found on vehicular pathways:

- Total Petroleum Hydrocarbons (TPH);
- Benzene, toluene, ethyl benzene, xylene (BTEX)
- Polycyclic Aromatic Hydrocarbons (PAH);
- Total heavy metals, consisting of:
    - Arsenic;
    - Cadmium;
    - Chromium;
    - Copper;
    - Lead;
    - Nickel; and
    - Zinc.
- pH.

In addition to the above suite of contaminants, sediment grain size was assessed. All sediment grain size analysis was conducted using the University of Waikato's MALVERN Mastersizer 2000 particle size analyser (a laser particle size analyser that measures the diffraction of the laser beams to detect the range of particle sizes present). This instrument is specifically designed for measuring sediment grain sizes between 0.02 - 2000 μm.

4.4 Water Quality Sampling Methodology

The following section describes the methodology used to obtain water quality data. The methodology was carried out using methods that are in accordance with the Auckland Councils Proprietary Device Evaluation Protocol (Wong *et al*, 2012) and stormwater device technical specifications (Humes, 2006).

4.4.1 Sample Locations

Samples were collected at the following locations:

- For forecourt drainage areas, influent water quality samples were collected from either the first catch pit (pre-treatment catch pit) in the stormwater reticulation that collects water from the forecourt, or if no pre-treatment catch pit was present, the sample was collected from the influent pipe that discharges to the primary chamber of the stormwater treatment device.

- Effluent water quality samples were collected at the location where effluent water (from the stormwater treatment device) discharged to the stormwater reticulation network. In all sample sites monitored, this was directly adjacent to the stormwater treatment device.
- For non-forecourt and control site drainage areas, water quality samples were obtained from the stormwater catch pit that drains the subject sample drainage area.

All sample locations described above, are illustrated in figures provided in Appendix A.

4.4.2 Sample Collection

Whilst the characteristics of the synthetic storm event may vary from site to site, the stormwater sampling methodology is consistent for each site monitored. Key water quality sampling attributes used in this project were:

- Water quality sampling was only conducted if at least three days dry antecedent weather conditions had occurred.
- A total of eight stormwater samples were collected from each service station, comprising:
  - One ‘first flush’ stormwater sample collected from initial stormwater discharge into the stormwater treatment device.
  - One ‘mid flow’ stormwater sample at the stormwater treatment device, collected approximately 30 minutes after the first flush sample was obtained (dependent on the size of the stormwater treatment device chambers).
  - One ‘first flush’ stormwater sample collected from initial stormwater discharge as it exits (effluent) the stormwater treatment device.
  - One ‘mid flow’ stormwater sample from discharge exiting the stormwater treatment device. This is collected approximately 30 minutes after the first flush effluent sample was obtained.
  - One ‘first flush’ stormwater sample collected from initial stormwater discharge into the catch pit from the ‘non-forecourt’ drainage area.
  - One ‘mid flow’ stormwater sample at the catch pit draining the ‘non-forecourt’ drainage area, collected approximately 30 minutes after the first flush sample was obtained.
  - One sample of the fire hydrant water used to create the synthetic storm. This sample is used to test the presence of contaminants before passing across the test areas.
- All stormwater/water samples were collected using manual grab sampling methods. A sampling pole (mighty gripper) was used (when required) to reduce risk to staff.
- All sampling equipment was washed with Decon 90 detergent between sites to ensure no cross contamination could occur.

- All samples were placed within ice filled chilly bins to ensure samples did not undergo photo and thermal degradation.
- Field notes and photographs were taken during the collection of samples at all sites.

4.4.3 Contaminants of Concern

All water quality samples collected were laboratory analysed for the following contaminants, which are considered to be typical of the metal and petroleum compounds found on vehicular pathways:

- Total Petroleum Hydrocarbons (TPH);
- Benzene, toluene, ethyl benzene, xylene (BTEX);
- Polycyclic Aromatic Hydrocarbons (PAH);
- Total heavy metals, consisting of:
  - Arsenic;
  - Cadmium;
  - Chromium;
  - Copper;
  - Lead;
  - Nickel; and
  - Zinc.
- Dissolved heavy metals (consisting of the same metal suite as total heavy metals);
- Total Suspended Solids;
- pH; and
- Electrical conductivity.

Where relevant, water quality samples were analysed at screen levels of detection.

In addition to the above contaminants, field measurements were collected using a handheld water quality sensor (Professional Plus YSI Multiparameter Handheld with Quatro Probe or a Horiba Multiparameter Water Quality U-50 series) for the following parameter suite:

- Dissolved oxygen (% Saturation);
- Temperature (˚C);
- Oxygen reduction potential (mV); and
- Turbidity (NTU)

4.5 Sample Collection Timing

Sediment and water quality sampling at each Z service station was undertaken on differing days. Sediment sampling occurred prior to the site maintenance discussed in Section 4.2 and was completed during the period 15 January 2013 to 21 January 2013. The collection of sediment and water quality samples from Control Sites A and B was undertaken on 28 February 2013. Water quality sampling at the Z service stations was carried out once site maintenance (as discussed in Section 4.2) for all service stations was completed. This occurred during the period 13 March 2013 and 26 March 2013.

4.5.1 Antecedent Rainfall Conditions

Table 6 below presents the date in which water quality samples were obtained, and the respective period of dry antecedent weather conditions prior to sampling.

Table 6: Antecedent Weather Conditions prior to sampling

Site	Date Sampled	Days of Dry Antecedent Weather
Z Browns Road	14/03/2013	10[1]
Z Highbrook	13/03/2013	9[1]
	26/03/2013	6[1]
Z Hunters Corner	14/03/2013	10[1]
Z Lakeside	26/03/2013	6[2]
Z Sylvia Park	13/03/2013	10[1]
Control Site A	28/02/2013	12[1]
Control Site B	28/02/2013	12[1]

Notes: 1. Rainfall data obtained from automatic rainfall station located at Auckland International Airport.
2. Rainfall data obtained from automatic rainfall station located Rosedale Treatment Ponds, Oteha.

4.6 Additional Sample Collection

In consultation with the Auckland Council, it was agreed by PDP and Z that an additional water quality sampling round was to be conducted at one service station. PDP selected Z Highbrook for the additional sampling assessment. The primary purpose of replicating a sample round was to provide quality assurance of data obtained, i.e. to check result repeatability.

During the period in which water quality samples were collected, it was also agreed by PDP and Z that additional water quality samples were to be obtained. This additional sampling was carried out to ensure that the rate at which contaminants were being discharged from the drainage area was being sufficiently determined (i.e. to ensure that the peak discharge of contaminants was being sampled).

In addition to the sampling methodology described in Section 4.4.2, the following was also carried out for Z Lakeside, and the replicated assessment at Z Highbrook:

- One 'mid flow' stormwater sample at the stormwater treatment device, collected approximately 10 minutes after the first flush sample was obtained (dependent on the size of the stormwater treatment device chambers).

- One 'mid flow' stormwater sample from the discharge exiting the stormwater treatment device. This was collected approximately 10 minutes after the first flush effluent sample was obtained.
- One 'mid flow' stormwater sample at the catch pit draining the 'non-forecourt' drainage area, collected approximately 10 minutes after the first flush sample was obtained.
- Time interval turbidity measurements (via the handheld water quality meter). These measurements were obtained to confirm the rate which contaminants were being discharged from these sites, and to verify the correct sample collection timing was carried out, i.e. were the first flush samples achieving maximum contaminant concentrations.

5.0 Results

The following section presents the results obtained during this project. Field observations made during the collection of samples, and the results of sediment and water quality sampling are provided.

5.1 Field Observations

The following section summarises the field observations made whilst PDP staff obtained samples at all sites.

5.1.1 Z Browns Road

Sediment sampling was carried out on 16 January 2013. The forecourt area sediment sample was collected from the primary chamber of the stormwater treatment device. The sediment grain size obtained was much larger than the sediment obtained from other sites sampled. Sediment comprised mostly of gravels and sands (i.e. 5 mm to 2 mm diameter).

The non-forecourt sediment sample was collected from the catch pit located in the northern corner of the site. This sample was rich in organic matter (leaves and sticks).

The water quality sampling was undertaken on 14 March 2013. The forecourt area was sampled first.

The slot drains on the northern edge of the forecourt were observed to contain organic material and sediment. Four sprinklers were used to simulate the rain event. Stormwater runoff took a long time to travel from the slot drain to the stormwater treatment device's influent sampling location. Stormwater runoff had a slight hydrocarbon odour and was dark in colour. The effluent discharge from the stormwater treatment device was relatively clear during the first flush and the 30 minute sample.

First flush discharge waters from the non-forecourt area had very low clarity and were black in colour. Samples had a strong hydrocarbon odour and an oil sheen was observed on the surface of the water flowing into the catch pit. By the mid-stream sample the stormwater runoff was observed to be much clearer.

5.1.2 Z Highbrook

Sediment sampling was carried out on 15 January 2013. The forecourt area sediment sample was collected from the primary chamber of the stormwater treatment device. Very little sediment was present within the chamber. Sediment collected had a very strong hydrocarbon odour, and water collected with the sediment sample had an oil sheen.

The non-forecourt sediment sample was collected from the catch pit located adjacent to the primary entrance (eastern entrance). This sample was rich in organic matter (leaves and sticks).

Water quality sampling was undertaken at Z Highbrook on 13 March 2013. A second sampling round was conducted on 26 March 2013. In both sampling rounds, the non-forecourt area was sampled prior to the forecourt area.

The location of the non-forecourt area was to the east of the station forecourt. The synthetic rain event was created using four sprinklers. The surface gradient of the area meant the water flowed into the catch pit to the western side of the entrance from Highbrook Drive. The initial first flush was sediment laden and black in colour. The colour of the stormwater runoff became clear however after a few minutes.

Similarly, the forecourt area was sampled in the same location for both sampling rounds (between pumps 2, 3, 4 and 5). The forecourt stormwater runoff drained into catch pits located in the middle of each of the two bays (between pumps 2 and 3, 4 and 5). These catch pits were observed to have oily emulsions floating on their water surface. The influent water to the stormwater treatment device was sampled from a man hole on the eastern side of the site. On both sampling rounds, the effluent from the stormwater treatment device was noted to have a hydrocarbon odour.

5.1.3 Z Hunters Corner

Sediment sampling was carried out on 15 January 2013. The forecourt area sediment sample was collected from the primary chamber of the stormwater treatment device.

Sediment from the non-forecourt area was obtained at the catch pit that provides drainage to the main access route to the refuelling bays.

At both the forecourt and non-forecourt sediment sampling locations, an approximate 2 cm thick layer of sediment was present within the catch pit and API oil-water separator.

Water quality sampling was undertaken on 14 March 2013. The non-forecourt area was sampled prior to the forecourt area at this site.

The synthetic rainstorm for the non-forecourt area was created using six sprinklers to increase the coverage of water.

The non-forecourt first flush of runoff to the catch pit was laden with sediment and was black in colour. Hydrocarbon odour and some sheen were observed. This odour and sheen were not present within a few minutes, and by 30 minutes the water samples obtained were clear and had minimal odour.

The forecourt area of the site has sumps in the middle of each pump bay, and the concrete is graded so water flows into a respective sump. Sumps were inspected prior to commencement of the sampling, and it was observed that a petroleum layer was present (~10 cm in thickness).

The refuelling bay between pumps 2 and 3 had been selected prior to arrival at the site. However, this location had to be altered, due to an obstacle. A sampling drainage area to the pump bay between pumps 4 and 5 was selected instead. Four sprinklers were used to irrigate the forecourt drainage area.

The first flush of water was less sediment-laden than other sites assessed, but samples still had a dark colour. The first flush of water from the API effluent was very foamy and had a detergent odour. This foaming was observed for approximately 20 minutes in the effluent discharge. After 30 minutes, effluent water from the API oil-water separator was clear, although the water quality sample obtained still foamed when poured into the sample vessels (as a result of these observations, Z have re-emphasised to all staff at the petrol station that windscreen wash is not to be discharged to the stormwater drainage system).

5.1.4 Z Lakeside

The sediment sampling was undertaken 21 January 2013. The forecourt area sediment sample was collected from the primary chamber of the stormwater treatment device. A very small amount of sediment (~ 1 cm thick) was present in the base of the chamber.

The sediment sample from the non-forecourt area was taken from the catch pit on the eastern edge of the retail shop, next to a landscaped garden. There was a limited amount of sediment (~ 3-4 cm thick) in the catch pit and the sediment appeared to be organic rich comprising mostly of leaves and sticks.

The water quality sampling was undertaken on 26 March 2013. The forecourt area was sampled prior to the non-forecourt area.

The forecourt area was sampled using four sprinklers. One sprinkler was located to the west of Pump 1, the remaining three between Pumps 2 and 3. Runoff flowed towards the slot drains across the entrance and exit on Taharoto Road. The influent sample was collected in the southern slot drain which accounted for approximately 70% of the flow, the additional 30% of flow went to the northern slot drain. The forecourt influent water sample collected five minutes after the first flush water sample appeared dark in colour. This discoloration was not observed after 30 minutes. The forecourt effluent water sample collected 5 minutes after the first flush water sample was pink in colour and foamed when sampled. By 30 minutes, stormwater runoff was relatively clear and the amount of foaming had reduced when the samples were taken.

The non-forecourt area was sampled using four sprinklers. The non-forecourt water sample collected 5 minutes after the first flush water sample was black in colour. After 30 minutes, the non-forecourt discharge colour was clear. No hydrocarbon odours were noted.

5.1.5 Z Sylvia Park

Sediment sampling was undertaken on 15 January 2013. Sediment for the forecourt drainage area was collected from the ACO drain. The sample was very organic rich and had a very strong hydrocarbon odour.

The non-forecourt sediment sample was collected from the catch pit that is adjacent to the main eastern entrance. As well as draining the main entrance to the service station, this catch pit also provides drainage for a car park area. Sediment within this catch pit was high in leaf litter content.

The water quality sampling occurred on 13 March 2013. The non-forecourt area was sampled prior to the forecourt area.

The non-forecourt area was sampled using four sprinklers, the initial flush of water was full of sediment and black in colour (this was likely due to the high organic content within the sediment), this cleared up by the 30 minute sample.

The influent slot drains to the north of the forecourt contained sediment and organic material. The initial flush of stormwater was heavily sediment laden. The effluent first flush from the API was however clear, but after approximately 2 minutes it turned black. Organic matter was also observed flowing out of the device after 5 minutes. By 10 minutes the discharge appeared to clear and by 30 minutes both the influent and effluent samples appeared clear, but a slight hydrocarbon odour was still present.

5.1.6 Control Site A

Sediment sampling and water quality sampling were conducted in respective order on the same day (28 February 2013).

During the process of obtaining the correct flow rate for fire hydrant water, an orange discharge occurred (likely to be iron oxides within the water supply pipe network). Because of this, fire hydrant water was irrigated over an adjacent grass area (not within the experimental drainage area) for a period of five minutes to ensure all traces of the orange discharge had been flushed.

During the irrigation of the car park, no issues were encountered or observations made that warrant comment.

5.1.7 Control Site B

Sediment sampling and water quality sampling were conducted in respective order on the same day (28 February 2013).

During the irrigation of the car park, no issues were encountered or observations made that warrant comment.

5.2 Sediment Results

Laboratory reports and analytical reports for sediment samples obtained are discussed in the following sections.

5.2.1 Sediment Quality

Appendix C contains the laboratory reports. Table 7 presents a summary of the sediment quality results obtained.

Upon receipt of sediment quality results, a review of data was carried out. This review identified a number of sampled parameters with elevated concentrations (particularly PAH and TPH).

Sites and parameters regarded as having elevated concentrations of PAH and TPH were:

- Z Browns Road Forecourt; Polycyclic Aromatic Hydrocarbons (Total PAH 139.5 mg/Kg)
- Z Browns Road Non-Forecourt; Polycyclic Aromatic Hydrocarbons (Total PAH 1123 mg/Kg)
- Z Highbrook Forecourt; Total Petroleum Hydrocarbons (250,000 mg/Kg)
- Z Sylvia Park Forecourt; Total Petroleum Hydrocarbons (197,000 mg/Kg)

TPH concentrations from Z Hunters Corner forecourt were also elevated. This sample location was not reassessed to confirm the result however, as it was consistent with results obtained by URS (2008).

In order to determine the reliability of the PAH and TPH results obtained, duplicate samples were collected and reanalysed. Table 8 presents results obtained from duplicate samples.

All service stations monitored had one or more heavy metal concentration that exceeded an ARC TP 153 referenced values for background concentrations of heavy metals within Auckland soils. This indicates that activities carried out on Z service stations have potential to contribute heavy metal load to the stormwater network. The highest concentrations were observed at Z Highbrook and Z Sylvia Park. Z Lakeside had heavy metal concentrations with only minor exceedances of ARC TP 153 values.

It is important to note that the results obtained from sediment samples demonstrate the nature of the contaminant within the treatment device, i.e. the measured concentrations are not being discharged from the service station. The concentrations of contaminants being discharged from the service station are provided by effluent water quality results discussed in section 5.3.

Table 7: Sediment Quality Results

		Z Service Station										Control Sites		Guideline
		Z Browns Road		Z Highbrook		Z Hunters Corner		Z Lakeside		Z Sylvia Park		Control Site A	Control Site B	ARC TP 153
Sample Location		Forecourt	Non forecourt	Forecourt	Non forecourt	Forecourt	Non forecourt	Forecourt	Non forecourt	Forecourt	Non forecourt	Stormwater catch pit	Stormwater catch pit	
Sample Field Reference no		BRN SS01	BRN SS02	HBK SS01	HBK SS02	HCR SS01	HCR SS02	LAK SS01	LAK SS02	SLV SS02	SLV SS01	BGC SS01	AMC SS01	
Sample Date		16/01/2013	16/01/2013	15/01/2013	15/01/2013	15/01/2013	15/01/2013	21/01/2013	21/01/2013	15/01/2013	15/01/2013	28/02/2013	28/02/2013	
Sample Parameter	**Units**													
Dry Matter	g/100g as rcvd	49	25	28	42	37	28	68	32	33	39	21	20	
Total Recoverable Phosphorus	mg/kg	1,260	1,040	1,430	1,170	1,730	960	1,000	660	1,270	1,430	2,100	1,560	
pH	pH Units	7.2	6.2	6.3	6.9	8.5	6.5	7.4	7.1	5.7	6.2	-	-	
Total Organic Carbon	g/100g	4.5	24	32	4.5	10.7	12.6	3.0	32	26	14.5	13.5	22	
Acenaphthene	mg/kg	<0.9	<2	<0.9	<0.10	0.66	<0.16	<0.07	<0.15	<0.8	<0.07	<0.11	<0.12	
Acenaphthylene	mg/kg	<0.9	<2	<0.9	<0.10	<0.13	<0.16	<0.07	<0.15	<0.8	<0.07	<0.11	<0.12	
Anthracene	mg/kg	0.9	7	<0.9	<0.10	0.91	<0.16	<0.07	<0.15	<0.8	<0.07	<0.11	<0.12	
Benzo[a]anthracene	mg/kg	6.9	55	<0.9	0.28	0.71	<0.16	0.11	<0.15	<0.8	0.10	0.13	<0.12	
Benzo[a]pyrene (BAP)	mg/kg	12.4	91	<0.9	0.30	0.50	<0.16	0.10	<0.15	<0.8	0.14	0.12	<0.12	
Benzo[b+j]fluoranthene	mg/kg	20	151	0.9	0.44	1.17	0.24	0.15	<0.15	2.1	0.24	0.23	<0.12	
Benzo[g,h,i]perylene	mg/kg	13.8	89	1.0	0.61	1.54	0.46	0.28	0.18	1.8	0.48	0.17	<0.12	
Benzo[k]fluoranthene	mg/kg	8.6	66	<0.9	0.16	0.23	<0.16	<0.07	<0.15	<0.8	0.07	<0.11	<0.12	
Chrysene	mg/kg	14.2	109	<0.9	0.32	0.95	<0.16	0.10	<0.15	<0.8	0.15	0.17	<0.12	
Dibenzo[a,h]anthracene	mg/kg	2.4	17	<0.9	<0.10	<0.13	<0.16	<0.07	<0.15	<0.8	<0.07	<0.11	<0.12	
Fluoranthene	mg/kg	19.9	198	1.6	0.77	2.6	0.26	0.25	0.19	1.2	0.25	0.38	<0.12	
Fluorene	mg/kg	<0.9	2	<0.9	<0.10	2.8	<0.16	<0.07	<0.15	<0.8	<0.07	<0.11	<0.12	
Indeno(1,2,3-c,d)pyrene	mg/kg	15.1	102	<0.9	0.20	0.35	<0.16	0.08	<0.15	0.9	0.10	<0.11	<0.12	
Naphthalene	mg/kg	<5	<10	<5	<0.5	17.0	3.1	<0.4	<0.8	<4	<0.4	<0.6	<0.6	
Phenanthrene	mg/kg	6.0	70	3.8	0.40	7.4	0.22	0.22	<0.15	<0.8	0.17	0.35	<0.12	
Pyrene	mg/kg	16.7	159	46	1.41	10.8	0.59	0.55	0.28	29	0.71	0.37	<0.12	
Total Recoverable Arsenic	mg/kg	4	13	6	4	13	4	6	<4	16	7	6	4	12
Total Recoverable Cadmium	mg/kg	0.22	0.70	1.30	0.77	0.40	0.73	0.23	<0.19	1.00	0.66	1.21	0.65	0.65
Total Recoverable Chromium	mg/kg	36	150	58	41	68	47	43	16	110	90	94	22	125
Total Recoverable Copper	mg/kg	74	181	109	63	135	141	94	63	230	159	96	69	90
Total Recoverable Lead	mg/kg	68	400	109	48	70	138	40	65	165	124	44	60	65
Total Recoverable Nickel	mg/kg	85	60	38	48	67	63	69	24	49	74	33	22	320
Total Recoverable Zinc	mg/kg	980	1,270	2,700	980	2,200	750	1,200	510	3,700	1,420	380	440	1160
BTEX in Soil														
Benzene	mg/kg	<0.11	<0.4	<0.4	<0.13	2.8	<0.4	<0.07	<0.18	<0.17	1.16	<0.5	<0.5	
Toluene	mg/kg	1.50	3.8	<0.4	1.88	55	7.2	2.8	0.27	<0.3	33	39	8.5	
Ethylbenzene	mg/kg	0.68	<0.4	0.6	<0.13	12.4	<0.4	<0.07	<0.18	<0.3	1.59	0.9	<0.5	
m&p-Xylene	mg/kg	2.4	<0.8	2.5	<0.3	67	<0.7	<0.13	<0.4	<0.4	6.5	<0.9	<1.0	
o-Xylene	mg/kg	1.08	<0.4	1.6	<0.13	29	<0.4	0.09	<0.18	<0.17	2.8	<0.5	<0.5	
C7 - C9	mg/kg	<30	<60	51	<30	1,680	179	<10	53	29	67	820	<40	
C10 - C14	mg/kg	52	<120	27,000	<60	9,800	370	26	158	13,300	65	240	<80	
C15 - C36	mg/kg	1,340	4,400	220,000	4,400	73,000	3,100	1,040	1,070	184,000	2,300	3,400	1,420	
Total hydrocarbons (C7 - C36)	mg/kg	1,400	4,400	250,000	4,400	84,000	3,600	1,060	1,290	197,000	2,400	4,500	1,420	

Notes:
1. *'-'denotes that this parameter was not sampled for.*
2. *All measurements (except pH) are expressed on a dry weight basis.*
3. *Highlighted values indicate heavy metal concentrations that exceed background ranges of trace elements in Auckland soils (ARC, 2001).*

Table 8: Sediment Quality Results for Retested Sites

		Z Service Station			
		Z Browns Road		Z Highbrook	Z Sylvia Park
Sample Location		**Forecourt**	**Non forecourt**	**Forecourt**	**Forecourt**
Sample Field Reference no		BRN SS01a	BRN SS02	HBK SS01a	SLV SS02a
Sample Date		05/02/2013	05/02/2013	05/02/2013	05/02/2013
Sample Parameter	**Units**				
Dry Matter	g/100 g as rcvd	38	26	30	54
Polycyclic Aromatic Hydrocarbons Screening in Soil					
Acenaphthene	mg/kg	0.16	0.89	-	-
Acenaphthylene	mg/kg	0.23	0.74	-	-
Anthracene	mg/kg	0.99	3.9	-	-
Benzo[a]anthracene	mg/kg	9.8	55	-	-
Benzo[a]pyrene (BAP)	mg/kg	14.9	63	-	-
Benzo[b+j]fluoranthene	mg/kg	22	93	-	-
Benzo[g,h,i]perylene	mg/kg	18.0	79	-	-
Benzo[k]fluoranthene	mg/kg	9.8	46	-	-
Chrysene	mg/kg	12.7	71	-	-
Dibenzo[a,h]anthracene	mg/kg	1.83	9.0	-	-
Fluoranthene	mg/kg	27	157	-	-
Fluorene	mg/kg	0.42	1.6	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg	18.6	65	-	-
Naphthalene	mg/kg	<0.7	<0.9	-	-
Phenanthrene	mg/kg	8.1	56	-	-
Pyrene	mg/kg	24	132	-	-
Total Petroleum Hydrocarbons in Soil					
C7 - C9	mg/kg	-	-	720	<30
C10 - C14	mg/kg	-	-	29,000	790
C15 - C36	mg/kg	-	-	280,000	26,000
Total hydrocarbons (C7 - C36)	mg/kg	-	-	310,000	27,000

Notes: 1. '-'denotes that this parameter was not sampled for.

The TPH results obtained for Z Highbrook and Z Sylvia Park suggest that the sediment sample obtained has a high proportion of petroleum residual attached to the sediment.

5.2.2 Sediment Grain Size Distribution Analysis

The quantity of sediment sample obtained at each sample location varied considerably. In general, non-forecourt drainage areas generated a greater quantity of sediment primarily due to landscaped areas being present within their drainage areas.

The grain size distribution of the sediment samples obtained was also dependent upon the drainage area type. Non-forecourt drainage areas commonly had a larger range of sediment particles present i.e. sediment both greater and less than 2.0 mm (a mix of sands and gravels), whilst forecourt drainage areas had sediment particles commonly less than 2.0 mm (sands and silts). Again, this is likely due to contributions of variable grain size provided by surrounding landscaped areas.

Table 9 below provides the % comparison of sediment grain sizes that are greater and less than 2.0 mm dia.

Table 9: % Comparison of Sediment Grain Sizes Greater and Less than 2.0 mm dia.

Site	Sample Location	%> 2.0 mm	%< 2.0 mm
Z Browns Road	Forecourt	92.4[1]	7.6
	Non-Forecourt	94.3[1]	5.7
Z Highbrook	Forecourt	0	100
	Non-Forecourt	51.2	48.8
Z Hunters Corner	Forecourt	0	100
	Non-Forecourt	38.3	61.7
Z Lakeside	Forecourt	30.8[1]	69.2
	Non-Forecourt	61.5	38.5
Z Sylvia Park	Forecourt	64.4[1]	35.6
	Non-Forecourt	4.3	95.7

Notes: 1. *The high proportion of sediment grain size > 2.0 mm is likely due to the stormwater treatment device and ACO drains being located within, and adjacent to, a landscaped area, respectively.*
2. *Capture of course sediments in ACO drains upstream of the sample location may also account for the generally low level of coarse material in the API's .*

Malvern Mastersizer 2000 analysis was undertaken on the sediment proportion that is less than 2.0 mm dia. Results obtained from the Malvern Mastersizer 2000 are presented in Appendix D. Grain size classification of this sediment proportion is provided in Table 10.

Table 10: Grain size classification of sediment proportion <2.0 mm dia

Site	Site Location	Grain Size Classification
Z Browns Road	Forecourt	Medium SAND with some silt
	Non-Forecourt	Well graded silty SAND
Z Highbrook	Forecourt	SILT with some fine sand and with minor clay
	Non-Forecourt	Coarse SAND with some fine sand
Z Hunters Corner	Forecourt	Well graded sandy SILT
	Non-Forecourt	Coarse SAND with some fine sand and with minor silt
Z Lakeside	Forecourt	Medium SAND with some Coarse sand
	Non-Forecourt	Medium coarse SAND
Z Sylvia Park	Forecourt	Coarse SAND with some fine sand
	Non-Forecourt	Well graded silty SAND

Notes: 1. *Interpretation of grain size description obtained from New Zealand Geotechnical Society Inc. (2005)*

5.3 Water Quality Results

Laboratory reports for water quality samples are provided in Appendix C and a summary of these results are presented in the following sections. Tables 11-16 present a summary of water quality information obtained for each service station assessed.

ANZECC (2000) 95% protection level trigger values and water quality data obtained from the two control sites are also included for comparison purposes.

Figures 1-6 provide graphs to present a comparison of the specific data obtained for the Z service stations at various monitoring locations and times.

Graphs are provided for the following:

- Total zinc - Forecourt.
- Total zinc - Non-forecourt.
- Total copper - Forecourt.
- Total copper - Non-forecourt.
- Total suspended solids - Forecourt.
- Total suspended solids - Non-forecourt.

Table 11: Z Browns Road Water Quality Results

		Z Service Station							Control Site					
		Z Browns Road							Control Site A		Control Site B		Guideline Trigger	
		Three Stage Interceptor				Catch pit			Catch pit		Catch pit			
Sample Location		**Forecourt Influent First Flush (0 min)**	**Forecourt Influent Mid Flow (30 min)**	**Forecourt Effluent First Flush (0 min)**	**Forecourt Effluent Mid flow (30 min)**	**Non-forecourt First Flush (0 min)**	**Non-Forecourt Mid Flow (30 min)**	**Fire Hydrant Water**	**Effluent First Flush (0 min)**	**Effluent Mid Flow (30 min)**	**Effluent First Flush (0 min)**	**Effluent Mid Flow (30 min)**	**ANZECC (2000) 95% trigger and MfE (1998)**	**ANZECC (2000) 80% trigger**
Sample Field Reference no		**BRN SW 004**	**BRN SW 006**	**BRN SW 005**	**BRN SW 007**	**BRN SW 001**	**BRN SW 002**	**BRN SW 003**	**ABG SW01**	**ABG SW02**	**AMU SW01**	**AMU SW02**		
Sample Date		14/03/2013	14/03/2013	14/03/2013	14/03/2013	14/03/2013	14/03/2013	14/03/2013	28/02/2013	28/02/2013	28/02/2013	28/02/2013		
Sample Time		0400	0430	0406	0436	0508	0538	0352	2130	2200	2315	2345		
Sample Parameter	**Units**													
Temperature	°C	22.6	19.6	21.6	20.2	16.9	17.2	20.1	20.6	19.0	20.6	19.4		
Dissolved Oxygen	% Sat	109.3	108.7	40.5	44.2	122.3	120.6	94.4	80.3	79.0	72.7	75.1		
Oxygen Reduction Potential	mV	260.1	215.8	240.6	219.3	219.5	218.5	257.9	258.6	358.6	309.8	399.1		
Electrical Conductivity	mS/m	117.6	18.4	15.0	16.1	31.5	16.3	15.4	51.4	17.2	33	14.6		
pH	pH Units	6.8	7.7	7.0	7.1	6.6	7.4	8.0	4.6	7.3	6.2	7.2		
Total Suspended Solids	g/m^3	48	< 3	22	6	540	9	< 3	320	25	380	7	100[3]	
Polycyclic Aromatic Hydrocarbons Screening in Water														
Acenaphthene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Acenaphthylene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Anthracene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[a]anthracene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[a]pyrene (BAP)	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[b+j]fluoranthene	mg/m^3	0.17	< 0.10	< 0.10	< 0.10	0.3	0.21	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[g,h,i]perylene	mg/m^3	0.21	< 0.10	< 0.10	< 0.10	0.22	0.17	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[k]fluoranthene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Chrysene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	0.19	0.16	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Dibenzo[a,h]anthracene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluoranthene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	0.6	0.54	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluorene	mg/m^3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Indeno(1,2,3-c,d)pyrene	mg/m^3	0.22	< 0.10	< 0.10	< 0.10	0.33	0.23	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Naphthalene	mg/m^3	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	16[1]	85[2]
Phenanthrene	mg/m^3	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4		
Pyrene	mg/m^3	< 0.2	< 0.2	< 0.2	< 0.2	0.3	0.3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn														
Total Recoverable Arsenic	g/m^3	0.0016	0.0012	< 0.0011	< 0.0011	0.0029	0.0012	< 0.0011	0.002	< 0.0011	0.0028	0.0012	0.013[1]	0.140[2]
Total Recoverable Cadmium	g/m^3	0.000114	< 0.000053	< 0.000053	< 0.000053	0.00021	< 0.000053	< 0.000053	0.00065	0.000073	0.00044	< 0.000053	0.0002[1]	0.0008[2]
Total Recoverable Chromium	g/m^3	0.002	< 0.00053	0.00062	< 0.00053	0.0057	0.00078	< 0.00053	0.0065	0.00076	0.0056	< 0.00053	0.001[1]	0.040[2]
Total Recoverable Copper	g/m^3	0.0172	0.0029	0.00186	0.003	0.037	0.0024	0.008	0.07	0.0032	0.064	0.002	0.0014[1]	0.0025[2]
Total Recoverable Lead	g/m^3	0.005	0.00043	0.00031	0.0004	0.024	0.00124	0.0019	0.0163	0.00139	0.024	0.00104	0.0034[1]	0.0094[2]
Total Recoverable Nickel	g/m^3	0.00197	< 0.00053	< 0.00053	0.00068	0.005	< 0.00053	< 0.00053	0.0068	< 0.00053	0.0062	< 0.00053	0.011[1]	0.017[2]
Total Recoverable Zinc	g/m^3	0.57	0.069	0.0147	0.034	0.7	0.056	0.0029	0.55	0.039	0.67	0.023	0.008[1]	0.031[2]
Dissolved Arsenic	g/m^3	< 0.0010	0.0011	< 0.0010	< 0.0010	0.0014	0.0012	0.0011	0.0013	< 0.0010	0.0018	0.001	0.013[1]	0.140[2]
Dissolved Cadmium	g/m^3	< 0.00005	< 0.00005	< 0.00005	< 0.00005	0.00013	< 0.00005	< 0.00005	0.00042	0.00006	0.00022	< 0.00005	0.0002[1]	0.0008[2]
Dissolved Chromium	g/m^3	0.0007	< 0.0005	< 0.0005	< 0.0005	0.0009	< 0.0005	0.0007	0.0016	< 0.0005	0.0011	< 0.0005	0.001[1]	0.040[2]
Dissolved Copper	g/m^3	0.0094	0.0023	0.0008	0.0016	0.02	0.0014	0.0011	0.042	0.002	0.035	0.0013	0.0014[1]	0.0025[2]
Dissolved Lead	g/m^3	0.00035	0.00013	< 0.00010	0.0002	0.00112	0.0002	0.00059	0.00113	0.00017	0.0034	0.0002	0.0034[1]	0.0094[2]
Dissolved Nickel	g/m^3	0.0009	< 0.0005	< 0.0005	< 0.0005	0.0015	< 0.0005	< 0.0005	0.0034	< 0.0005	0.0034	< 0.0005	0.011[1]	0.017[2]
Dissolved Zinc	g/m^3	0.165	0.051	0.0051	0.0151	0.48	0.044	0.0014	0.37	0.032	0.35	0.0174	0.008[1]	0.031[2]
BTEX in Water by Headspace														
Benzene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.95[1]	2.0[2]
Toluene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010		
Ethylbenzene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010		
m&p-Xylene	g/m^3	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.2[1]	0.34[2]
o-Xylene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.35[1]	0.64[2]
Total Petroleum Hydrocarbons in Water														
C7 - C9	g/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
C10 - C14	g/m^3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
C15 - C36	g/m^3	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4		
Total hydrocarbons (C7 - C36)	g/m^3	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	15[3]	

Notes:
1. *ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality. Freshwater 95% level of protection.*
2. *ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality. Freshwater 80% level of protection.*
3. *MfE (1998) Environmental guidelines for water discharges from petroleum industry sites in New Zealand.*
4. *Highlighted values indicate exceedances against a referenced guideline. Red cells donate exceedance of 80% and 95% ANZECC (2001) triggers, Yellow cells donate exceedance in 95% ANZECC (2001) trigger only. Orange cells donate exceedance in MfE (1998) values.*

Table 12: Z Highbrook Water Quality Results 13 March 2012

		Z Service Station							Control Site					
		Z Highbrook							Control Site A		Control Site B		Guideline Trigger	
		API Oil-Water Separator (Model 5500)				Catch Pit			Catch Pit		Catch Pit			
Sample Location		**Forecourt Influent First Flush (0 min)**	**Forecourt Influent Mid Flow (30 min)**	**Forecourt Effluent First Flush (0 min)**	**Forecourt Effluent Mid flow (30 min)**	**Non-forecourt First Flush (0 min)**	**Non-Forecourt Mid Flow (30 min)**	**Fire Hydrant Water**	**Effluent First Flush (0 min)**	**Effluent Mid Flow (30 min)**	**Effluent First Flush (0 min)**	**Effluent Mid Flow (30 min)**	**ANZECC (2000) 95% trigger and MfE (1998)**	**ANZECC (2000) 80% trigger**
Sample Field Reference no		**HBK SW 004**	**HBK SW 006**	**HBK SW 005**	**HBK SW 007**	**HBK SW 001**	**HBK SW 002**	**HBK SW 003**	**ABG SW01**	**ABG SW02**	**AMU SW01**	**AMU SW02**		
Sample Date		13/03/2013	13/03/2013	13/03/2013	13/03/2013	13/03/2013	13/03/2013	13/03/2013	28/02/2013	28/02/2013	28/02/2013	28/02/2013		
Sample Time		2318	2348	2321	2351	2220	2250	2210	2130	2200	2315	2345		
Sample Parameter	**Units**													
Temperature	°C	21.9	19.3	24.6	22.3	21.8	20.5	19.5	20.6	19.0	20.6	19.4		
Dissolved Oxygen	% Sat	54.2	100.3	31.6	32.1	90.0	80.3	107.7	80.3	79.0	72.7	75.1		
Oxygen Reduction Potential	mV	132.6	79.3	256.4	10.8	233.4	438.1	313	258.6	358.6	309.8	399.1		
Electrical Conductivity	mS/m	51.6	17.8	35.4	32.8	33.2	16	15.7	51.4	17.2	33	14.6		
pH	pH Units	7.0	7.8	7.3	6.9	7.0	7.4	8	4.6	7.3	6.2	7.2		
Total Suspended Solids	g/m^3	310	5	163	15	970	15	< 3	320	25	380	7	100[3]	
Polycyclic Aromatic Hydrocarbons Screening in Water														
Acenaphthene	mg/m^3	< 0.7	0.17	< 0.10	0.14	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Acenaphthylene	mg/m^3	< 0.7	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Anthracene	mg/m^3	< 0.7	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[a]anthracene	mg/m^3	< 0.7	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[a]pyrene (BAP)	mg/m^3	< 0.7	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[b+j]fluoranthene	mg/m^3	< 0.7	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[g,h,i]perylene	mg/m^3	< 0.7	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[k]fluoranthene	mg/m^3	< 0.7	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Chrysene	mg/m^3	< 0.7	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Dibenzo[a,h]anthracene	mg/m^3	< 0.7	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluoranthene	mg/m^3	1.7	0.13	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluorene	mg/m^3	2.5	0.5	< 0.2	0.6	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Indeno(1,2,3-c,d)pyrene	mg/m^3	< 0.7	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Naphthalene	mg/m^3	< 4	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	16[1]	85[2]
Phenanthrene	mg/m^3	4.6	0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4		
Pyrene	mg/m^3	5.2	3.3	0.6	1.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn														
Total Recoverable Arsenic	g/m^3	0.0013	< 0.0011	< 0.0011	< 0.0011	0.0025	< 0.0011	< 0.0011	0.002	< 0.0011	0.0028	0.0012	0.013[4]	0.140[2]
Total Recoverable Cadmium	g/m^3	0.000113	< 0.000053	0.000081	0.000090	0.00061	< 0.000053	< 0.000053	0.00065	0.000073	0.00044	< 0.000053	0.0002[4]	0.0008[2]
Total Recoverable Chromium	g/m^3	0.0031	0.00055	0.00106	0.00075	0.0082	0.00082	0.00063	0.0065	0.00076	0.0056	< 0.00053	0.001[4]	0.040[2]
Total Recoverable Copper	g/m^3	0.0199	0.0036	0.0040	0.0052	0.048	0.0021	0.0087	0.07	0.0032	0.064	0.002	0.0014[4]	0.0025[2]
Total Recoverable Lead	g/m^3	0.0188	0.0028	0.0027	0.0023	0.033	0.0013	0.00076	0.0163	0.00139	0.024	0.00104	0.0034[4]	0.0094[2]
Total Recoverable Nickel	g/m^3	0.0055	0.00070	0.0052	0.0048	0.0080	< 0.00083	< 0.00053	0.0068	< 0.00053	0.0062	< 0.00053	0.011[4]	0.017[2]
Total Recoverable Zinc	g/m^3	0.24	0.062	0.78	0.34	1.29	0.059	0.01	0.55	0.039	0.67	0.023	0.008[4]	0.031[2]
Dissolved Arsenic	g/m^3	< 0.0010	0.0010	< 0.0010	< 0.0010	0.0012	< 0.0010	0.0011	0.0013	< 0.0010	0.0018	0.001	0.013[1]	0.140[2]
Dissolved Cadmium	g/m^3	0.00005	< 0.00005	< 0.00005	< 0.00005	0.00035	< 0.00005	< 0.00005	0.00042	0.00006	0.00022	< 0.00005	0.0002[1]	0.0008[2]
Dissolved Chromium	g/m^3	0.0009	< 0.0005	0.0007	0.0007	0.0016	< 0.0005	0.0006	0.0016	< 0.0005	0.0011	< 0.0005	0.001[1]	0.040[2]
Dissolved Copper	g/m^3	0.0054	0.0024	0.0014	0.0023	0.021	0.0011	0.0025	0.042	0.002	0.035	0.0013	0.0014[1]	0.0025[2]
Dissolved Lead	g/m^3	0.00058	0.00033	0.00044	0.00041	0.00193	0.0001	0.0002	0.00113	0.00017	0.0034	0.0002	0.0034[1]	0.0094[2]
Dissolved Nickel	g/m^3	0.0036	< 0.0005	0.0035	0.0033	0.0031	< 0.0005	< 0.0005	0.0034	< 0.0005	0.0034	< 0.0005	0.011[1]	0.017[2]
Dissolved Zinc	g/m^3	0.054	0.040	0.35	0.166	0.62	0.045	0.0073	0.37	0.032	0.35	0.0174	0.008[1]	0.031[2]
BTEX in Water by Headspace														
Benzene	g/m^3	0.0042	< 0.0010	0.0015	0.079	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.95[1]	2.0[2]
Toluene	g/m^3	0.50	< 0.0010	0.0083	1.44	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010		
Ethylbenzene	g/m^3	0.0018	< 0.0010	0.0028	0.126	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010		
m&p-Xylene	g/m^3	0.021	< 0.002	< 0.002	0.81	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.2[1]	0.34[2]
o-Xylene	g/m^3	0.0154	< 0.0010	0.0115	0.46	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.35[1]	0.64[2]
Total Petroleum Hydrocarbons in Water														
C7 - C9	g/m^3	1.5	< 0.10	0.18	2.9	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
C10 - C14	g/m^3	240	2.5	< 0.2	0.8	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
C15 - C36	g/m^3	3,400	41	1.7	5.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4		
Total hydrocarbons (C7 - C36)	g/m^3	3,700	44	1.9	9.0	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	15[3]	

Notes:
1. *ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality. Freshwater 95% level of protection.*
2. *ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality. Freshwater 80% level of protection.*
3. *MfE (1998) Environmental guidelines for water discharges from petroleum industry sites in New Zealand.*
4. *Highlighted values indicate exceedances against a referenced guideline. Red cells donate exceedance of 80% and 95% ANZECC (2001) triggers, Yellow cells donate exceedance in 95% ANZECC (2001) trigger only. Orange cells donate exceedance in MfE (1998) values.*

Table 13: Z Hunters Corner Water Quality Results

		Z Service Station							Control Site					
		Z Hunters Corner							Control Site A		Control Site B		Guideline Trigger	
		API Oil-Water Separator (Model 3000)				Catch Pit			Catch Pit		Catch Pit			
Sample Location		**Forecourt Influent First Flush (0 min)**	**Forecourt Influent Mid Flow (30 min)**	**Forecourt Effluent First Flush (0 min)**	**Forecourt Effluent Mid flow (30 min)**	**Non-forecourt First Flush (0 min)**	**Non-Forecourt Mid Flow (30 min)**	**Fire Hydrant Water**	**Effluent First Flush (0 min)**	**Effluent Mid Flow (30 min)**	**Effluent First Flush (0 min)**	**Effluent Mid Flow (30 min)**	**ANZECC (2000) 95% trigger and MfE (1998)**	**ANZECC (2000) 80% trigger**
Sample Field Reference no		**HCR SW 004**	**HCR SW 006**	**HCR SW 005**	**HCR SW 007**	**HCR SW 001**	**HCR SW 002**	**HCR SW 003**	**ABG SW01**	**ABG SW02**	**AMU SW01**	**AMU SW02**		
Sample Date		14/03/2013	14/03/2013	14/03/2013	14/03/2013	14/03/2013	14/03/2013	14/03/2013	28/02/2013	28/02/2013	28/02/2013	28/02/2013		
Sample Time		0206	0236	0210	0240	0122	0152	0118	2130	2200	2315	2345		
Sample Parameter	**Units**													
Temperature	°C	19.2	18.7	22.4	21.2	21.6	19.7	20.6	20.6	19.0	20.6	19.4		
Dissolved Oxygen	% Sat	111.2	120.8	44.4	44.9	102.9	103.7	101.8	80.3	79.0	72.7	75.1		
Oxygen Reduction Potential	mV	252.8	260.2	149.2	30.0	1779	259.9	265.3	258.6	358.6	309.8	399.1		
Electrical Conductivity	mS/m	20.6	16.5	25.3	26.2	26.1	15.9	15.6	51.4	17.2	33	14.6		
pH	pH Units	7.6	7.8	7.3	7.0	6.7	7.4	7.8	4.6	7.3	6.2	7.2		
Total Suspended Solids	g/m^3	76	<3	21	18	330	5	< 3	320	25	380	7	100[3]	
Acenaphthene	mg/m^3	< 0.10	< 0.10	< 0.10	0.29	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Acenaphthylene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Anthracene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[a]anthracene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[a]pyrene (BAP)	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[g,h,i]perylene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[k]fluoranthene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Chrysene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Dibenzo[a,h]anthracene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluoranthene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluorene	mg/m^3	< 0.2	< 0.2	< 0.2	0.8	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Indeno(1,2,3-c,d)pyrene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Naphthalene	mg/m^3	< 0.5	< 0.5	< 0.5	15.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	16[1]	85[2]
Phenanthrene	mg/m^3	< 0.4	< 0.4	< 0.4	0.6	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4		
Pyrene	mg/m^3	0.3	< 0.2	0.3	0.7	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn														
Total Recoverable Arsenic	g/m^3	0.0015	0.0013	0.0037	0.0022	0.0016	< 0.0011	0.0011	0.002	< 0.0011	0.0028	0.0012	0.013[4]	0.140[2]
Total Recoverable Cadmium	g/m^3	< 0.000053	< 0.000053	< 0.000053	< 0.000053	0.000096	< 0.000053	< 0.000053	0.00065	0.000073	0.00044	< 0.000053	0.0002[4]	0.0008[2]
Total Recoverable Chromium	g/m^3	0.00129	< 0.00053	0.00108	0.00146	0.0035	0.00056	0.00062	0.0065	0.00076	0.0056	< 0.00053	0.001[4]	0.040[2]
Total Recoverable Copper	g/m^3	0.0098	0.00152	0.0079	0.0095	0.03	0.0022	0.011	0.07	0.0032	0.064	0.002	0.0014[4]	0.0025[2]
Total Recoverable Lead	g/m^3	0.0047	0.00043	0.00166	0.0021	0.0114	0.00067	0.0036	0.0163	0.00139	0.024	0.00104	0.0034[4]	0.0094[2]
Total Recoverable Nickel	g/m^3	0.00118	< 0.00053	0.0046	0.0023	0.0032	< 0.00053	< 0.00053	0.0068	< 0.00053	0.0062	< 0.00053	0.011[4]	0.017[2]
Total Recoverable Zinc	g/m^3	0.114	0.0125	0.3	0.2	0.49	0.04	0.078	0.55	0.039	0.67	0.023	0.008[4]	0.031[2]
Dissolved Arsenic	g/m^3	< 0.0010	0.001	0.0029	0.002	0.0013	0.001	0.0011	0.0013	< 0.0010	0.0018	0.001	0.013[1]	0.140[2]
Dissolved Cadmium	g/m^3	< 0.00005	< 0.00005	< 0.00005	< 0.00005	0.00005	< 0.00005	< 0.00005	0.00042	0.00006	0.00022	< 0.00005	0.0002[1]	0.0008[2]
Dissolved Chromium	g/m^3	< 0.0005	< 0.0005	0.0012	0.0011	0.0007	< 0.0005	< 0.0005	0.0016	< 0.0005	0.0011	< 0.0005	0.001[1]	0.040[2]
Dissolved Copper	g/m^3	0.0025	0.0008	0.0056	0.0061	0.0151	0.0013	0.0011	0.042	0.002	0.035	0.0013	0.0014[1]	0.0025[2]
Dissolved Lead	g/m^3	0.0001	< 0.00010	0.00105	0.00147	0.00057	< 0.00010	0.00018	0.00113	0.00017	0.0034	0.0002	0.0034[1]	0.0094[2]
Dissolved Nickel	g/m^3	< 0.0005	< 0.0005	0.0038	0.002	0.0014	< 0.0005	< 0.0005	0.0034	< 0.0005	0.0034	< 0.0005	0.011[1]	0.017[2]
Dissolved Zinc	g/m^3	0.0144	0.0052	0.22	0.15	0.3	0.031	0.053	0.37	0.032	0.35	0.0174	0.008[1]	0.031[2]
BTEX in Water by Headspace														
Benzene	g/m^3	< 0.0010	< 0.0010	< 0.0010	0.100	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.95[1]	2.0[2]
Toluene	g/m^3	< 0.0010	< 0.0010	< 0.0010	0.93	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010		
Ethylbenzene	g/m^3	< 0.0010	< 0.0010	< 0.0010	0.065	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010		
m&p-Xylene	g/m^3	< 0.002	< 0.002	< 0.002	0.66	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.2[1]	0.34[2]
o-Xylene	g/m^3	< 0.0010	< 0.0010	< 0.0010	0.33	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.35[1]	0.64[2]
Total Petroleum Hydrocarbons in Water														
C7 - C9	g/m^3	< 0.10	< 0.10	< 0.10	2.2	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
C10 - C14	g/m^3	< 0.2	< 0.2	< 0.2	1.6	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
C15 - C36	g/m^3	< 0.4	< 0.4	< 0.4	1.1	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4		
Total hydrocarbons (C7 - C36)	g/m^3	< 0.7	< 0.7	< 0.7	4.9	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	15[3]	

Notes:
1. *ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality. Freshwater 95% level of protection.*
2. *ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality. Freshwater 80% level of protection.*
3. *MfE (1998) Environmental guidelines for water discharges from petroleum industry sites in New Zealand.*
4. *Highlighted values indicate exceedances against a referenced guideline. Red cells donate exceedance of 80% and 95% ANZECC (2001) triggers, Yellow cells donate exceedance in 95% ANZECC (2001) trigger only. Orange cells donate exceedance in MfE (1998) values.*

Submission #44770

Table 14: Z Lakeside Water Quality Results

		Z Service Station										Control Site				Guideline Trigger	
		Z Lakeside										Control Site A		Control Site B			
		Two Stage Oil-Water Interceptor						Catch Pit				Catch Pit		Catch Pit			
Sample Location		Forecourt Influent First Flush (0 min)	Forecourt Influent Mid Flow (10 min)	Forecourt Influent Mid Flow (30 min)	Forecourt Effluent First Flush (0 min)	Forecourt Effluent Mid flow (10 min)	Forecourt Effluent Mid flow (30 min)	Non-forecourt First Flush	Non-Forecourt Mid Flow (10 min)	Non-Forecourt Mid Flow (30 min)	Fire Hydrant Water	Effluent First Flush (0 min)	Effluent Mid Flow (30 min)	Effluent First Flush (0 min)	Effluent Mid Flow (30 min)	ANZECC (2000) 95% trigger and MfE (1998)	ANZECC (2000) 80% trigger
Sample Field Reference no		LAK SW 004	LAK SW 008	LAK SW 006	LAK SW 005	LAK SW 009	LAK SW 007	LAK SW 001	LAK SW 010	LAK SW 002	LAK SW 003	ABG SW01	ABG SW02	AMU SW01	AMU SW02		
Sample Date		26/03/2013	26/03/2013	26/03/2013	26/03/2013	26/03/2013	26/03/2013	26/03/2013	26/03/2013	26/03/2013	26/03/2013	28/02/2013	28/02/2013	28/02/2013	28/02/2013		
Sample Time		0141	0151	0211	0143	0153	0213	0255	0305	0325	0130	2130	2200	2315	2345		
Sample Parameter	**Units**																
Temperature	°C	18.06	18.19	17.83	19.06	18.19	17.95	19.00	18.75	18.17	19.74	20.6	19.0	20.6	19.4		
Dissolved Oxygen	% Sat	103.1	79.9	100.9	80.7	102.6	74.2	101.3	75.8	76.9	112.6	80.3[3]	79.0[3]	72.7[3]	75.1[3]		
Oxygen Reduction Potential	mV	260	245	427	7	200	393	442	516	619	425	258.6	358.6	309.8	399.1		
Electrical Conductivity	mS/m	17.7	-	16.7	17.2	-	17	18.2	-	16.7	15.7	51.4	17.2	33	14.6		
pH	pH Units	7.9	7.86	7.9	7.1	6.9	7.2	8.0	7.91	8.0	7.9	4.6	7.3	6.2	7.2		
Total Suspended Solids	g/m^3	9	5	3	15	18	9	49	17	18	3	320	25	380	7	100[6]	
Polycyclic Aromatic Hydrocarbons Screening in Water																	
Acenaphthene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Acenaphthylene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Anthracene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[a]anthracene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[a]pyrene (BAP)	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[g,h,i]perylene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[k]fluoranthene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Chrysene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Dibenzo[a,h]anthracene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluoranthene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluorene	mg/m^3	< 0.2	-	< 0.2	< 0.2	-	< 0.2	< 0.2	-	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Indeno(1,2,3-c,d)pyrene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Naphthalene	mg/m^3	< 0.5	-	< 0.5	< 0.5	-	< 0.5	< 0.5	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	16[4]	85[5]
Phenanthrene	mg/m^3	< 0.4	-	< 0.4	< 0.4	-	< 0.4	< 0.4	-	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4		
Pyrene	mg/m^3	0.3	-	< 0.2	0.4	-	0.2	< 0.2	-	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn																	
Total Recoverable Arsenic	g/m^3	< 0.0011	-	< 0.0011	0.0017	-	0.0012	< 0.0011	-	< 0.0011	< 0.0011	0.002	< 0.0011	0.0028	0.0012	0.013[4]	0.140[5]
Total Recoverable Cadmium	g/m^3	< 0.000053	-	< 0.000053	< 0.000053	-	< 0.000053	< 0.000053	-	< 0.000053	< 0.000053	0.00065	0.000073	0.00044	< 0.000053	0.0002[4]	0.0008[5]
Total Recoverable Chromium	g/m^3	0.00118	-	0.00066	0.0021	-	0.00056	0.00177	-	0.00117	0.00081	0.0065	0.00076	0.0056	< 0.00053	0.001[4]	0.040[5]
Total Recoverable Copper	g/m^3	0.0042	-	0.00131	0.0126	-	0.003	0.0086	-	0.00137	0.0173	0.07	0.0032	0.064	0.002	0.0014[4]	0.0025[5]
Total Recoverable Lead	g/m^3	0.00109	-	0.00025	0.0023	-	0.00067	0.0032	-	0.00069	0.00192	0.0163	0.00139	0.024	0.00104	0.0034[4]	0.0094[5]
Total Recoverable Nickel	g/m^3	< 0.00053	-	< 0.00053	0.00138	-	< 0.00053	0.00105	-	< 0.00053	< 0.00053	0.0068	< 0.00053	0.0062	< 0.00053	0.011[4]	0.017[5]
Total Recoverable Zinc	g/m^3	0.039	-	0.014	0.72	-	0.055	0.087	-	0.0188	0.0124	0.55	0.039	0.67	0.023	0.008[4]	0.031[5]
Dissolved Arsenic	g/m^3	< 0.0010	-	< 0.0010	0.0013	-	< 0.0010	< 0.0010	-	< 0.0010	< 0.0010	0.0013	< 0.0010	0.0018	0.001	0.013[4]	0.140[5]
Dissolved Cadmium	g/m^3	< 0.00005	-	< 0.00005	< 0.00005	-	< 0.00005	< 0.00005	-	< 0.00005	< 0.00005	0.00042	0.00006	0.00022	< 0.00005	0.0002[4]	0.0008[5]
Dissolved Chromium	g/m^3	0.0007	-	< 0.0005	0.0014	-	< 0.0005	0.0007	-	0.0006	0.0008	0.0016	< 0.0005	0.0011	< 0.0005	0.001[4]	0.040[5]
Dissolved Copper	g/m^3	0.0026	-	0.001	0.008	-	0.0018	0.0018	-	0.0006	0.0017	0.042	0.002	0.035	0.0013	0.0014[4]	0.0025[5]
Dissolved Lead	g/m^3	0.0002	-	< 0.00010	0.00094	-	0.00013	0.00012	-	< 0.00010	0.00023	0.00113	0.00017	0.0034	0.0002	0.0034[4]	0.0094[5]
Dissolved Nickel	g/m^3	< 0.0005	-	< 0.0005	0.0011	-	< 0.0005	< 0.0005	-	< 0.0005	< 0.0005	0.0034	< 0.0005	0.0034	< 0.0005	0.011[4]	0.017[5]
Dissolved Zinc	g/m^3	0.0147	-	0.0076	0.55	-	0.039	0.0135	-	0.0065	0.0033	0.37	0.032	0.35	0.0174	0.008[4]	0.031[5]
BTEX in Water by Headspace																	
Benzene	g/m^3	< 0.0010	-	< 0.0010	< 0.0010	-	< 0.0010	< 0.0010	-	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.95[4]	2.0[5]
Toluene	g/m^3	< 0.0010	-	< 0.0010	0.0052	-	0.001	< 0.0010	-	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010		
Ethylbenzene	g/m^3	< 0.0010	-	< 0.0010	< 0.0010	-	< 0.0010	< 0.0010	-	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010		
m&p-Xylene	g/m^3	< 0.002	-	< 0.002	0.002	-	< 0.002	< 0.002	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.2[4]	0.34[5]
o-Xylene	g/m^3	< 0.0010	-	< 0.0010	0.0014	-	< 0.0010	< 0.0010	-	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.35[4]	0.64[5]
Total Petroleum Hydrocarbons in Water																	
C7 - C9	g/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
C10 - C14	g/m^3	< 0.2	< 0.2	< 0.2	0.6	0.4	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
C15 - C36	g/m^3	2.6	0.9	< 0.4	2.7	2.3	0.6	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4		
Total hydrocarbons (C7 - C36)	g/m^3	2.6	0.9	< 0.7	3.3	2.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	15[6]	

Notes:

1. *Note additional water quality samples were collected at 10 minutes after first flush sample were collected. These additional water quality samples were obtained at all monitoring locations (except the fire hydrant). Water quality parameters collected were TSS and TPH only.*
2. *Note a Horiba multi parameter water quality sensor was used to obtain field measurements at Z Lakeside.*
3. *'-' denotes that this parameter was not sampled.*
4. *ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality. Freshwater 95% level of protection.*
5. *ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality. Freshwater 80% level of protection.*
6. *MfE (1998) Environmental guidelines for water discharges from petroleum industry sites in New Zealand.*
7. *Highlighted values indicate exceedances against a referenced guideline. Red cells donate exceedance of 80% and 95% ANZECC (2001) triggers, Yellow cells donate exceedance in 95% ANZECC (2001) trigger only. Orange cells donate exceedance in MfE (1998) values.*

Table 15: Z Sylvia Park Water Quality Results

		Z Service Station							Control Site				Guideline Trigger	
		Z Sylvia Park							Control Site A		Control Site B			
		API Oil-Water Separator (Model 3500)				Catch Pit			Catch Pit		Catch Pit			
Sample Location		**Forecourt Influent First Flush (0 min)**	**Forecourt Influent Mid Flow (30 min)**	**Forecourt Effluent First Flush (0 min)**	**Forecourt Effluent Mid Flow (30 min)**	**Non-forecourt First Flush (0 min)**	**Non-Forecourt Mid Flow (30 min)**	**Fire Hydrant Water**	**Effluent First Flush (0 min)**	**Effluent Mid Flow (30 min)**	**Effluent First Flush (0 min)**	**Effluent Mid Flow (30 min)**	**ANZECC (2000) 95% trigger and MfE (1998)**	**ANZECC (2000) 80% trigger**
Sample Field Reference no		**SYL SW 004**	**SYL SW 006**	**SYL SW 005**	**SYL SW 007**	**SYL SW 001**	**SYL SW 002**	**SYL SW 003**	**ABG SW01**	**ABG SW02**	**AMU SW01**	**AMU SW02**		
Sample Date		13/03/2013	13/03/2013	13/03/2013	13/03/2013	13/03/2013	13/03/2013	13/03/2013	28/02/2013	28/02/2013	28/02/2013	28/02/2013		
Sample Time		0210	0240	0220	0250	1224	1254	1215	2130	2200	2315	2345		
Sample Parameter	**Units**													
Temperature	°C	20.8	19.4	23.1	20.9	18.7	17.8	19.9	20.6	19.0	20.6	19.4		
Dissolved Oxygen	% Sat	92.0	95.8	34.7	48.0	84.8	81.0	73.9	80.3	79.0	72.7	75.1		
Oxygen Reduction Potential	mV	258.0	245.7	252.9	128.2	215.4	291.8	292.3	258.6	358.6	309.8	399.1		
Electrical Conductivity	mS/m	25.4	18.3	17.5	16.0	31.7	15.8	15.7	51.4	17.2	33	14.6		
pH	pH Units	7.3	8.0	7.6	8.9	6.8	7.2	7.7	4.6	7.3	6.2	7.2		
Total Suspended Solids	g/m^3	92	4	51	8	850	6	< 3	320	25	380	7	100[3]	
Polycyclic Aromatic Hydrocarbons Screening in Water														
Acenaphthene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Acenaphthylene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Anthracene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[a]anthracene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[a]pyrene (BAP)	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[b+j]fluoranthene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[g,h,i]perylene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[k]fluoranthene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Chrysene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Dibenzo[a,h]anthracene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluoranthene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluorene	mg/m^3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Indeno(1,2,3-c,d)pyrene	mg/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Naphthalene	mg/m^3	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	16[1]	85[2]
Phenanthrene	mg/m^3	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4		
Pyrene	mg/m^3	0.6	0.5	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn														
Total Recoverable Arsenic	g/m^3	0.0019	< 0.0011	0.0043	0.0015	0.0024	< 0.0011	< 0.0011	0.002	< 0.0011	0.0028	0.0012	0.013[4]	0.140[2]
Total Recoverable Cadmium	g/m^3	0.000122	< 0.000053	0.00012	< 0.000053	0.00028	< 0.000053	0.000063	0.00065	0.000073	0.00044	< 0.000053	0.0002[4]	0.0008[2]
Total Recoverable Chromium	g/m^3	0.0039	0.00072	0.0186	0.00087	0.0059	0.00064	< 0.00053	0.0065	0.00076	0.0056	< 0.00053	0.001[4]	0.040[2]
Total Recoverable Copper	g/m^3	0.034	0.0061	0.036	0.0032	0.056	0.002	0.0024	0.07	0.0032	0.064	0.002	0.0014[4]	0.0025[2]
Total Recoverable Lead	g/m^3	0.0109	0.001	0.059	0.0012	0.0176	0.00125	0.0023	0.0163	0.00139	0.024	0.00104	0.0034[4]	0.0094[2]
Total Recoverable Nickel	g/m^3	0.0046	0.00059	0.0186	< 0.00053	0.0085	< 0.00053	0.00058	0.0068	< 0.00053	0.0062	< 0.00053	0.011[4]	0.017[2]
Total Recoverable Zinc	g/m^3	0.26	0.055	1.78	0.152	0.73	0.047	0.005	0.55	0.039	0.67	0.023	0.008[4]	0.031[2]
Dissolved Arsenic	g/m^3	0.0013	0.0012	< 0.0010	0.0012	0.0012	< 0.0010	< 0.0010	0.0013	< 0.0010	0.0018	0.001	0.013[1]	0.140[2]
Dissolved Cadmium	g/m^3	< 0.00005	< 0.00005	< 0.00005	< 0.00005	0.00015	< 0.00005	< 0.00005	0.00042	0.00006	0.00022	< 0.00005	0.0002[1]	0.0008[2]
Dissolved Chromium	g/m^3	0.0009	< 0.0005	< 0.0005	< 0.0005	0.0008	< 0.0005	< 0.0005	0.0016	< 0.0005	0.0011	< 0.0005	0.001[1]	0.040[2]
Dissolved Copper	g/m^3	0.0146	0.0046	0.0006	0.0013	0.03	0.0011	0.0007	0.042	0.002	0.035	0.0013	0.0014[1]	0.0025[2]
Dissolved Lead	g/m^3	0.0006	0.00014	0.00013	0.00021	0.00092	0.00043	0.00024	0.00113	0.00017	0.0034	0.0002	0.0034[1]	0.0094[2]
Dissolved Nickel	g/m^3	0.0019	< 0.0005	0.0006	< 0.0005	0.004	< 0.0005	< 0.0005	0.0034	< 0.0005	0.0034	< 0.0005	0.011[1]	0.017[2]
Dissolved Zinc	g/m^3	0.076	0.0193	0.197	0.057	0.41	0.036	< 0.0010	0.37	0.032	0.35	0.0174	0.008[1]	0.031[2]
BTEX in Water by Headspace														
Benzene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.95[1]	2.0[2]
Toluene	g/m^3	< 0.0010	< 0.0010	< 0.0010	0.0048	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010		
Ethylbenzene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010		
m&p-Xylene	g/m^3	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.2[1]	0.34[2]
o-Xylene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.35[1]	0.64[2]
Total Petroleum Hydrocarbons in Water														
C7 - C9	g/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
C10 - C14	g/m^3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
C15 - C36	g/m^3	< 0.4	2.5	< 0.4	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4		
Total hydrocarbons (C7 - C36)	g/m^3	< 0.7	2.5	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	15[3]	

Notes:
1. *ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality. Freshwater 95% level of protection.*
2. *ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality. Freshwater 80% level of protection.*
3. *MfE (1998) Environmental guidelines for water discharges from petroleum industry sites in New Zealand.*
4. *Highlighted values indicate exceedances against a referenced guideline. Red cells donate exceedance of 80% and 95% ANZECC (2001) triggers, Yellow cells donate exceedance in 95% ANZECC (2001) trigger only. Orange cells donate exceedance in MfE (1998) values.*

Table 16: Z Highbrook Water Quality Results 26 March 2012

Sample Location		Z Service Station – Z Highbrook – API Oil-Water Separator (Model 5500): Forecourt Influent First Flush (0 min)	Forecourt Influent Mid Flow (10 min)	Forecourt Influent Mid Flow (30 min)	Forecourt Effluent First Flush (0 min)	Forecourt Effluent Mid flow (10 min)	Forecourt Effluent Mid flow (30 min)	Catch Pit: Non-forecourt First Flush (0 min)	Non-Forecourt Mid Flow (10 min)	Non-Forecourt Mid Flow (30 min)	Fire Hydrant Water	Control Site – Control Site A – Catch Pit: Effluent First Flush (0 min)	Effluent Mid Flow (30 min)	Control Site B – Catch Pit: Effluent First Flush (0 min)	Effluent Mid Flow (30 min)	Guideline Trigger: ANZECC (2000) 95% trigger and MfE (1998)	ANZECC (2000) 80% trigger
Sample Field Reference no		**HBK SW 004a**	**HBK SW 009a**	**HBK SW 006a**	**HBK SW 005a**	**HBK SW 010a**	**HBK SW 007a**	**HBK SW 001a**	**HBK SW 008a**	**HBK SW 002a**	**HBK SW 003a**	**ABG SW01**	**ABG SW02**	**AMU SW01**	**AMU SW02**		
Sample Date		26/03/2013	26/03/2013	26/03/2013	26/03/2013	26/03/2013	26/03/2013	26/03/2013	26/03/2013	26/03/2013	26/03/2013	28/02/2013	28/02/2013	28/02/2013	28/02/2013		
Sample Time		2314	2324	2344	2316	2326	2346	2213	2223	2243	2200	2130	2200	2315	2345		
Sample Parameter	**Units**																
Temperature	°C	20.13	-[3]	19.44	22.26	-[3]	21.11	20.29	19.7	19.06	21.16	20.6	19.0	20.6	19.4		
Dissolved Oxygen	% Sat	61.6	-[3]	70.3	34.9	-[3]	42.5	102.5	101.8	101.5	128.4	80.3[3]	79.0[3]	72.7[3]	75.1[3]		
Oxygen Reduction Potential	mV	17	-[3]	156	34	-[3]	21	418	466	601	326	258.6	358.6	309.8	399.1		
Electrical Conductivity	mS/m	36.6	-	20.1	18.5	-	22.6	16.4	-	15.7	15.6	51.4	17.2	33	14.6		
pH	pH Units	7.2	-	7.5	7.2	-	7.0	7.5	-	7.7	8.2	4.6	7.3	6.2	7.2		
Total Suspended Solids	g/m^3	18	10	7	8	7	10	30	20	10	<3	320	25	380	7	100[6]	
Polycyclic Aromatic Hydrocarbons Screening in Water																	
Acenaphthene	mg/m^3	< 0.10	-	< 0.00010	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Acenaphthylene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Anthracene	mg/m^3	< 0.10	-	0.12	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[a]anthracene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[a]pyrene (BAP)	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[g,h,i]perylene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[k]fluoranthene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Chrysene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Dibenzo[a,h]anthracene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluoranthene	mg/m^3	< 0.10	-	0.11	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluorene	mg/m^3	< 0.2	-	< 0.2	< 0.2	-	< 0.2	< 0.2	-	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Indeno(1,2,3-c,d)pyrene	mg/m^3	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	-	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Naphthalene	mg/m^3	< 0.05	-	< 0.5	< 0.5	-	< 0.5	< 0.5	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	16[4]	85[5]
Phenanthrene	mg/m^3	< 0.4	-	< 0.4	< 0.4	-	< 0.4	< 0.4	-	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4		
Pyrene	mg/m^3	1.8	-	2.5	0.9	-	0.0015	< 0.2	-	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn																	
Total Recoverable Arsenic	g/m^3	0.0012	-	< 0.0011	< 0.0011	-	< 0.0011	0.0011	-	< 0.0011	< 0.0011	0.002	< 0.0011	0.0028	0.0012	0.013[4]	0.140[5]
Total Recoverable Cadmium	g/m^3	0.000105	-	< 0.000053	< 0.000053	-	< 0.000053	0.000154	-	< 0.000053	< 0.000053	0.00065	0.000073	0.00044	< 0.000053	0.0002[4]	0.0008[5]
Total Recoverable Chromium	g/m^3	0.00179	-	0.00055	0.00177	-	0.0021	0.00182	-	0.00093	0.033	0.0065	0.00076	0.0056	< 0.00053	0.001[4]	0.040[5]
Total Recoverable Copper	g/m^3	0.012	-	0.003	0.0041	-	0.006	0.0057	-	0.00087	0.0027	0.07	0.0032	0.064	0.002	0.0014[4]	0.0025[5]
Total Recoverable Lead	g/m^3	0.0048	-	0.00177	0.00085	-	0.00174	0.0056	-	0.00089	0.00033	0.0163	0.00139	0.024	0.00104	0.0034[4]	0.0094[5]
Total Recoverable Nickel	g/m^3	0.00183	-	< 0.00053	0.0028	-	0.003	0.00129	-	< 0.00053	0.0027	0.0068	< 0.00053	0.0062	< 0.00053	0.011[4]	0.017[5]
Total Recoverable Zinc	g/m^3	0.11	-	0.035	0.35	-	0.21	0.21	-	0.035	0.0033	0.55	0.039	0.67	0.023	0.008[4]	0.031[5]
Dissolved Arsenic	g/m^3	< 0.0010	-	< 0.0010	< 0.0010	-	< 0.0010	< 0.0010	-	< 0.0010	< 0.0010	0.0013	< 0.0010	0.0018	0.001	0.013[4]	0.140[5]
Dissolved Cadmium	g/m^3	0.00005	-	< 0.00005	< 0.00005	-	< 0.00005	0.00008	-	< 0.00005	< 0.00005	0.00042	0.00006	0.00022	< 0.00005	0.0002[4]	0.0008[5]
Dissolved Chromium	g/m^3	0.0008	-	< 0.0005	0.0012	-	0.0015	< 0.0005	-	0.0005	0.0006	0.0016	< 0.0005	0.0011	< 0.0005	0.001[4]	0.040[5]
Dissolved Copper	g/m^3	0.005	-	0.0013	0.0026	-	0.0031	0.0022	-	0.0006	0.0006	0.042	0.002	0.035	0.0013	0.0014[4]	0.0025[5]
Dissolved Lead	g/m^3	0.0005	-	0.00022	0.0005	-	0.00058	0.00016	-	< 0.00010	0.00013	0.00113	0.00017	0.0034	0.0002	0.0034[4]	0.0094[5]
Dissolved Nickel	g/m^3	0.0013	-	< 0.0005	0.0022	-	0.0024	< 0.0005	-	< 0.0005	< 0.0005	0.0034	< 0.0005	0.0034	< 0.0005	0.011[4]	0.017[5]
Dissolved Zinc	g/m^3	0.04	-	0.0198	0.25	-	0.122	0.086	-	0.02	0.0031	0.37	0.032	0.35	0.0174	0.008[4]	0.031[5]
BTEX in Water by Headspace																	
Benzene	g/m^3	< 0.0010	-	< 0.0010	< 0.0010	-	0.006	< 0.0010	-	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.95[4]	2.0[5]
Toluene	g/m^3	0.007	-	< 0.0010	0.0035	-	0.124	< 0.0010	-	0.003	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010		
Ethylbenzene	g/m^3	0.001	-	< 0.0010	0.0018	-	0.0138	< 0.0010	-	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010		
m&p-Xylene	g/m^3	0.004	-	< 0.002	0.012	-	0.189	< 0.002	-	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.2[4]	0.34[5]
o-Xylene	g/m^3	0.0025	-	< 0.0010	0.0052	-	0.119	< 0.0010	-	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.35[4]	0.64[5]
Total Petroleum Hydrocarbons in Water																	
C7 - C9	g/m^3	< 0.10	< 0.10	< 0.10	< 0.10	0.26	0.43	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
C10 - C14	g/m^3	3.8	1.4	1.3	< 0.2	0.2	0.4	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
C15 - C36	g/m^3	72	30	32	1.5	2	4.1	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4		
Total hydrocarbons (C7 - C36)	g/m^3	76	31	33	1.5	2.5	5	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	15[6]	

Notes:
1. *Note additional water quality samples were collected at 10 minutes after first flush sample were collected. These additional water quality samples were obtained at all monitoring locations (except the fire hydrant). Water quality parameters collected were TSS and TPH only.*
2. *Note a Horiba multi parameter water quality sensor was used to obtain field measurements at Z Lakeside.*
3. *'-' denotes that this parameter was not sampled.*
4. *ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality. Freshwater 95% level of protection.*
5. *ANZECC (2000) Australian and New Zealand guidelines for fresh and marine water quality. Freshwater 80% level of protection.*
6. *MfE (1998) Environmental guidelines for water discharges from petroleum industry sites in New Zealand.*
7. *Highlighted values indicate exceedances against a referenced guideline. Red cells donate exceedance of 80% and 95% ANZECC (2001) triggers, Yellow cells donate exceedance in 95% ANZECC (2001) trigger only. Orange cells donate exceedance in MfE (1998) values.*

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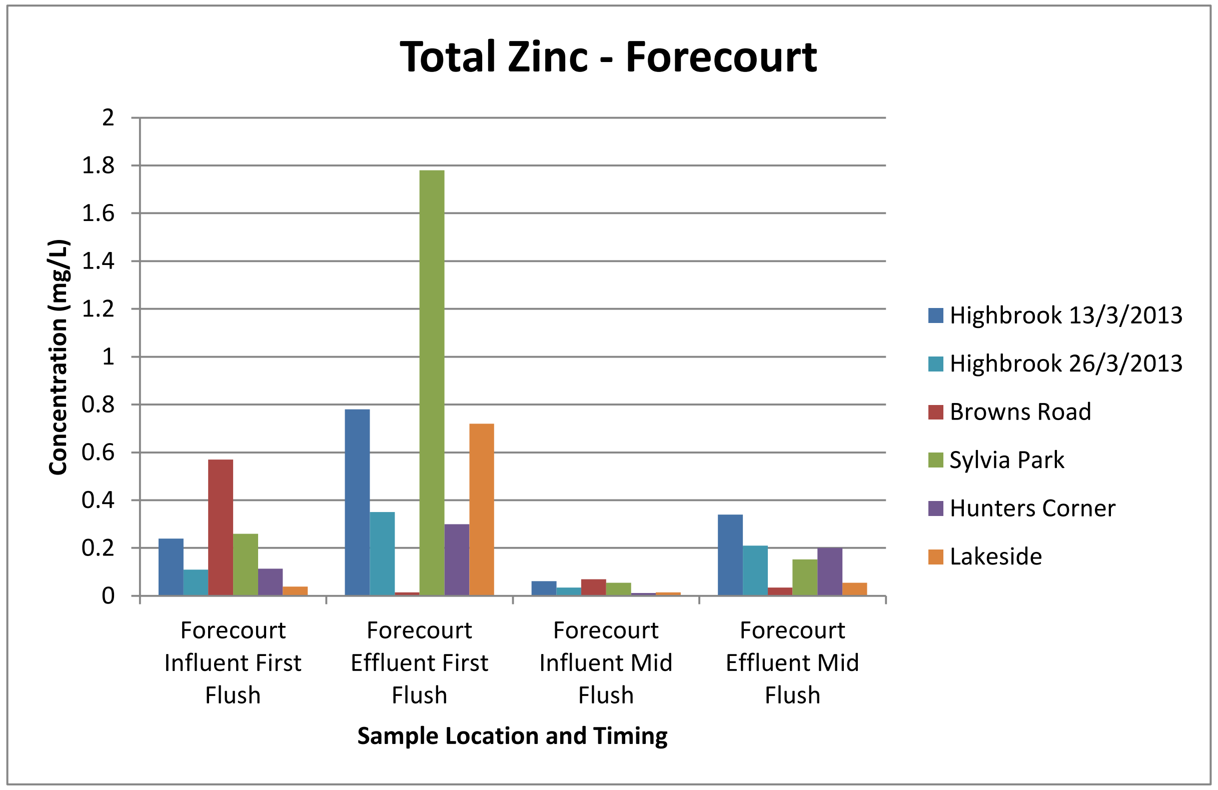

Figure 1: Water Quality Results of Total Zinc from Z Forecourts

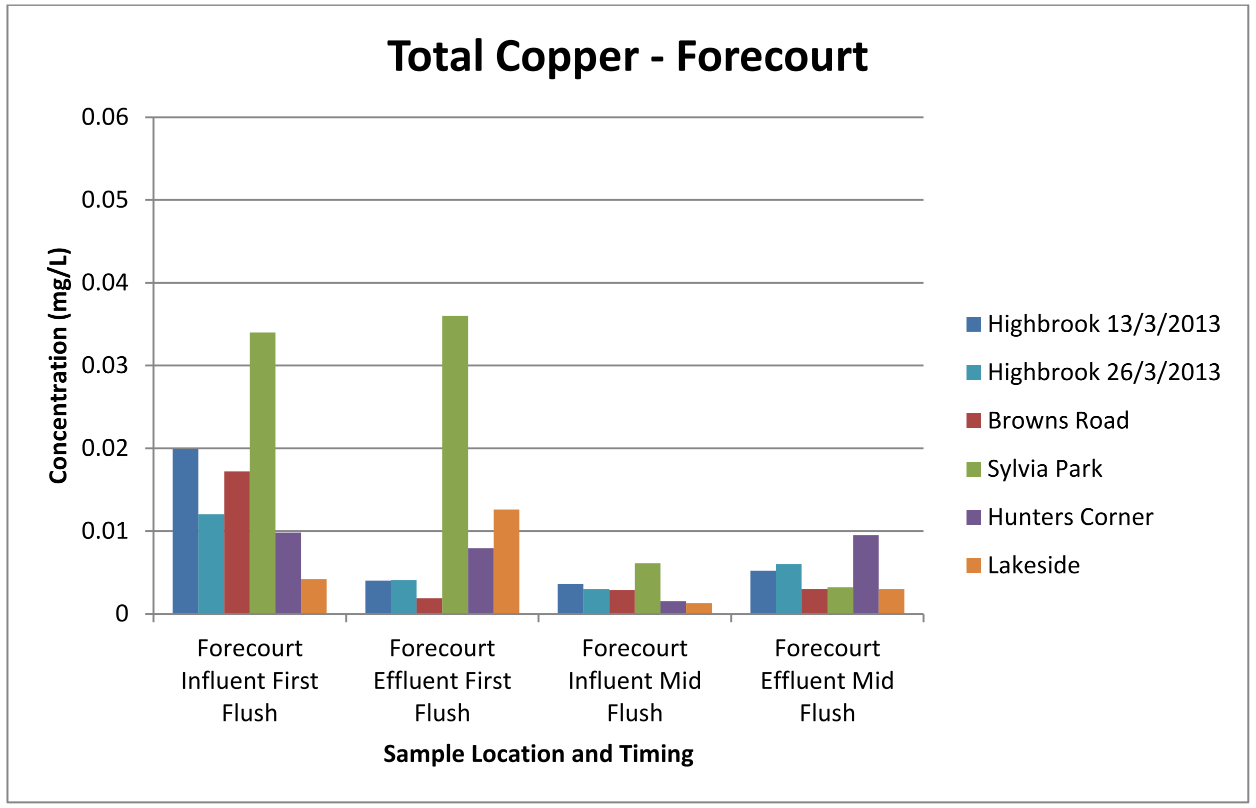

Figure 3: Water Quality Results of Total Copper from Z Forecourts

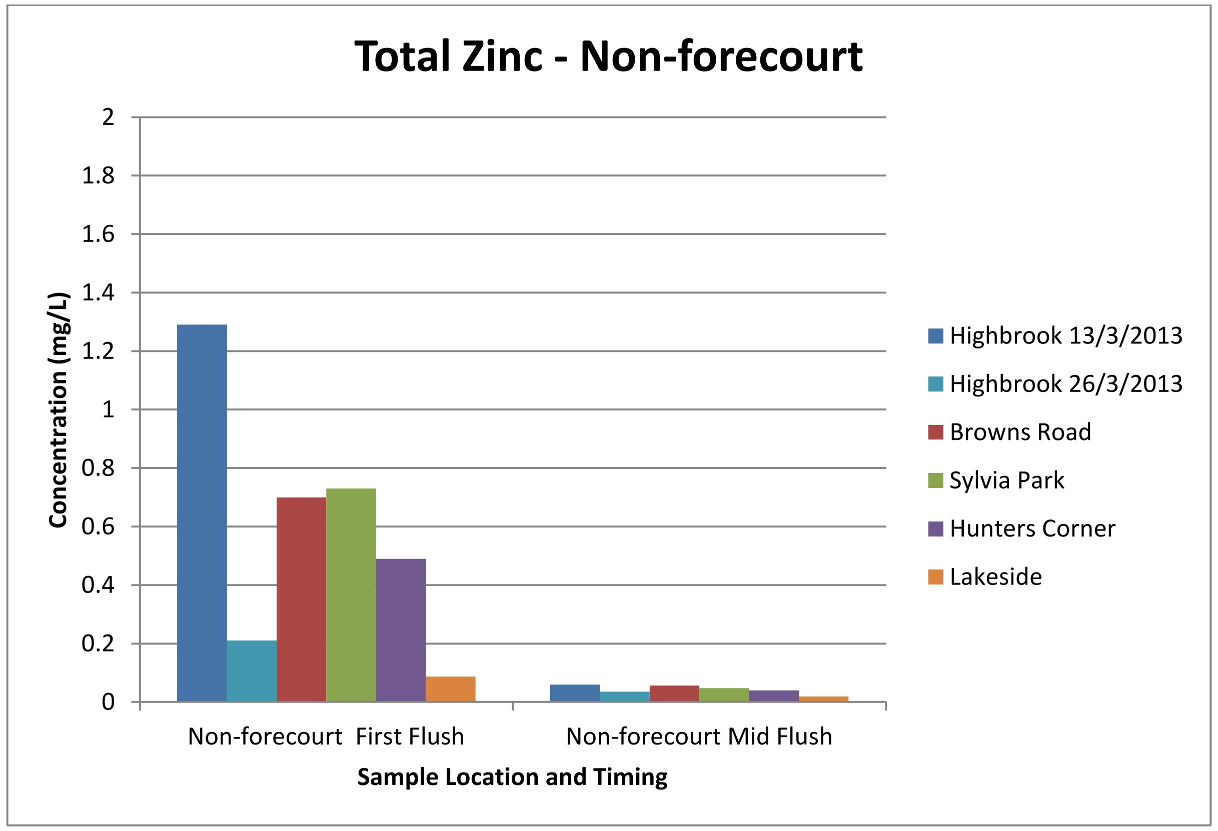

Figure 2: Water Quality Results of Total Zinc from Z Non-Forecourts

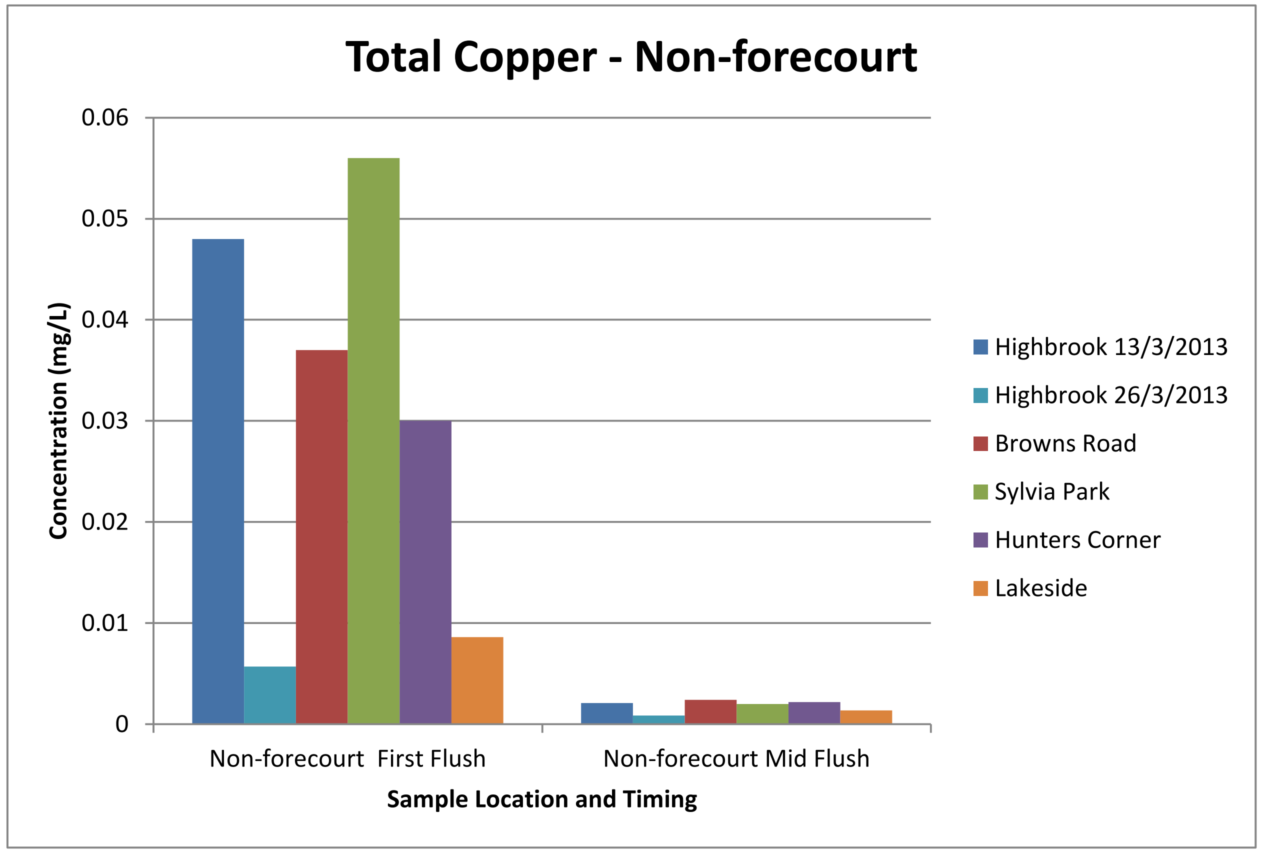

Figure 4: Water Quality Results of Total Copper from Z Non-Forecourts

Submission #44770

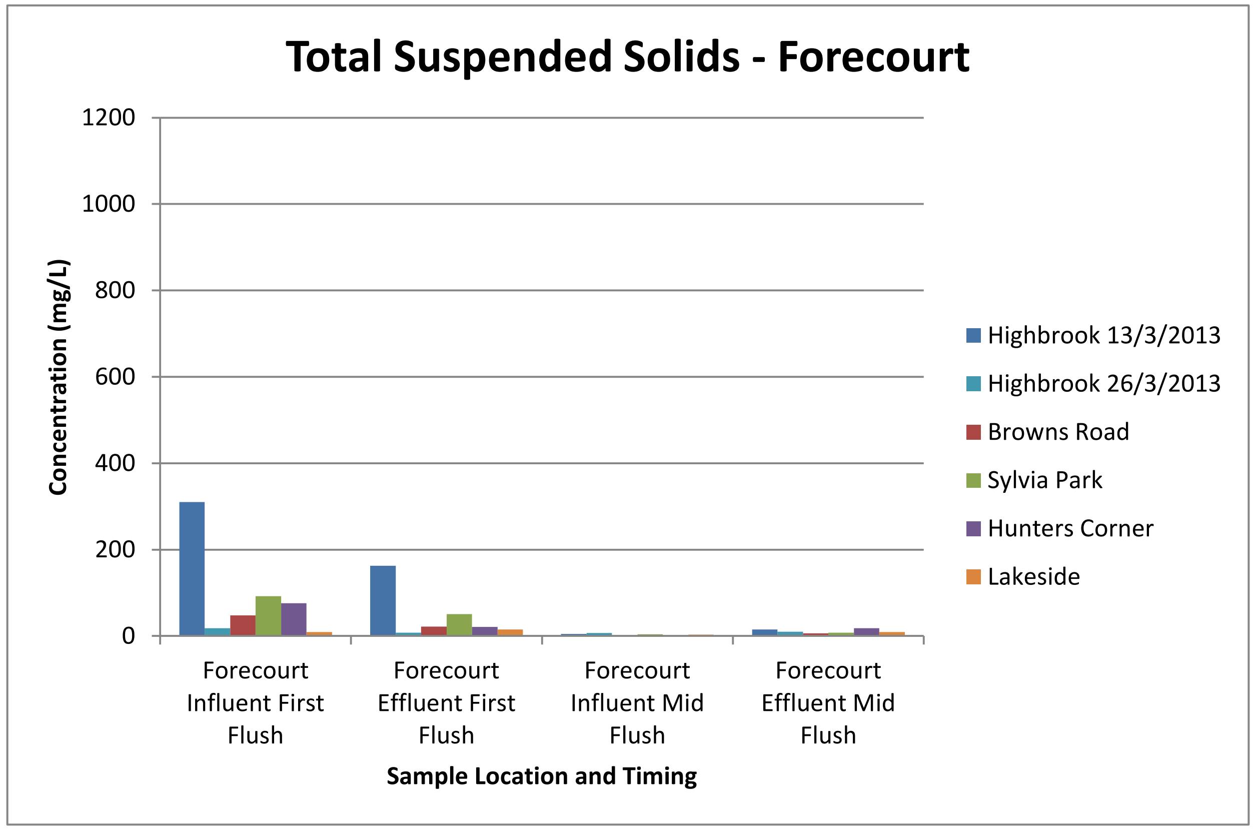

Figure 5: Water Quality Results of Total Suspended Solids from Z Forecourts

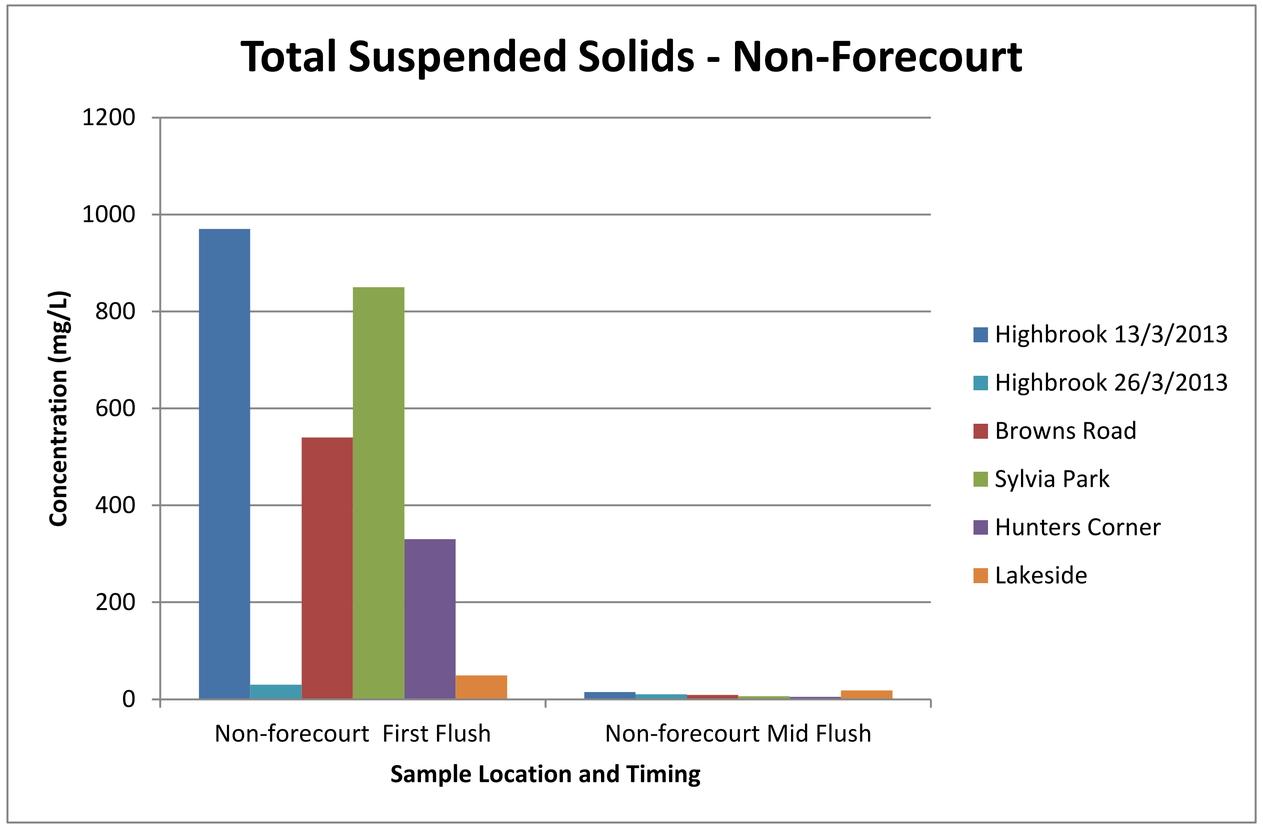

Figure 6: Water Quality Results of Total Suspended Solids from Z Non-Forecourts

5.3.1 First Flush Assessment

To ascertain whether the above sampling captured the first flush (or peak flux of the contamination discharged from the drainage area), turbidity measurements were obtained during water quality sampling at Z Lakeside and Z Highbrook on 26 March 2013. Turbidity measurements were selected as a surrogate parameter to assess for the first flush across all contaminants.

Figures 7 and 8 below illustrate turbidity results obtained for Z Lakeside and Z Highbrook, respectively. For both of these sites, the first flush occurred immediately with the first waters discharged from the site, i.e. there was no increase in contaminant load over time.

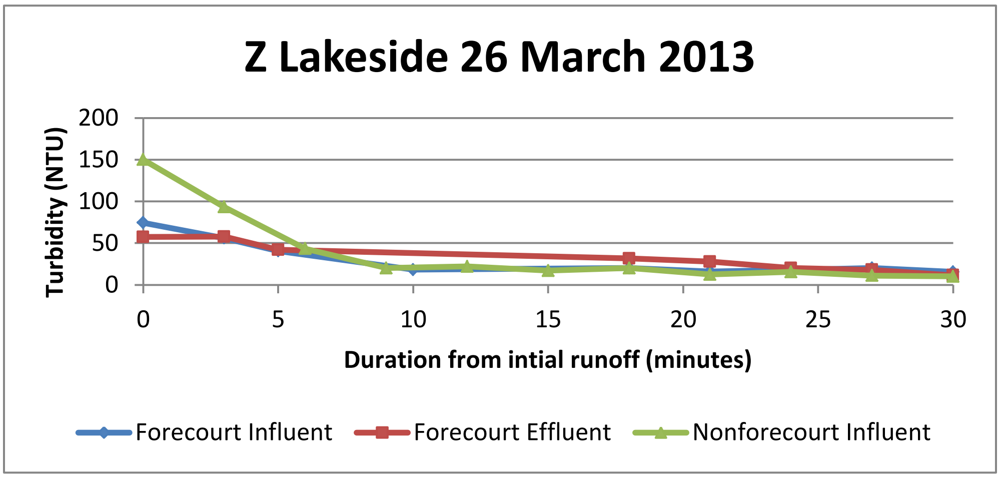

Figure 7: Z Lakeside Turbidity Results

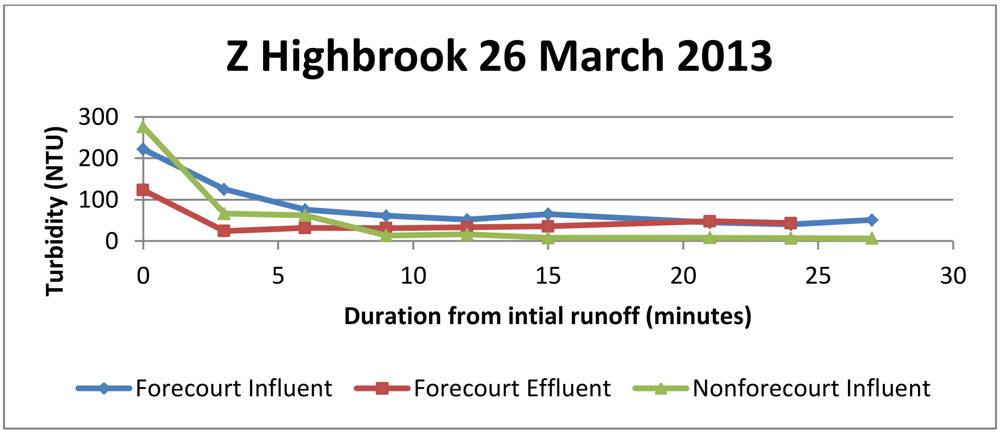

Figure 8: Z Highbrook Turbidity Results

Based on the information presented in Figures 7 and 8, the majority of the contaminant load is discharged within the first five minutes of the stormwater runoff occurring. It is assumed that this result is typical for all contaminants and for all sites assessed in this project, due to the similar drainage area characteristics for all sites, i.e. the timing in which peak stormwater discharges from the monitored drainage areas are anticipated to be similar. This verifies that the grab samples collected as soon as stormwater entered into the monitoring location (be it the stormwater treatment device or the catch pit) represent the first flush and therefore the peak contaminant concentrations.

5.4 Mass Load Assessment

A simple contaminant load calculation was undertaken using forecourt effluent data (the discharge from the oil-water separator/interceptor) and the non-forecourt data (untreated discharge to the catch pit) to estimate the average annual contaminant load contribution from all drainage areas assessed in this project, i.e. the amount of contaminants produced per given source area in a given time (Kg/annum/hectare).

The assessment was carried out in two stages:

- Stage one was used to calculate the average contaminant load contributions from first flush and mid flow data. This assessment defines the ranges of possible contaminant mass load that could be (based on the obtained data) discharged from the forecourt and non-forecourt drainage areas.
- Stage two involved calculating the annual average contaminant load contribution from the forecourt and non-forecourt drainage areas.

The stage one methodology used to determine the mass loads from first flush and mid flow, involved the multiplication of the measured contaminant concentration and the annual stormwater flow discharged from the sampled catchment area. This resultant was then divided by the drainage area that was monitored.

In order to establish the estimated annual contaminant loads from the drainage areas, the Auckland Airport 2012 annual precipitation value of 1,063 mm was used (NIWA, 2013).

The annual stormwater flow was calculated using the Rational Method (i.e. stormwater discharge = Runoff co-efficient x rainfall x drainage area). For the purposes of this project, a runoff co-efficient of 0.95 was used to represent that not all rainfall events produce a stormwater discharge, i.e. 5% of the annual rainfall does not produce sufficient rainfall to produce a stormwater discharge. This runoff co-efficient is representative for an impervious surface e.g. concrete or asphalt (Horner *et al.* 1994).

For the purposes of comparing the obtained results with published data, all results are reported in units of Kg/annum/hectare.

For comparison purposes, contaminant yield assessments were carried out for both first flush and the mid flow (30 minutes) data. Tables 17 and 18 present first flush and the mid flow results, respectively. For purposes of comparison of data, a similar assessment was carried out for the two control sites.

The contaminant yields calculated have been compared to available contaminant load information from the following publications:

- URS (2008) - This report presented contaminant yield results obtained from the monitoring of actual storm events across five Auckland service stations (not exclusive to Z service stations). The values presented are the average contaminant yields obtained from all five service stations assessed.
- Kennedy and Sutherland (2008) – This technical report presents the mass loads and contaminant yields determined for three stormwater catchments in the Auckland area, namely Mission Bay (residential catchment), Auckland CBD (commercial catchment) and Mt Wellington (industrial catchment).

The stage two methodology was used to determine the 'best estimate' of annual contaminant load contribution from the forecourt and non-forecourt drainage areas.

Based on the turbidity data collected to determine the characteristics of the first flush event (refer to figures 7 and 8), the median load would occur within the first five minutes of the stormwater discharge.

At an average 1 L/s irrigation flow rate across the Z Service Stations, and an average irrigation area of 100 m^2, the applied synthetic rainfall for 5 minutes is 300 L per 100 m^2, or 3 mm of rainfall, would be discharged at the first flush concentration. For rainfall depths greater than 3 mm, contaminant concentrations would then be discharged at the mid flow contaminant concentration.

Median first flush and mid flow concentrations for the forecourt and non-forecourt drainage areas were used in this assessment.

20 years of rainfall record (obtained from the Auckland International Airport) were used to estimate the average annual depth from rainfall events 3 mm or less, plus the first 3 mm of rainfall for larger events. The ratio of this to the total annual rainfall was then used to prorate the first flush to mid flow concentration data.

Table 19 presents annual contaminant mass loads for forecourt and non-forecourt drainage areas. For comparative purposes, Table 19 also includes data obtained from Kennedy and Sutherland (2008) for residential, commercial and industrial land uses.

Table 17: Average Contaminant Mass Load for Z Service Stations Assessed -First Flush Scenario

Parameter	Z Service Stations		Control Sites		URS (2009)		Kennedy and Sutherland (2008)		
	Forecourt Effluent	Non-Forecourt Effluent	Control Site A Effluent	Controls Site B Effluent	Forecourt Effluent	Non-Forecourt Effluent	Central Business District	Residential	Industrial
Total Copper	0.112	0.258	0.729	0.667	0.19	0.36	0.14	0.08	0.14
Total Lead	0.112	0.103	0.170	0.250	0.086	0.07	0.12	0.06	0.14
Total Zinc	6.64	5.21	5.73	6.98	4.53	4.34	1.63	0.57	5.2
Total Suspended Solids	472.43	4660.46	3333.57	3958.61	303.12	359.96	310	620	252
Total Petroleum Hydrocarbons	14.85	7.07	<7.29	<7.29	63.15	12.12	-	-	-

Notes: 1. *All results are expressed as Kg/annum/hectare*

2. *'-' denotes that this parameter has not been calculated.*

3. *Service station forecourt area for sites used in this study ranged between 280 m^2 and 350 m^2. Service station non-forecourt area for sites used in this study ranged between1,100 m^2 and 1,700 m^2 (based on GIS assessment).*

Table 18: Average Contaminant Mass Load for Z Service Stations Assessed -Mid Flow Scenario

Parameter	Z Service Stations		Control Sites		URS (2009)		Kennedy and Sutherland (2008)		
	Forecourt Effluent	Non-Forecourt Effluent	Control Site A Effluent	Controls Site B Effluent	Forecourt Effluent	Non-Forecourt Effluent	Central Business District	Residential	Industrial
Total Copper	0.050	0.018	0.033	0.021	0.17	0.21	0.14	0.08	0.14
Total Lead	0.014	0.010	0.014	0.011	0.115	0.166	0.12	0.06	0.14
Total Zinc	1.67	0.43	0.41	0.24	3.15	5.68	1.63	0.57	5.2
Total Suspended Solids	111.08	106.03	260.44	72.92	267.76	381.43	310	620	252
Total Petroleum Hydrocarbons	35.345	7.069	<7.292	<7.292	8.21	81.08	-	-	-

Notes: 1. *All results are expressed as Kg/annum/hectare*

2. *'-' denotes that this parameter has not been calculated.*

3. *URS (2009) mid flow results were collected approximately one hour after the first flush sample.*

4. *This studies mid flow samples were collected 30 minutes after the first flush sample.*

Table 19: Average Annual Contaminant Mass Load for Z Service Stations Assessed - Drainage Area Type

Parameter	Drainage Area Type				
	Z Energy		Kennedy and Sutherland (2008)		
	Forecourt Effluent	Non-Forecourt Effluent	Central Business District	Residential	Industrial
Total Copper	0.05	0.06	0.14	0.08	0.14
Total Lead	0.02	0.03	0.12	0.06	0.14
Total Zinc	2.4	1.2	1.63	0.57	5.2
Total Suspended Solids	119	653	310	620	252
Total Petroleum Hydrocarbons	28	8	-	-	-

Notes: 1. All results are expressed as Kg/annum/hectare
2. '-' denotes that this parameter has not been calculated.

6.0 Discussion

6.1 Sediment Quality

The following section discusses the sediment quality results obtained. Comments below are specific to contaminants that have specific values that are significantly different when compared to other sediment quality data obtained in this project or results obtained by URS (2008).

6.1.1 pH

From the sediment quality results obtained, the pH varied considerably across the service stations assessed (ranging from 5.7-8.5 pH units).

A relationship of pH and total organic carbon can be formed, i.e. when total organic carbon concentrations are elevated, pH concentrations are usually reduced. This implies that organic matter (such as leaf litter) is a key component for determining the sediment pH, due to a reducing environment resulting from organic degradation.

This correlation however, is not consistent with the Hunters Corner forecourt result where values of 8.5 pH units and 10.7 g/100g of total organic carbon were obtained. It is therefore assumed that a second source may have caused the pH increase. This would be consistent with the presence of detergent in the sediment.

6.1.2 Polycyclic Aromatic Hydrocarbons

In general, based on the sample results obtained, PAH compounds bind well to sediment particles when present. PAH compounds bound to sediment, clearly accumulate within the stormwater oil-water interceptors/separators and sumps. This is specifically demonstrated by the elevated sediment concentrations of PAH at Z Browns Road and Z Sylvia Park while water quality results obtained had very low PAH concentrations.

6.1.3 Heavy Metals

Elevated concentrations of heavy metals were obtained at all Z service stations and control sites. All service stations had heavy metal concentrations that were greater than background concentrations within Auckland soils. Meaning that the activities undertaken at the service stations were contributing heavy metal load. This result is consistent with other studies and reports that have monitored vehicle related land uses (Moores *et al*, 2009a, Moores *et al*, 2009b, Kennedy and Sutherland, 2008, URS, 2008).

Key heavy metal sources that may have generated the observed contaminants are:

- Vehicular movements leading to tyre wear, brake lining wear;
- Vehicle emissions, from vehicle movement and vehicle starting; and
- Vehicle oils losses.

High concentrations of zinc at Highbrook and Hunters Corner may be attributed to the silts and clays present at these sites. This is due to the greater capacity for smaller sediment particles to adsorb contaminants. In comparison, due to a larger grain size distribution being present at Browns Road, the concentrations of zinc were considerably less.

Sylvia Park had the greatest concentration of heavy metals present in sediments. A possible explanation for this is the additional transport related activities that occur at this site in comparison to all other sites (e.g. the Repco and NZ Courier depots).

As previously discussed, Z Silvia Park now has a Hynds Environmental Upflow Filter installed to further treat stormwater prior to discharge from the site to the public stormwater reticulation network.

6.1.4 BTEX Compounds

BTEX compounds are volatile and degrade readily in the presence of oxygen. This is the likely reason why the majority of sites assessed had little to no BTEX compounds present in the sediment samples obtained. The only site that had BTEX concentrations different to other samples obtained in this project was the Z Hunters Corner forecourt sample. Whilst it cannot be confirmed, a possible explanation for this result may be from a recent spill event (in the past day) where BTEX compounds may not have had sufficient time to allow volatilisation to occur. This theory is in alignment with visual observations made at Z Hunters Corner (Section 5.1.3).

6.1.5 Total Petroleum Hydrocarbons

The TPH results obtained varied across all sites assessed. TPH concentrations were commonly greatest in sediment that is discharged from forecourts into the treatment devices. TPH concentrations were also lowest at sites where trucks are not common (e.g. Z Lakeside and Z Browns Road (whilst being in a predominantly industrial catchment, few trucks use Z Browns Road, due to Z Roscommon Road (sited approximately 2 km north) having a dedicated truck stop refuelling facility)). This statement is verified by the TPH chromatograms obtained during water quality sampling for samples from Z Highbrook, Z Hunters Corner, and Z Sylvia Park, which indicate that the predominant sources of TPH are derived from high carbon chain compounds e.g., diesels, oils and lubricants, or degraded petrol.

Comparing non-forecourt sediment and water quality TPH samples, TPH concentrations were, in the majority, only measureable in the sediment particulate datasets for the sample events measured. This suggests that the majority of TPH concentrations derived within the non-forecourt area readily attach to sediment particles. Catch pits will therefore remove the coarse fraction of sediment and associated TPH load.

Very elevated concentrations of TPH were measured at Z Highbrook and Z Sylvia Park forecourts (250,000 mg/Kg and 197,000 mg/Kg, respectively).

To confirm these results, a second sediment sample was collected at both service stations on 5 February 2013. The result of the second sample at Z Sylvia Park provided a TPH concentration that was significantly reduced compared to the first result obtained (27,000 mg/Kg). Possible explanations for this significant difference between the results may be;

- A possible hydrocarbon globule was analysed in first sample.
- Any contaminated sediments that were retained within the treatment device/catch pit, were flushed by a storm event that occurred between the two sampling dates (21 mm of rainfall occurred on 4 February 2013[1])

TPH results obtained at the Z Highbrook forecourt were consistently elevated (the second sample had a TPH measure of 310,000 mg/Kg). A possible reason for the elevated TPH results may be the uncovered truck stop located at Z Highbrook. This area may be exposed to a greater potential for leaking oils and lubricants from trucks and for diesel losses during filling. It is noted that petrol spills are relatively rapidly evaporated whereas diesel, being less volatile) tends to leave a residue of heavy end hydrocarbons on the ground. Visual evidence of oil staining on the truck stop area provides some indication of this.

Comparison of the sediment quality TPH results to water quality TPH results (discussed in Section 6.2.7) indicates that the TPH discharges are binding well to sediments associated with the discharge, rather than remaining mobile in the influent and effluent waters

[1] Data recorded at the Auckland International Airport. Data obtained from the NZ Climate Database.

discharged from site. This clearly reflects the low solubility of diesel and oil range hydrocarbons.

6.2 Water Quality

The following section discusses the water quality results obtained. The comments below are specific to contaminants that have measured exceedances (compared with ANZECC (2000) 95% and 80% protection trigger values), or contaminants that have specific values that are significantly different when compared to other data obtained in this project. This information provides insight into whether the stormwater treatment device located at Z service stations are able to treat the various contaminants measured in this study and how the contaminant loads compare to other types of land-use.

It is important to note that water quality results obtained are for a single storm event at a given time. The following discussion is therefore based only on the data obtained during this project. Data obtained does not represent the long-term performance that may be achieved from the stormwater treatment devices located at Z service stations. By testing across several sites, general conclusions are inferred about contaminant loading and treatment device performance.

6.2.1 pH

Similar to the pH measurements obtained from sediment quality monitoring, the water quality pH measurements obtained also showed a significant variability across the service stations and control sites.

Water quality pH results from services stations varied from 6.6 to 8.9 pH units.

The pH of the discharge water should be within the range 5.0–9.0, assuming that the buffering capacity of the water is low near the extremes of the pH limits (ANZECC, 2000).

No specific trend between forecourt and non-forecourt drainage areas could be identified. This implies that the potential sources for pH modification are either sourced in both areas, or more likely, can be easily tracked/transported by vehicular movements or wind. As discussed in Section 6.1.1, detergent may be a source of elevated pH within the forecourt discharges.

The value of 8.9 pH units obtained at Sylvia Park forecourt effluent mid-flow, may be explained by the installation of an Upflow filter™[2] during February. To install this treatment device, concrete would have had to been cut and removed. It is assumed that residual concrete dust from this installation could have caused the elevated pH measurement obtained.

[2] A stormwater treatment proprietary product.

6.2.2 Dissolved Oxygen and Oxygen Reduction Potential

Dissolved oxygen concentrations and oxygen reduction potential measurements were significantly less in forecourt effluent samples than compared to forecourt influent samples. A possible explanation for this is due to the influence of water residing within the stormwater treatment devices during the dry antecedent weather conditions. Whilst no measurements were obtained, it is assumed that biological oxygen demanding (BOD) substances and chemical oxygen demanding (COD) substances would be present within the stormwater treatment devices and the stagnant water within the devices would have dissolved oxygen concentrations reduced by the BOD and COD substances. As an example, organic matter present within the stormwater treatment devices may undergo biological degradation and cause a depletion of dissolved oxygen concentrations.

The forecourt effluent dissolved oxygen concentration sample at Z Lakeside was however elevated (80.7% saturation). Oxygen reduction potential was however, very low (7 mV), meaning that the water has chemical properties that may allow dissolved oxygen concentrations to become reduced. A possible explanation for this is the reduced live storage within this device and increased turbulence (i.e. the two stage interceptor has lesser volume of stagnant water retained within the device than compared to all other treatment devices), as discussed in Section 3.2.1.

6.2.3 Total Suspended Solids

High sediment loads were commonly correlated to service stations that had landscaped areas. Sediment is likely to have been transferred to the forecourt and non-forecourt areas by either being wind-blown or tracked by vehicles throughout the service station.

As expected, TSS concentrations were greatest in first flush samples. TSS concentrations then reduce over time, typically within the first 5 minutes of discharge.

Table 20 below presents the sediment removal performance achieved by the installed stormwater treatment devices for the events monitored.

Table 20: % TSS Removal Achieved by Installed Stormwater Treatment Devices

Site	Sample Location	% TSS removal[1]
Z Browns Road	Three Stage Interceptor	54
Z Highbrook	5.0 API oil water separator	47[2]
		55[3]
Z Hunters Corner	3.0 API oil water separator	72
Z Lakeside	Two Stage Interceptor	-66
Z Sylvia Park	3.5 API oil water separator	44

Notes: 1. Assessment is based on comparative values recorded from first flush samples.
2. Sample date 13 March 2013
3. Sample date 26 March 2013

The value obtained for the two stage interceptor (Z Lakeside) indicates an export of sediment from the device. This result is considered to be due to the reduced live storage of the device and increased turbulence within the treatment device itself and that this result is an outlier and should not be considered as a 'typical' result that can be achieved from stormwater treatment devices located on Z service stations. If the measurement from Z Lakeside is removed from the dataset, the average TSS removed by the stormwater treatment devices, during the events sampled, was 54%. It is noted that the Z Lakeside site is scheduled for a drainage upgrade (the existing drainage is a relic from the previous service station operator and does not meet Z standards).

The results obtained are consistent with other TSS monitoring results for devices with low TSS influent concentrations.

Moores *et al.* (2012) assessed the contaminant removal efficiencies of a range of proprietary stormwater treatment devices from car park runoff, including:

- Hynds Up-Flow Filters;
- Stormwater 360 Stormfilters; and
- Humes Filternators.

All stormwater treatment devices used in the Moores *et al*. (2012) study, use filtration processes to treat stormwater. The oil-water interceptors/separators treatment devices monitored in this project, however, use sedimentation processes. Key differences between these two stormwater treatment processes are:

- Filtration devices enable the stormwater to pass through a filter media, e.g. zeolite, perlite; and
- Sedimentation devices require a detention of the stormwater to allow for the settlement of entrained contaminants to occur.

Based on the differing processes, it is expected that filtration devices should provide a greater performance in removing TSS from stormwater. This conclusion is consistent with results presented in the USEPA BMP database[3], where a filtration device should achieve an average 83% reduction in TSS[4], while a sedimentation type device should achieve an average 47% reduction in TSS[5].

However, results obtained from the Moores *et al* (2012) study, found that the majority of TSS removal efficiencies for these devices (for the storm events assessed) were not able to achieve 75% TSS removal, even though all of these stormwater treatment devices are Auckland Council accredited to achieve this performance standard. Table 21 presents the per cent TSS removal achieved for the above stormwater treatment devices during the Moores *et al.* (2012) study.

Table 21: % TSS Removal Achieved by Other Stormwater Treatment Devices during the Moores *et al.*(2012) Study.

Stormwater Treatment Device	% TSS removal
Up-Flow Filter	15[1]
Stormfilter	24
Filternator	68[2]

Notes:
1. *Moores et al. (2012) attributes the low % TSS removal due to the fine sediment grainsize that was present, and the overall low sediment load in the influent sample.*
2. *Events sampled for the Filternator had a significantly less flow rate than other devices. The sample event used to assess the Filternator only had a peak influent flow rate of 2.2 L/s, whilst the Up-Flow Filter and the Stormfilter had peak influent flow rates of 31.0 L/s and 32.4 L/s, respectively.*

The results obtained by Moores *et al.* (2012) demonstrate the variability that can occur in stormwater treatment devices when removing TSS from stormwater discharges from car parks.

Moores *et al.* (2012) attributes the reduced TSS removal performance to a low TSS concentration in the influent. During the Moores *et al.* (2012) study, typical influent TSS concentrations ranged from 14 to 150 mg/L. These TSS influent results are similar to those obtained in this study.

Therefore due to the variability of TSS removal performance that may occur in stormwater treatment devices when they are located within land uses with high proportions of impermeable surfaces (e.g. service stations and car parks), the results obtained in this study are consistent with data reported in the USEPA BMP database for other sedimentation type devices. It is considered that the oil-water separators/interceptors monitored in this project (except the two stage interceptor) were performing appropriately.

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[3] United States Environmental Protection Agency Best Management Practice Database.
[4] Based on 'media filter' treatment.
[5] Based on 'manufactured device' treatment.

6.2.4 Polycyclic Aromatic Hydrocarbons

For the water quality samples obtained in this project, PAH concentrations were commonly below laboratory detection limits for most water quality samples discharged from Z service stations and control sites. For any PAH compounds that were detected, these were less than ANZECC (2000) 95% protection trigger values. This reported result is consistent with other studies (URS, 2008).

As discussed in Section 6.1.2, of the PAH data collected, the majority of PAH load is associated with sediment. This suggests that for the sampling conducted in this study, PAH compounds that are derived within service stations, are commonly bound to sediment particles, which are then able to be captured and retained within sedimentation type stormwater treatment devices.

6.2.5 Heavy Metals

During the sampled events, all sites assessed (services stations and control sites) had elevated heavy metal concentrations. Zinc, copper, and chromium were common parameters that exceeded ANZECC (2000) 95% protection level triggers. From comparison to ANZECC (2000) 80% protection level triggers, exceedances are only common for zinc and copper. In the majority, the quantity of exceedances for zinc and copper are the same (compared between ANZECC (2000) 95% and 80% protection level triggers), however the 80% protection level is commonly not exceeded in the effluent discharge.

As discussed in Section 6.1.3, key sources that are likely to contribute such concentrations, are:

- Vehicular movements leading to tyre wear (zinc), brake lining wear (copper);
- Vehicle emissions, from vehicle movement and vehicle starting; and
- Vehicle oils losses.

Roof areas of service stations are commonly piped directly to the stormwater reticulation network, i.e. no discharge of roof runoff occurs across forecourt or non-forecourt areas. For all the Z service stations assessed, all roof runoff was piped directly to the stormwater reticulation network.

In general, the forecourt drainage areas had lower heavy metal concentrations than the non-forecourt drainage areas. This may be due to an increase in sources available in the non-forecourt drainage areas, such as; atmospheric deposition from additional surrounding sources or the activities that take place in the two drainage areas differ. The vehicular movement is of particular difference. In the non-forecourt drainage areas, tyre wear and brake lining wear are likely to be greater. Due to the difference in vehicle speeds (and therefore vehicle braking requirements) and more turning movements as vehicles pull into the forecourt. Non-forecourt areas are commonly asphalted, whilst forecourt areas are concreted. Due to the greater roughness of asphalt (compared to concrete), it is assumed that tyre wear may be greater than compared to the smoother concrete surfaces located on forecourts.

A higher dissolved fraction of heavy metals was obtained in the non-forecourt areas than compared to the forecourt areas. This result may be attributed to the sediment grain sizes present in each drainage area. Forecourt sediments were predominantly of smaller grain size than non-forecourt sediments (silts versus sands respectively). This may be attributed to the finer sediment particles having being already washed away by previous rainfall events in non-forecourt drainage areas.

In forecourt drainage areas, the effluent heavy metal concentrations are commonly greater than influent heavy metal concentrations. This may be due to the exportation of fine grained sediment from the stormwater treatment device. It is assumed that coarse grained sediment is retained within the devices based on the sediment particle size distributions obtained from within the primary chambers of the stormwater treatment devices.

In some instances, total and dissolved metal concentrations (particularly zinc) in the forecourt effluent flow were greater than the influent flow. This is illustrated in figures 1 and 3. Possible explanations for this may be attributed to:

- The galvanised grill within the API oil-water separators. Stagnant water within the API oil-water separator during the inter event dry period can increase dissolved zinc concentrations as it is in continual contact with a source of zinc;
- Entrainment of previous accumulated fine particles during the monitored events. Fine particles that were discharged into the stormwater treatment devices from a previous storm event may have become remobilised as the next storm events first flush waters pass through the device.

This study has identified that in comparison to the effluent heavy metal loads obtained from forecourt drainage areas with the control sites (car parks), forecourts typically had lower effluent concentrations. Non-forecourt drainage areas typically had similar heavy metal effluent concentrations to the control sites.

The results obtained in this project are consistent with the majority of other studies considered. The results obtained by URS (2008) and during this study both showed elevated effluent concentrations of zinc and copper in particular. URS (2008) also concluded however, that the treated effluent concentrations obtained from the API's and non-forecourt drainage areas monitored, were generally comparable to the control sites (high use car parks) monitored. The results of this study also found that forecourt and non-forecourt drainage areas were comparable to the control sites monitored.

6.2.6 BTEX Compounds

As previously discussed in Section 6.1.4, BTEX compounds are volatile and readily degrade in the presence of oxygen. As anticipated then, for the events sampled, BTEX discharges were, in the majority, compliant with ANZECC (2000) 95% protection trigger values. The only site that did have exceedances was Z Highbrook.

6.2.7 Total Petroleum Hydrocarbons

All TPH discharges from the Z services stations assessed were compliant with MfE guidelines (MfE, 1998) during the events sampled. This result is consistent with results achieved by URS (2008).

Significant TPH removal was recorded at Z Highbrook on 13 March 2013. A possible reason for this result may be associated with a comparable high TSS concentration also observed. This implies that the TPH present at Z Highbrook readily bonds to the sediment. Therefore, if the sediment is effectively removed by the stormwater treatment device, the TPH concentration will also be effectively removed.

In general, and as expected, TPH concentrations were greatest in forecourt areas. Samples collected from non-forecourt drainage areas commonly had TPH concentrations below laboratory levels of detection. As such, from the sample events measured, stormwater catch pits will retain the proportion of TPH attached to coarser sediment particles.

6.2.8 Mass Load Assessment

Contaminant loads discharged during the effluent first flush were consistent with values reported by URS (2009). Effluent mid flow results however, had poor correlations with URS (2009) data. Whilst it is not clear the reason for this, a possible explanation could be due to variable rainfall intensities that were observed when URS sampled. URS used actual rainfall events of lower intensity to obtain their data, whereas this study used synthetic rainfall that was applied at a constant intensity. If the rainfall intensity were to change over time (increase or decrease), the characteristics of the peak discharge may be different, i.e. the peak discharge concentration may occur for a longer or shorter duration.

Mass loads discharged from non-forecourt drainage areas are aligned to results obtained from the control sites. This is a key result which indicates that the loading rates discharged from the non-forecourt drainage areas and high use car parks are similar.

Best estimates of annual effluent contaminant mass loads in comparison to other land use categories, best align to an industrial land use. This result is expected given that the similarity in activities carried out at industrial sites and service stations (compared to activities carried out in commercial and residential areas).

7.0 Conclusion

Key conclusions from the sediment monitoring are:

- The quantity of sediment captured within catch pits/treatment devices is variable across the sites assessed. A key driver of the quantity of sediment captured is the extent of landscaped areas adjacent to and within the service stations, i.e. landscaped areas are the key source of sediment at sites assessed.

- Catch pits and oil-water separators/interceptors are capturing significant amounts of contaminants loads that are bound to the sediment, particularly heavy end petroleum products.
- Treatment devices managing forecourts areas are, in the majority, retaining higher TPH load in comparison to non-forecourt drainage areas (ranging from a 4 to 100 fold difference), whilst non-forecourt drainage areas produce a higher heavy metal load in comparison to forecourt areas (approximately a 2-3 fold difference).
- Comparison of the sediment quality PAH and TPH results to water quality PAH and TPH results (discussed in Sections 6.1.2 and 6.2.7) indicates that the PAH and the heavy end petroleum fraction are binding well to sediments associated with the discharge, rather than remaining mobile in the influent and effluent waters discharged from site.

For the water quality monitoring events sampled, the following key conclusions were achieved:

- Effluent dissolved oxygen concentrations from the oil-water separators/interceptors may be strongly affected by residual waters contained within the devices from previous storm events. A reduced live storage volume (and therefore increased turbulence) within the two stage interceptor located at Z Lakeside produced an elevated dissolved oxygen result. However this reduced live storage, also caused a reduced contaminant removal performance for other contaminants during the event sampled, i.e. TSS removal.
- Oil-water separators (API's) achieved a TSS removal performance between 42 and 72% for the events sampled. The triple oil-water interceptor (located at Z Browns Road) achieved a TSS removal performance of 54%. This result is consistent with other stormwater treatment devices that operate using sedimentation processes.
- Due to increased turbulence within the two stage interceptor (Z Lakeside) the effluent TSS concentration was higher in the discharge for the event sampled. This site was selected as the drainage system was inherited and is due to be upgraded.
- Forecourt stormwater is characterised by a first flush with elevated levels of TPH and TSS. BTEX and heavy metal concentrations are correspondingly elevated. By mid flow however, the concentration of contaminants within the forecourt had typically reduced by 50 to 90%.
- Heavy metal concentrations for copper, zinc, and chromium from forecourt and non-forecourt drainage areas often exceeded ANZECC (2000) 95% protection level triggers. Some ANZECC (2000) 80% protection level triggers were also exceeded. This result is consistent with other studies of service stations and sites which have low speed vehicle movement (URS, 2008, Moores *et al*, 2012). Copper and zinc trigger levels were also commonly exceeded in effluent

discharges from both control car parks. This result is expected due to the vehicular activities present at the sites.

- During the events monitored dissolved heavy metal loads were greatest in non-forecourt areas. The reason for this is unknown/unclear.
- During the events monitored, effluent BTEX concentrations at Z Highbrook were elevated. For the majority of sites monitored however, BTEX concentrations were below laboratory levels of detection. This is because BTEX compounds are volatile and are readily degradable in the presence of oxygen.
- All TPH effluent concentrations from the service stations assessed were well within the MfE (1998) discharge standard (15 mg/L).
- Effluent first flush mass loads obtained in this project are similar to other monitoring studies (URS, (2008)) carried out previously. However the first flush results are not representative of contaminant load through the duration of a rainfall event as concentrations decline rapidly.
- Mass loads discharged from non-forecourt drainage areas were not significantly different to the results obtained from the control sites.

8.0 References

ANZECC, 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environmental and Conservation Council (ANZECC), October 2000.

ARC, 2003. Stormwater Management Devices: Design Guideline Manual (2nd edition). Auckland Regional Council Technical Publication 10.

ARC, 2001. Background concentrations of inorganic elements in soils from the Auckland Regional. Auckland Regional Council Technical Publication 153.

Horner, R. Skupien, J. Livingston, E, Shaver, E. 1994. Fundamentals of Urban Runoff Management: Technical and Institutional Issues. Produced by the Terrene Institute Washington DC in cooperation with the US Environmental Protection Agency, August 1994.

Humes. 2006. API Oil Interceptor - Protecting our Environment. Technical Specifications Brochure. Humes, 2006.

Kennedy, P., Sutherland, S. 2008. Urban Sources of Copper, Lead and Zinc. Prepared by Golders for Auckland Regional Council. Auckland Regional Council Technical Report 2008/023.

Ministry for the Environment. 1998. Guidelines for Water Discharges from Petroleum Industry Site in New Zealand.

Moores, J, Gadd, J, Pattinson, P, Hyde, C and Miselis, P. 2012. Field evaluation of media filtration stormwater treatment devices. *NZ Transport Agency research report 493.* 255pp

Moores, J., Pattinson, P., Hyde, C. 2009a. Richardson Road Study Measurement and Sampling of Runoff and Catchpit Solids. Prepared by NIWA for Auckland Regional Council. Auckland Regional Council Document Type 2009/119.

Moores, J., Hunt, J., Pattinson, P., 2009b. Quantification of Catchpit Sediments and Contaminants. Data Collection. Prepared by NIWA Ltd for Auckland Regional Council. Auckland Regional Council Technical Report 2009/123.

New Zealand Geotechnical Society Inc. 2005. Field description of soil and rock. Guideline for the field classification and description of soil and rock for engineering purposes. New Zealand Geotechnical Society Inc, December 2005.

NIWA, 2013. Annual Climate Summary 2012. Issued 10 January 2013.

URS, 2008. Stormwater and Sediment Monitoring Data from Service Stations and Control Sites in the Auckland Region. Report prepared for the Oil Industry Environmental Working Group, 2008.

Wong, G., Ansen, J., Fassman, E. 2012. GD03 Proprietary Devices Evaluation Protocol (PDEP) for Stormwater Quality Treatment Devices. Prepared by Auckland Council. Auckland Council Guideline Document 03, 12 December 2012.

Appendix A

Site Maps

Submission #44770

STORMWATER AND SEDIMENT MONITORING, Z LAKESIDE, 33 TAHAROTO ROAD, TAKAPUNA – Z ENERGY LTD

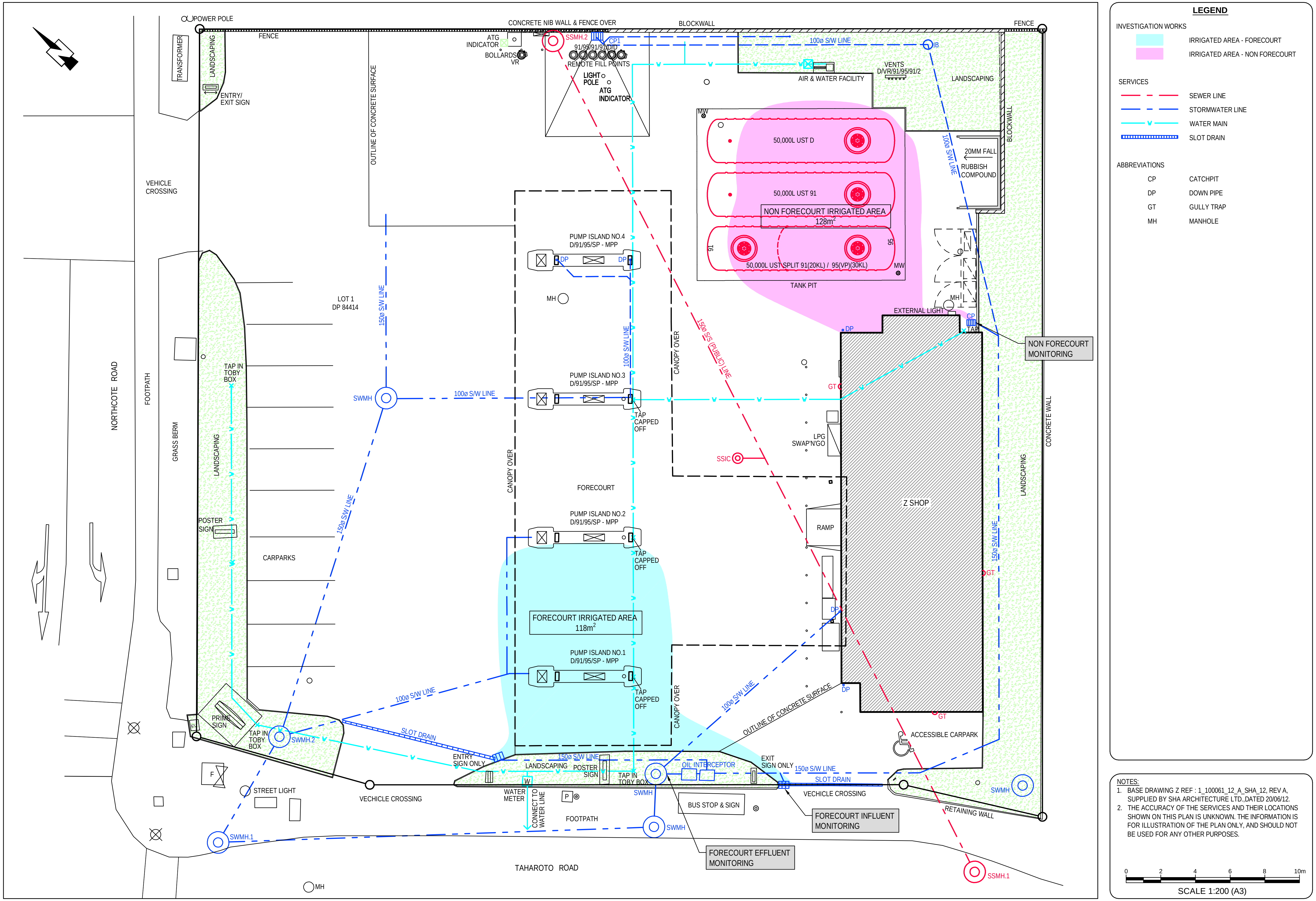


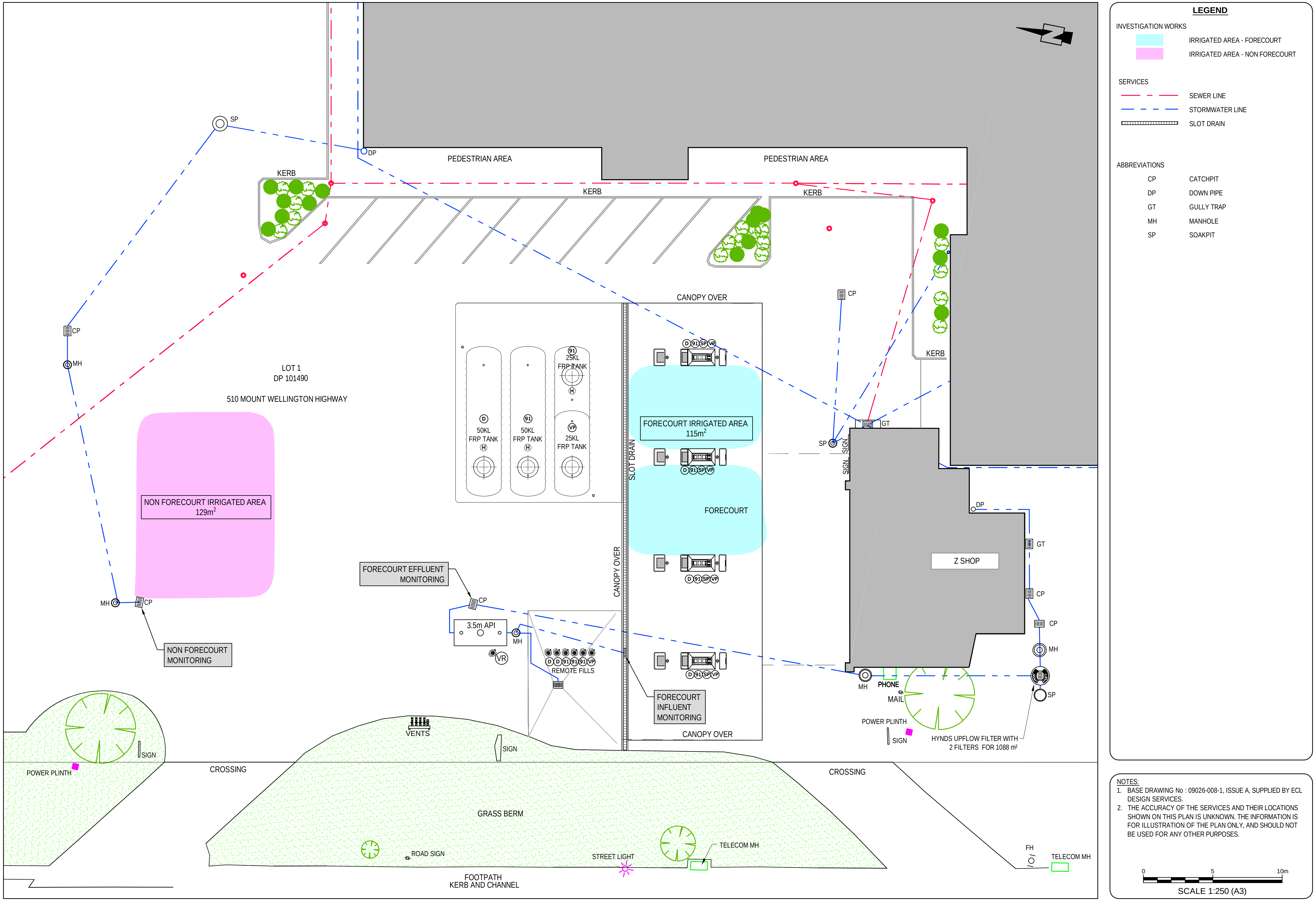
FIGURE A1 : SITE PLAN - LAKESIDE

PATTLE DELAMORE PARTNERS LTD

A02579800D001_Lakeside.dwg Oct-13 FINAL

Submission #44770

STORMWATER AND SEDIMENT MONITORING, Z SILVIA PARK, 510 MT WELLINGTON HIGHWAY – Z ENERGY LTD



NOTES:
1. BASE DRAWING No : 09026-008-1, ISSUE A, SUPPLIED BY ECL DESIGN SERVICES.
2. THE ACCURACY OF THE SERVICES AND THEIR LOCATIONS SHOWN ON THIS PLAN IS UNKNOWN. THE INFORMATION IS FOR ILLUSTRATION OF THE PLAN ONLY, AND SHOULD NOT BE USED FOR ANY OTHER PURPOSES.

0 5 10m
SCALE 1:250 (A3)

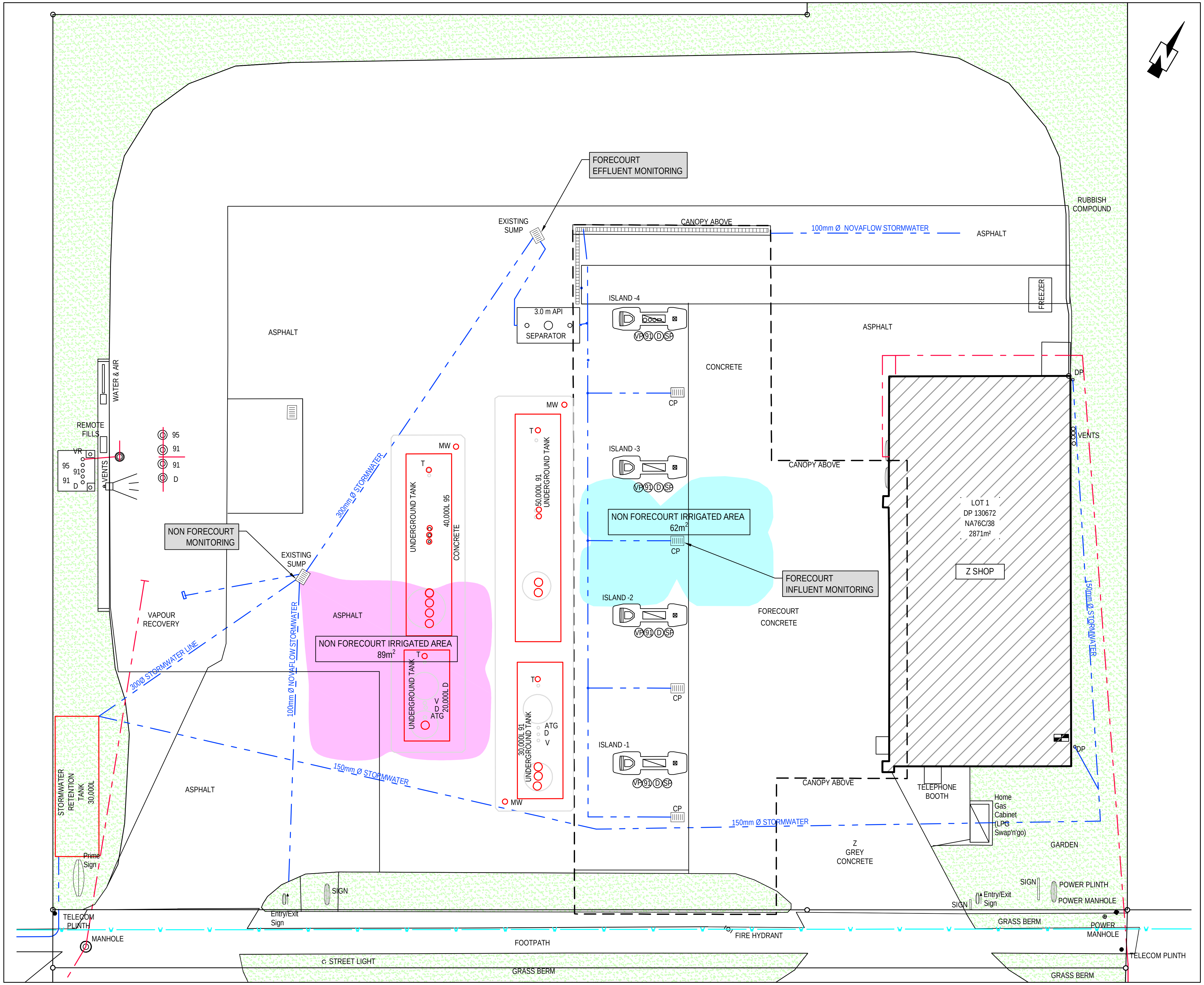
FIGURE A2 : SITE PLAN - SILVIA PARK

PATTLE DELAMORE PARTNERS LTD

A02579800D002_SilviaPark.dwg Oct-13 FINAL

Submission #44770

STORMWATER AND SEDIMENT MONITORING, Z HUNTERS CORNER, 72–76 EAST TAMAKI ROAD – Z ENERGY LTD



LEGEND

INVESTIGATION WORKS

- IRRIGATED AREA - FORECOURT
- IRRIGATED AREA - NON FORECOURT

SERVICES

- SEWER LINE
- STORMWATER LINE
- WATER MAIN
- SLOT DRAIN

ABBREVIATIONS

CP	CATCHPIT
DP	DOWN PIPE
GT	GULLY TRAP
MH	MANHOLE
SP	SOAKPIT

NOTES:
1. BASE DRAWING Z REF : 1_100632_12_U_SHA_01, REV F, SUPPLIED BY SHA ARCHITECTURE LTD, DATED 30/08/12.
2. THE ACCURACY OF THE SERVICES AND THEIR LOCATIONS SHOWN ON THIS PLAN IS UNKNOWN. THE INFORMATION IS FOR ILLUSTRATION OF THE PLAN ONLY, AND SHOULD NOT BE USED FOR ANY OTHER PURPOSES.

0 2 4 6 8 10m
SCALE 1:200 (A3)

FIGURE A3 : SITE PLAN - HUNTERS CORNER

A025798000003_HuntersCorner.dwg Oct-13 FINAL

PATTLE DELAMORE PARTNERS LTD

Submission #44770

STORMWATER AND SEDIMENT MONITORING, Z BROWNS ROAD, 255 BROWNS ROAD, MANUKAU CITY – Z ENERGY LTD

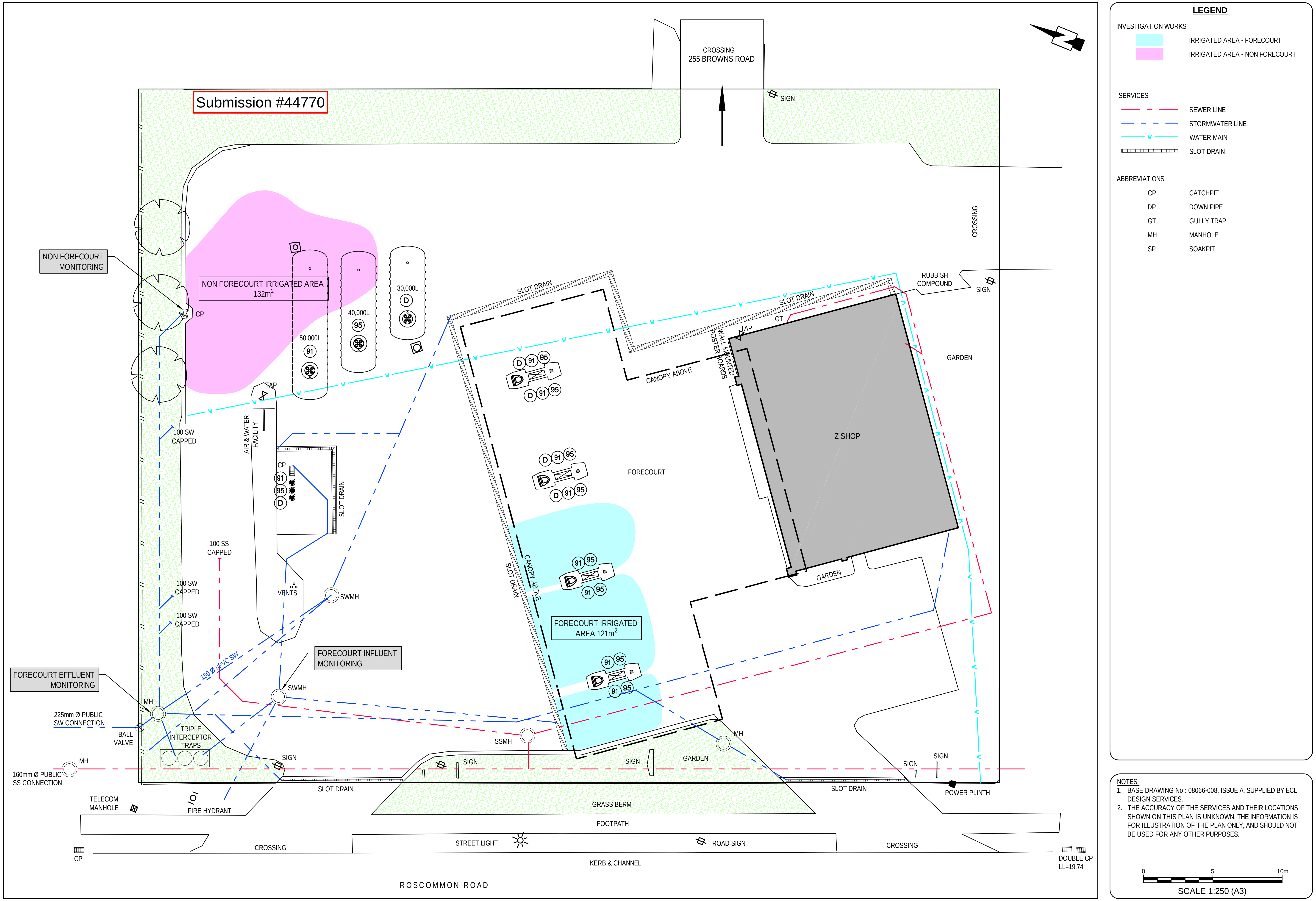
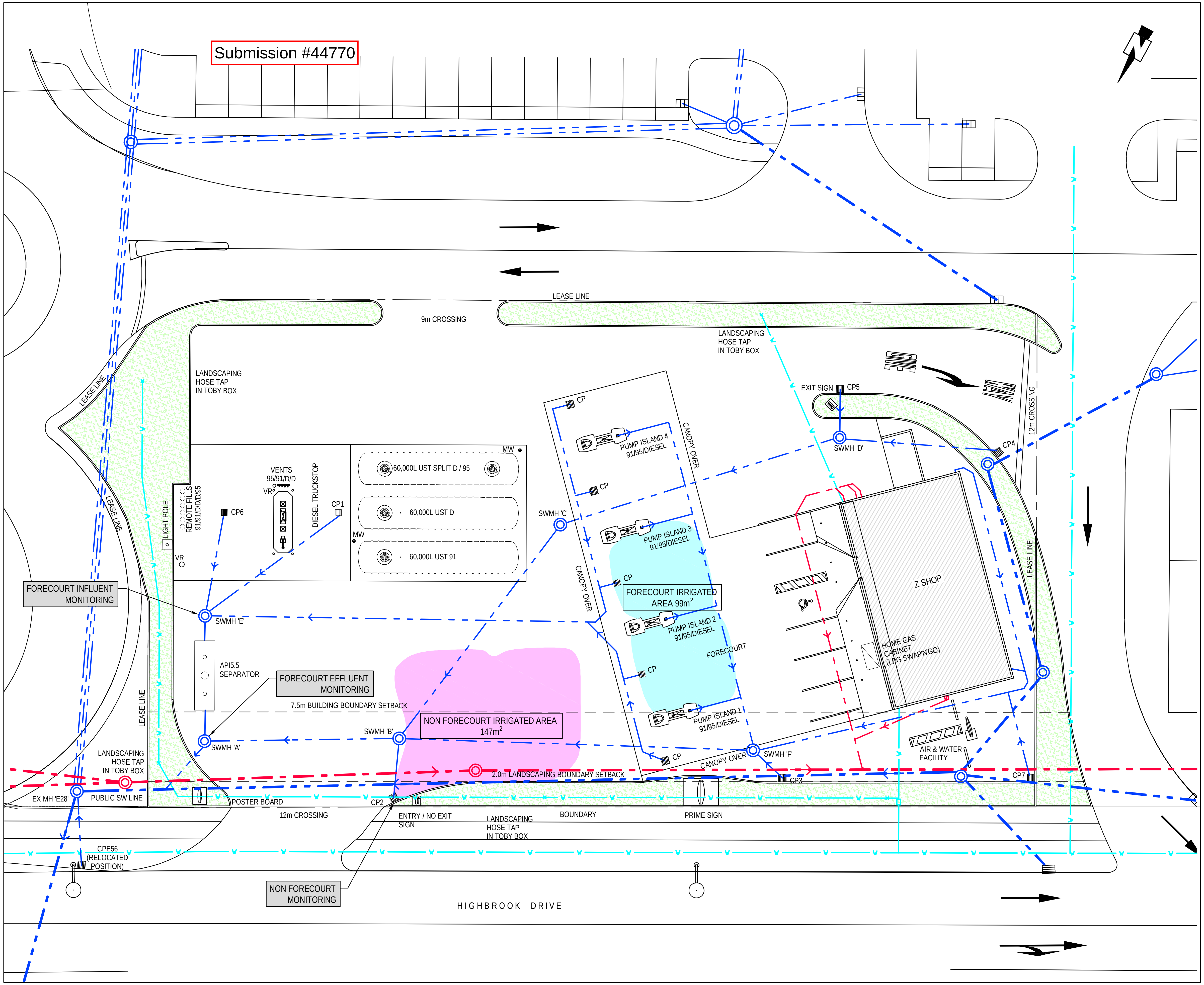


FIGURE A4 : SITE PLAN - BROWNS ROAD

A025798000004_Browns.dwg Oct-13 FINAL

PATTLE DELAMORE PARTNERS LTD

STORMWATER AND SEDIMENT MONITORING, Z HIGHBROOK, 60 HIGHBROOK DRIVE EAST, MANUKAU – Z ENERGY LTD



LEGEND

INVESTIGATION WORKS
- IRRIGATED AREA - FORECOURT
- IRRIGATED AREA - NON FORECOURT

SERVICES
- SEWER LINE
- STORMWATER LINE
- WATER MAIN
- SLOT DRAIN

ABBREVIATIONS

CP	CATCHPIT
DP	DOWN PIPE
GT	GULLY TRAP
MH	MANHOLE
SP	SOAKPIT

OTHER

XXX

NOTES:
1. BASE DRAWING Z REF : 1_221955_10_U_SHA_01, REV D, SUPPLIED BY SHA ARCHITECTURE LTD.,DATED 20/06/12.
2. THE ACCURACY OF THE SERVICES AND THEIR LOCATIONS SHOWN ON THIS PLAN IS UNKNOWN. THE INFORMATION IS FOR ILLUSTRATION OF THE PLAN ONLY, AND SHOULD NOT BE USED FOR ANY OTHER PURPOSES.

0 5 10 15m

SCALE 1:300 (A3)

FIGURE A5 : SITE PLAN - HIGHBROOK 13.03.13

A025798000005_Highbrook.dwg Oct-13 FINAL

PATTLE DELAMORE PARTNERS LTD

Submission #44770

STORMWATER AND SEDIMENT MONITORING, Z HIGHBROOK, 60 HIGHBROOK DRIVE EAST, MANUKAU – Z ENERGY LTD

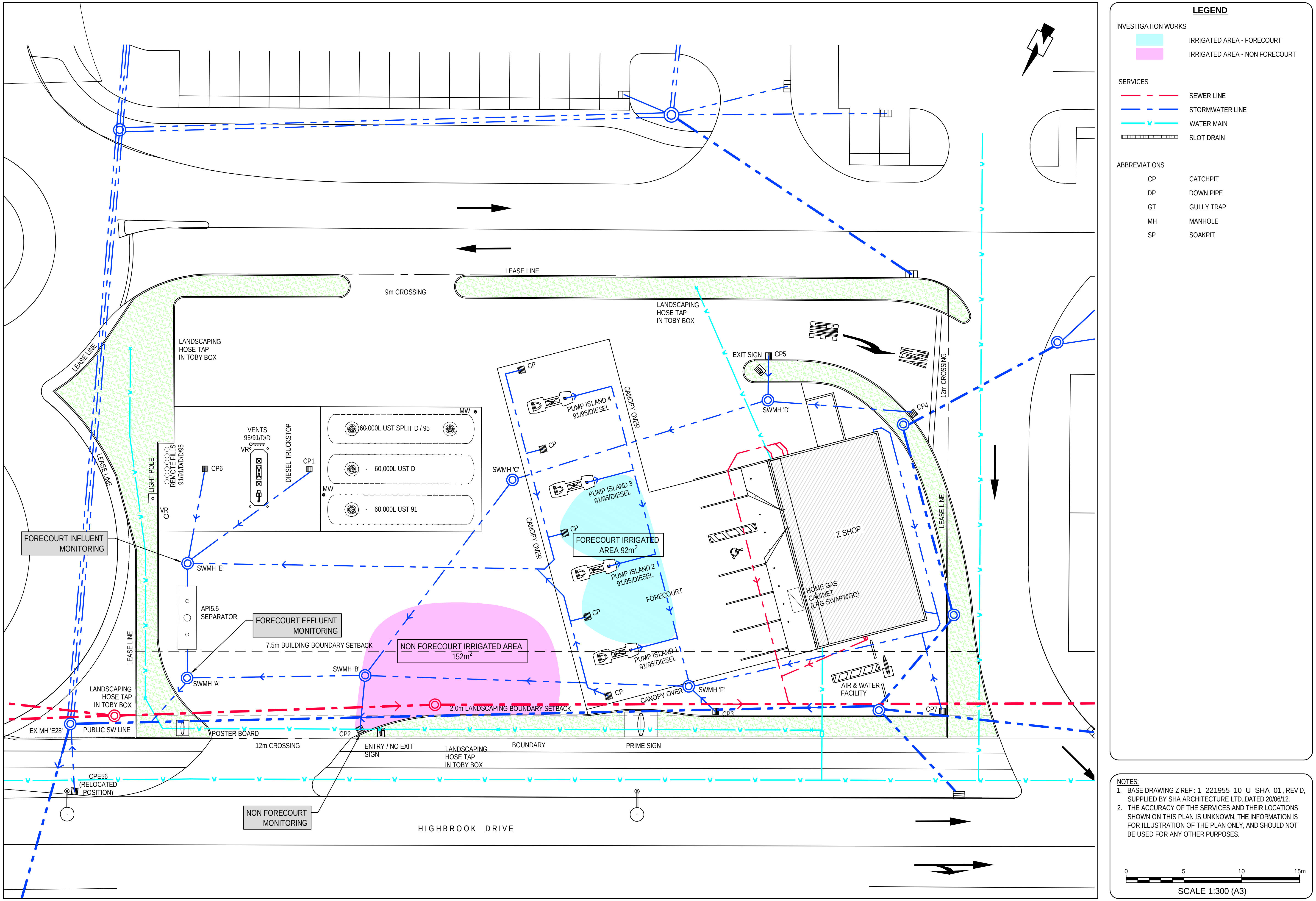


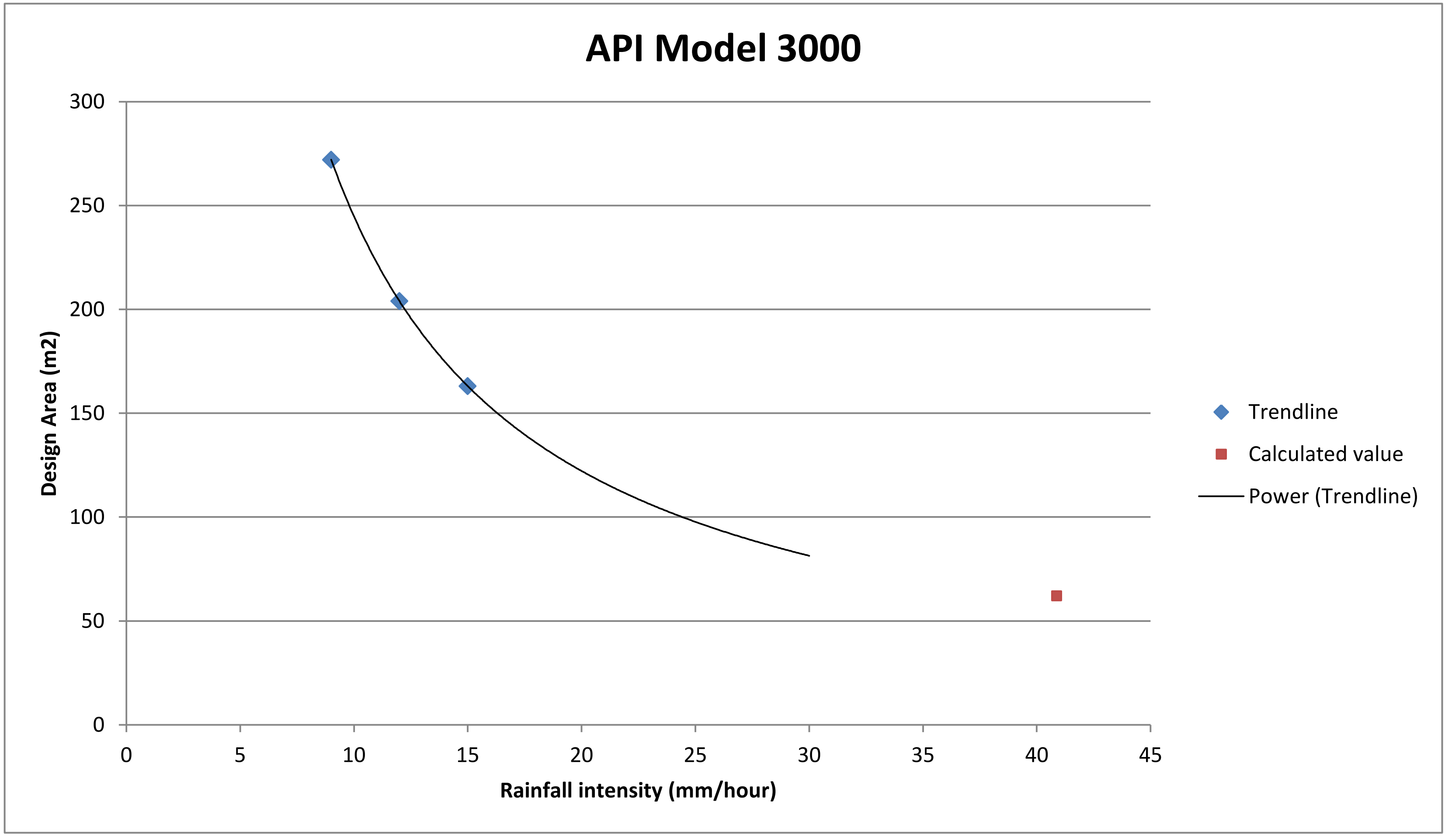
FIGURE A6 : SITE PLAN - HIGHBROOK 26.03.13

Submission #44770

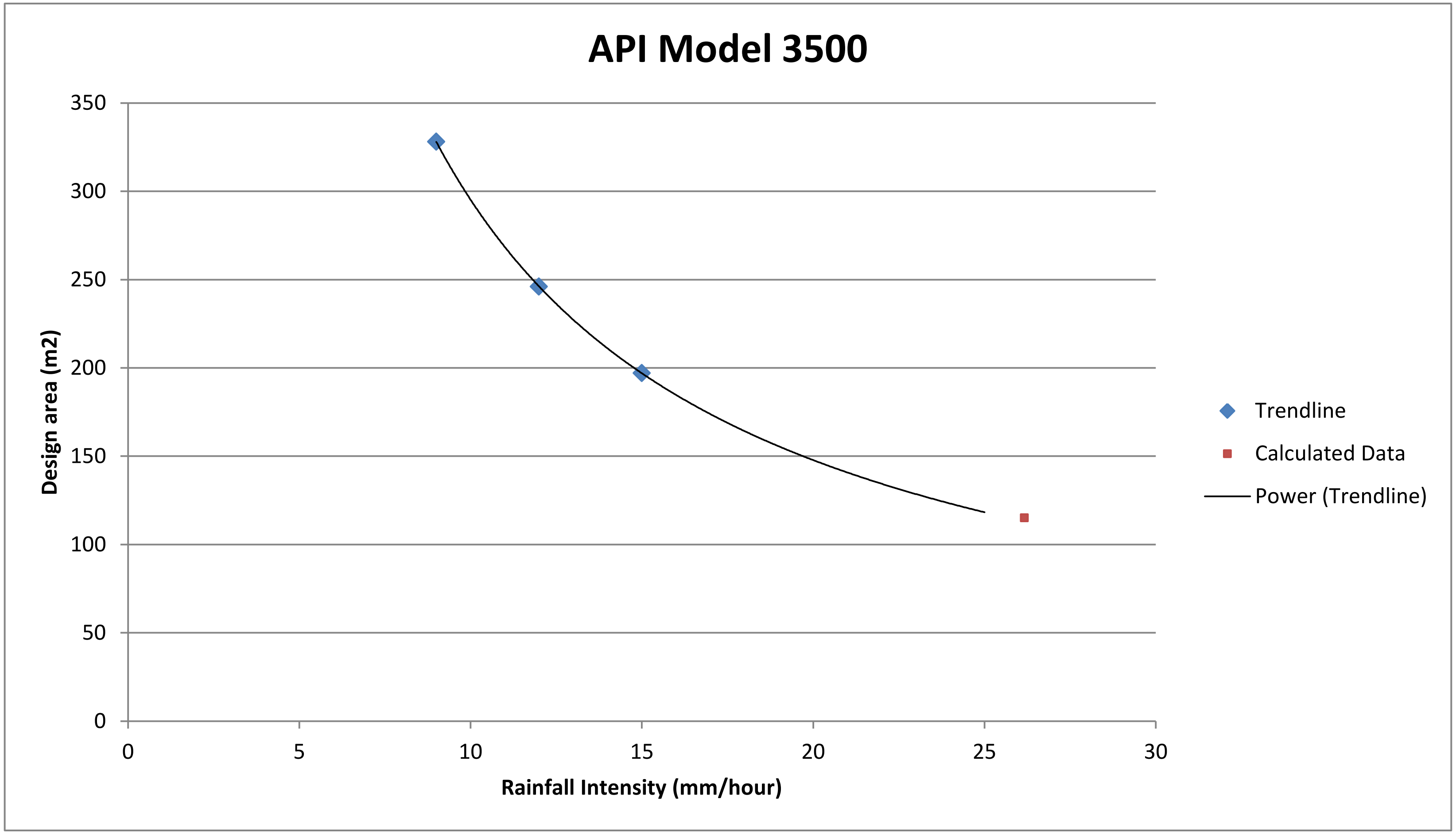
Appendix B

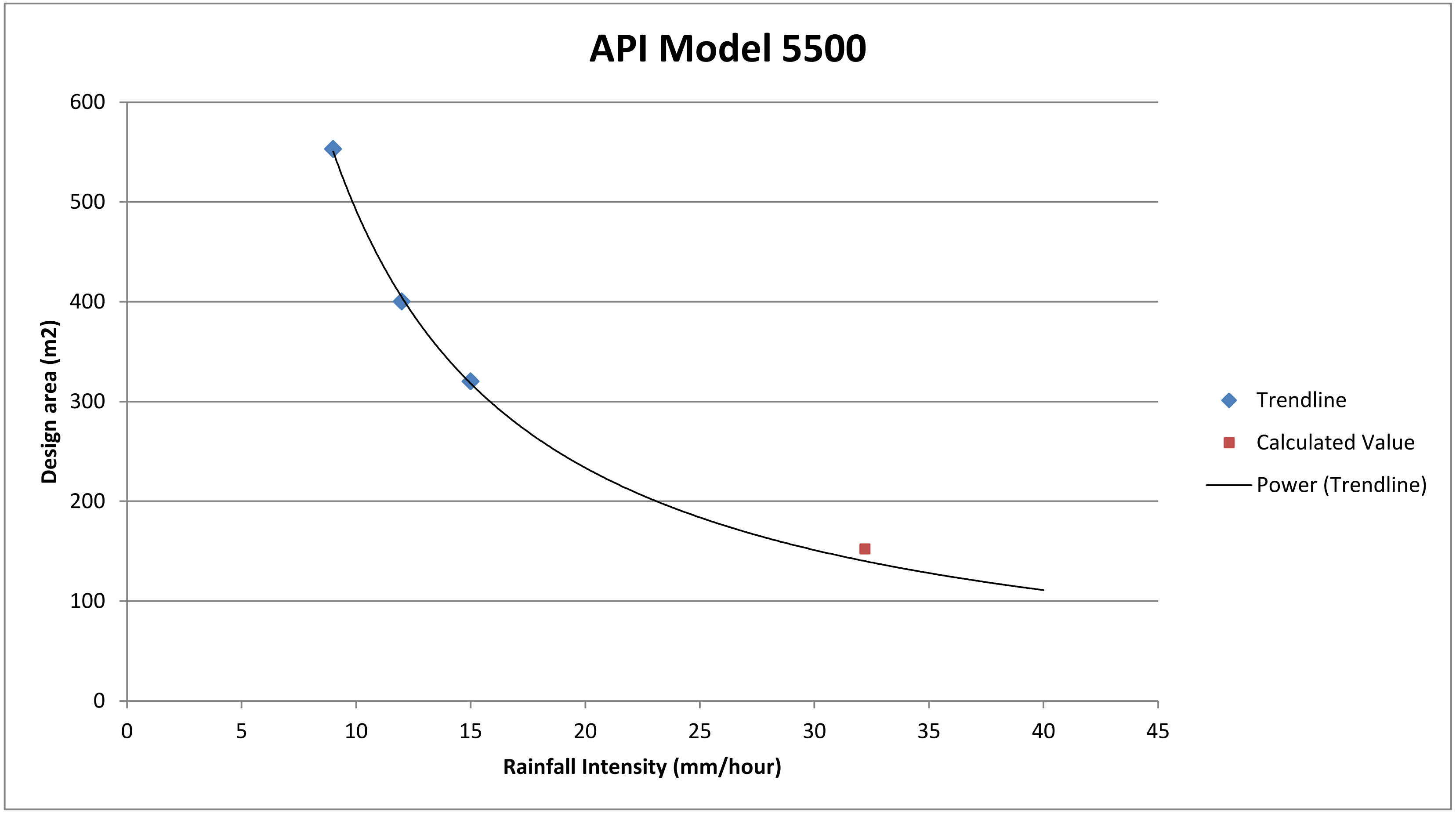
Flow Rate/Rainfall Intensity Verification

Submission #44770



Submission #44770




API Model 5500
600
500
400
300
200
100
0
Design area (m2)
0
5
10
15
20
25
30
35
40
45
Rainfall Intensity (mm/hour)
Trendline
Calculated Value
Power (Trendline)

Submission #44770

Appendix C

Laboratory Reports

Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	1089736 SPv1
Contact:	H Easton	**Date Registered:**	16-Jan-2013
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	31-Jan-2013
	PO Box 9528	**Quote No:**	51293
	Newmarket	**Order No:**	
	AUCKLAND 1149	**Client Reference:**	A02579800
		Submitted By:	Chris Foote

Sample Type: Sediment

Sample Name:		SLV SS01 15-Jan-2013	SLV SS02 15-Jan-2013	HBK SS01 15-Jan-2013	HBK SS02 15-Jan-2013	HCR SS01 15-Jan-2013
Lab Number:		1089736.1	1089736.2	1089736.3	1089736.4	1089736.5
Individual Tests						
Dry Matter	g/100g as rcvd	39	33	28	42	37
Total Recoverable Phosphorus	mg/kg dry wt	1,430	1,270	1,430	1,170	1,730
pH*	pH Units	6.2	5.7	6.3	6.9	8.5
Total Organic Carbon*	g/100g dry wt	14.5	26	32	4.5	10.7
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	7	16	6	4	13
Total Recoverable Cadmium	mg/kg dry wt	0.66	1.00	1.30	0.77	0.40
Total Recoverable Chromium	mg/kg dry wt	90	110	58	41	68
Total Recoverable Copper	mg/kg dry wt	159	230	109	63	135
Total Recoverable Lead	mg/kg dry wt	124	165	109	48	70
Total Recoverable Nickel	mg/kg dry wt	74	49	38	48	67
Total Recoverable Zinc	mg/kg dry wt	1,420	3,700	2,700	980	2,200
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	1.16	< 0.17	< 0.4	< 0.13	2.8
Toluene	mg/kg dry wt	33	< 0.3	< 0.4	1.88	55
Ethylbenzene	mg/kg dry wt	1.59	< 0.3	0.6	< 0.13	12.4
m&p-Xylene	mg/kg dry wt	6.5	< 0.4	2.5	< 0.3	67
o-Xylene	mg/kg dry wt	2.8	< 0.17	1.6	< 0.13	29
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.07	< 0.8	< 0.9	< 0.10	0.66
Acenaphthylene	mg/kg dry wt	< 0.07	< 0.8	< 0.9	< 0.10	< 0.13
Anthracene	mg/kg dry wt	< 0.07	< 0.8	< 0.9	< 0.10	0.91
Benzo[a]anthracene	mg/kg dry wt	0.10	< 0.8	< 0.9	0.28	0.71
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.14	< 0.8	< 0.9	0.30	0.50
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.24	2.1	0.9	0.44	1.17
Benzo[g,h,i]perylene	mg/kg dry wt	0.48	1.8	1.0	0.61	1.54
Benzo[k]fluoranthene	mg/kg dry wt	0.07	< 0.8	< 0.9	0.16	0.23
Chrysene	mg/kg dry wt	0.15	< 0.8	< 0.9	0.32	0.95
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.07	< 0.8	< 0.9	< 0.10	< 0.13
Fluoranthene	mg/kg dry wt	0.25	1.2	1.6	0.77	2.6
Fluorene	mg/kg dry wt	< 0.07	< 0.8	< 0.9	< 0.10	2.8
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.10	0.9	< 0.9	0.20	0.35
Naphthalene	mg/kg dry wt	< 0.4	< 4	< 5	< 0.5	17.0
Phenanthrene	mg/kg dry wt	0.17	< 0.8	3.8	0.40	7.4
Pyrene	mg/kg dry wt	0.71	29	46	1.41	10.8
Total Petroleum Hydrocarbons in Soil						

Sample Type: Sediment

Sample Name:		SLV SS01 15-Jan-2013	SLV SS02 15-Jan-2013	HBK SS01 15-Jan-2013	HBK SS02 15-Jan-2013	HCR SS01 15-Jan-2013
Lab Number:		1089736.1	1089736.2	1089736.3	1089736.4	1089736.5
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	67	29	51	< 30	1,680
C10 - C14	mg/kg dry wt	65	13,300	27,000	< 60	9,800
C15 - C36	mg/kg dry wt	2,300	184,000	220,000	4,400	73,000
Total hydrocarbons (C7 - C36)	mg/kg dry wt	2,400	197,000	250,000	4,400	84,000

Sample Name:		HCR SS02 15-Jan-2013				
Lab Number:		1089736.6				
Individual Tests						
Dry Matter	g/100g as rcvd	28	-	-	-	-
Total Recoverable Phosphorus	mg/kg dry wt	960	-	-	-	-
pH*	pH Units	6.5	-	-	-	-
Total Organic Carbon*	g/100g dry wt	12.6	-	-	-	-
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	4	-	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.73	-	-	-	-
Total Recoverable Chromium	mg/kg dry wt	47	-	-	-	-
Total Recoverable Copper	mg/kg dry wt	141	-	-	-	-
Total Recoverable Lead	mg/kg dry wt	138	-	-	-	-
Total Recoverable Nickel	mg/kg dry wt	63	-	-	-	-
Total Recoverable Zinc	mg/kg dry wt	750	-	-	-	-
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.4	-	-	-	-
Toluene	mg/kg dry wt	7.2	-	-	-	-
Ethylbenzene	mg/kg dry wt	< 0.4	-	-	-	-
m&p-Xylene	mg/kg dry wt	< 0.7	-	-	-	-
o-Xylene	mg/kg dry wt	< 0.4	-	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.16	-	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.16	-	-	-	-
Anthracene	mg/kg dry wt	< 0.16	-	-	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.16	-	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.16	-	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.24	-	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	0.46	-	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.16	-	-	-	-
Chrysene	mg/kg dry wt	< 0.16	-	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.16	-	-	-	-
Fluoranthene	mg/kg dry wt	0.26	-	-	-	-
Fluorene	mg/kg dry wt	< 0.16	-	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.16	-	-	-	-
Naphthalene	mg/kg dry wt	3.1	-	-	-	-
Phenanthrene	mg/kg dry wt	0.22	-	-	-	-
Pyrene	mg/kg dry wt	0.59	-	-	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	179	-	-	-	-
C10 - C14	mg/kg dry wt	370	-	-	-	-
C15 - C36	mg/kg dry wt	3,100	-	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	3,600	-	-	-	-

Analyst's Comments

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

Appendix No.2 - Total Petroleum Hydrocarbon Chromatograms

Appendix No.3 - Particle Size Report - 1089736

Appendix No.4 - Particle Size Report - 1089736

SUMMARY OF METHODS

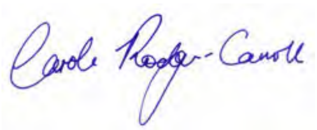
The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Samples
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-6
Soil Prep Dry & Sieve for Agriculture	Air dried at 35°C and sieved, <2mm fraction.	-	1-6
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	1-6
TPH + PAH + BTEX profile	Sonication extraction, SPE cleanup, GC & GC-MS analysis	-	1-6
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1-6
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-6
Particle size analysis*	Malvern Laser Sizer particle size analysis. Subcontracted to Earth Sciences Department, Waikato University, Hamilton.	-	1-6
Total Recoverable Phosphorus	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	1-6
pH*	1:2 (v/v) soil : water slurry followed by potentiometric determination of pH.	0.1 pH Units	1-6
Total Organic Carbon*	Acid pretreatment to remove carbonates if present, neutralisation, Elementar Combustion Analyser.	0.05 g/100g dry wt	1-6

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

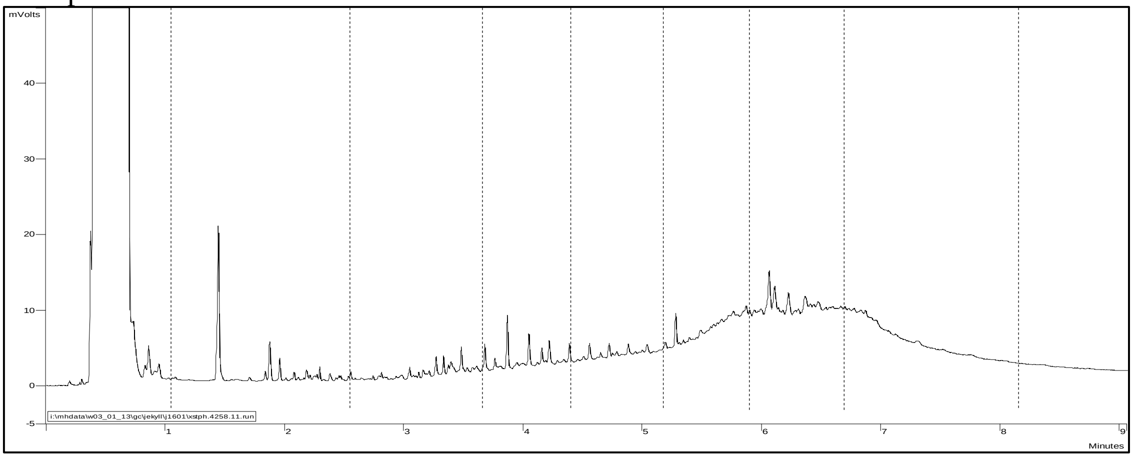
Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.



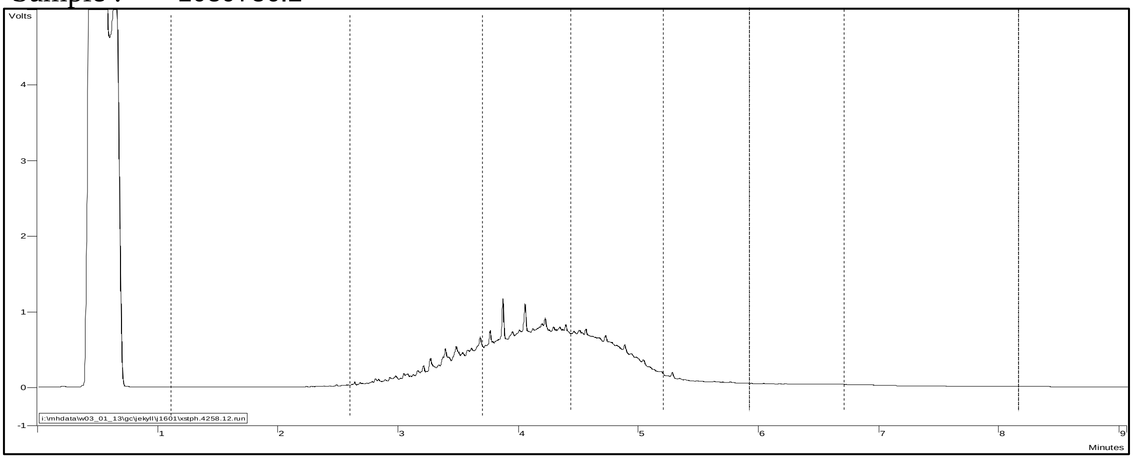
Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental Division

Submission #44770

Sample : 1089736.1



Sample : 1089736.2



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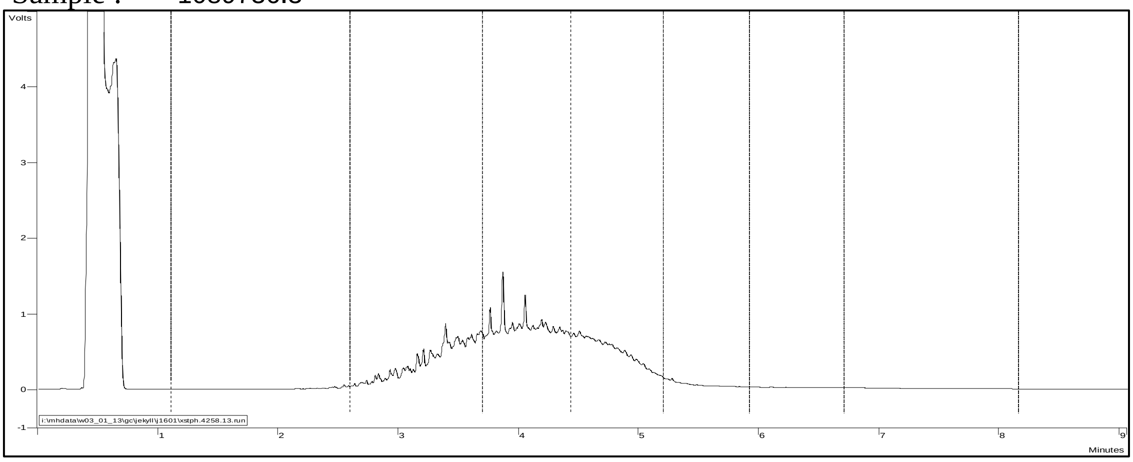
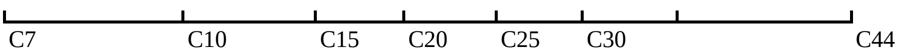
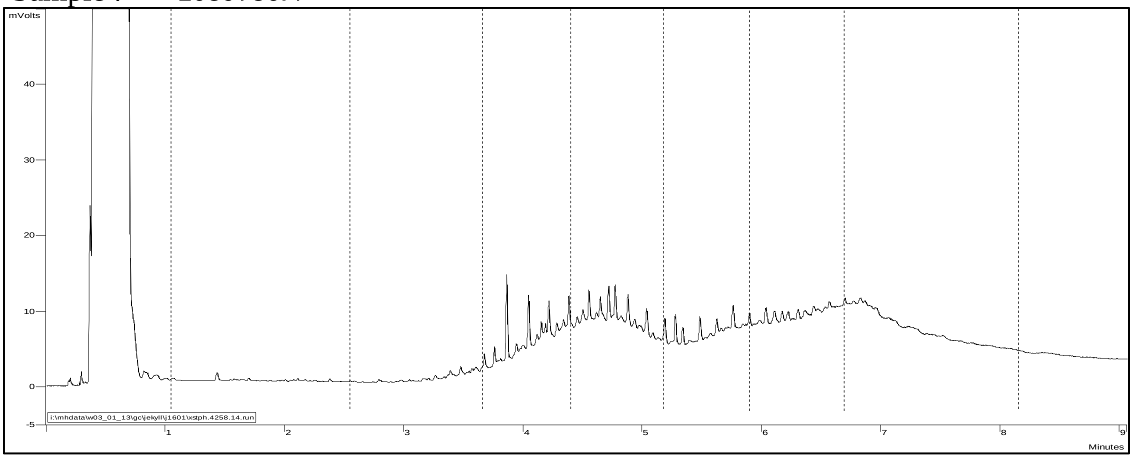


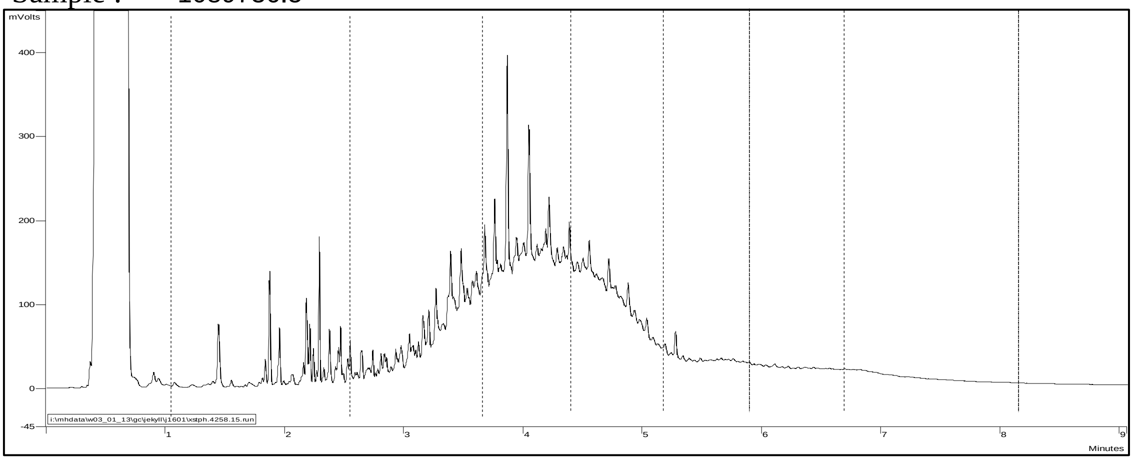


Submission #44770

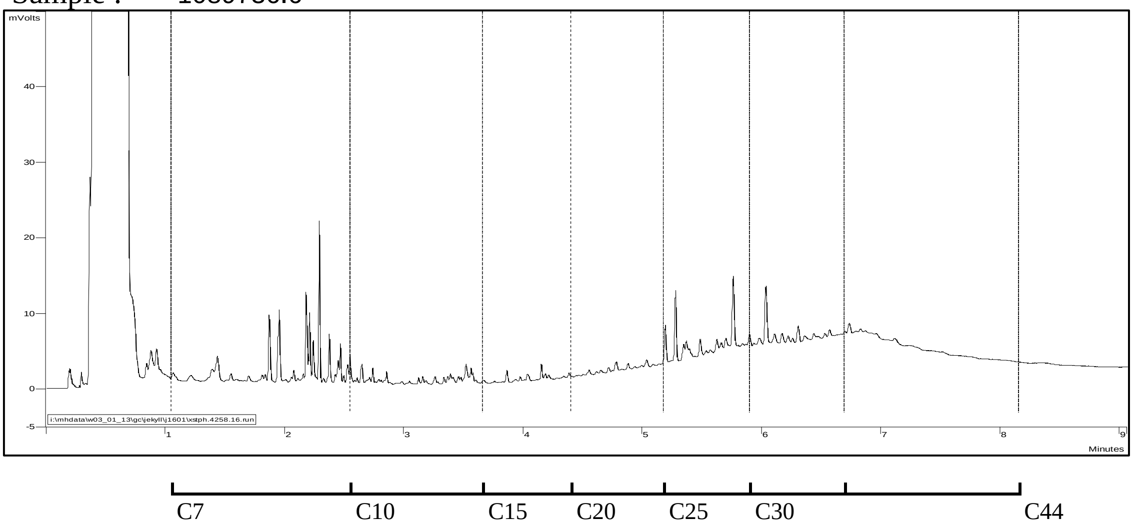
Sample : 1089736.4



Sample : 1089736.5



Sample : 1089736.6



Submission #44770

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ANALYSIS REPORT

SPv1

Client:	Pattle Delamore Partners Ltd	**Lab No:**	1090879
Contact:	Chris Foote	**Date Registered:**	18-Jan-2013
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	01-Feb-2013
	PO Box 9528	**Quote No:**	51293
	Newmarket	**Order No:**	
	AUCKLAND 1149	**Client Reference:**	A02579800
		Submitted By:	H Easton

Sample Type: Sediment

Sample Name:		BRN SS01 16-Jan-2013	BRN SS02 16-Jan-2013			
Lab Number:		1090879.1	1090879.2			
Individual Tests						
Dry Matter	g/100g as rcvd	49	25	-	-	-
Total Recoverable Phosphorus	mg/kg dry wt	1,260	1,040	-	-	-
pH*	pH Units	7.2	6.2	-	-	-
Total Organic Carbon*	g/100g dry wt	4.5	24	-	-	-
Acenaphthene	mg/kg dry wt	< 0.9	< 2	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.9	< 2	-	-	-
Anthracene	mg/kg dry wt	0.9	7	-	-	-
Benzo[a]anthracene	mg/kg dry wt	6.9	55	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	12.4	91	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	20	151	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	13.8	89	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	8.6	66	-	-	-
Chrysene	mg/kg dry wt	14.2	109	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	2.4	17	-	-	-
Fluoranthene	mg/kg dry wt	19.9	198	-	-	-
Fluorene	mg/kg dry wt	< 0.9	2	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	15.1	102	-	-	-
Naphthalene	mg/kg dry wt	< 5	< 10	-	-	-
Phenanthrene	mg/kg dry wt	6.0	70	-	-	-
Pyrene	mg/kg dry wt	16.7	159	-	-	-
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	4	13	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.22	0.70	-	-	-
Total Recoverable Chromium	mg/kg dry wt	36	150	-	-	-
Total Recoverable Copper	mg/kg dry wt	74	181	-	-	-
Total Recoverable Lead	mg/kg dry wt	68	400	-	-	-
Total Recoverable Nickel	mg/kg dry wt	85	60	-	-	-
Total Recoverable Zinc	mg/kg dry wt	980	1,270	-	-	-
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.11	< 0.4	-	-	-
Toluene	mg/kg dry wt	1.50	3.8	-	-	-
Ethylbenzene	mg/kg dry wt	0.68	< 0.4	-	-	-
m&p-Xylene	mg/kg dry wt	2.4	< 0.8	-	-	-
o-Xylene	mg/kg dry wt	1.08	< 0.4	-	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 30	< 60	-	-	-

Sample Type: Sediment						
	Sample Name:	BRN SS01 16-Jan-2013	BRN SS02 16-Jan-2013			
	Lab Number:	1090879.1	1090879.2			
Total Petroleum Hydrocarbons in Soil						
C10 - C14	mg/kg dry wt	52	< 120	-	-	-
C15 - C36	mg/kg dry wt	1,340	4,400	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	1,400	4,400	-	-	-

Analyst's Comments

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

Appendix No.2 - Particle Size Report - BRN SS01 & BRN SS02 - 1090879.1 & .2

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Samples
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-2
Soil Prep Dry & Sieve for Agriculture	Air dried at 35°C and sieved, <2mm fraction.	-	1-2
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	1-2
TPH + PAH + BTEX profile	Sonication extraction, SPE cleanup, GC & GC-MS analysis	-	1-2
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1-2
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-2
Particle size analysis*	Malvern Laser Sizer particle size analysis. Subcontracted to Earth Sciences Department, Waikato University, Hamilton.	-	1-2
Total Recoverable Phosphorus	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	1-2
pH*	1:2 (v/v) soil : water slurry followed by potentiometric determination of pH.	0.1 pH Units	1-2
Total Organic Carbon*	Acid pretreatment to remove carbonates if present, neutralisation, Elementar Combustion Analyser.	0.05 g/100g dry wt	1-2
Acenaphthene	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-2
Acenaphthylene	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-2
Anthracene	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-2
Benzo[a]anthracene	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-2
Benzo[a]pyrene (BAP)	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-2
Benzo[b]fluoranthene + Benzo[j] fluoranthene	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-2
Benzo[g,h,i]perylene	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-2
Benzo[k]fluoranthene	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-2
Chrysene	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-2
Dibenzo[a,h]anthracene	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-2
Fluoranthene	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-2
Fluorene	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-2
Indeno(1,2,3-c,d)pyrene	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-2
Naphthalene	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.05 mg/kg dry wt	1-2

Sample Type: Sediment			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Phenanthrene	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-2
Pyrene	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis. Modified US EPA 8270.	0.010 mg/kg dry wt	1-2

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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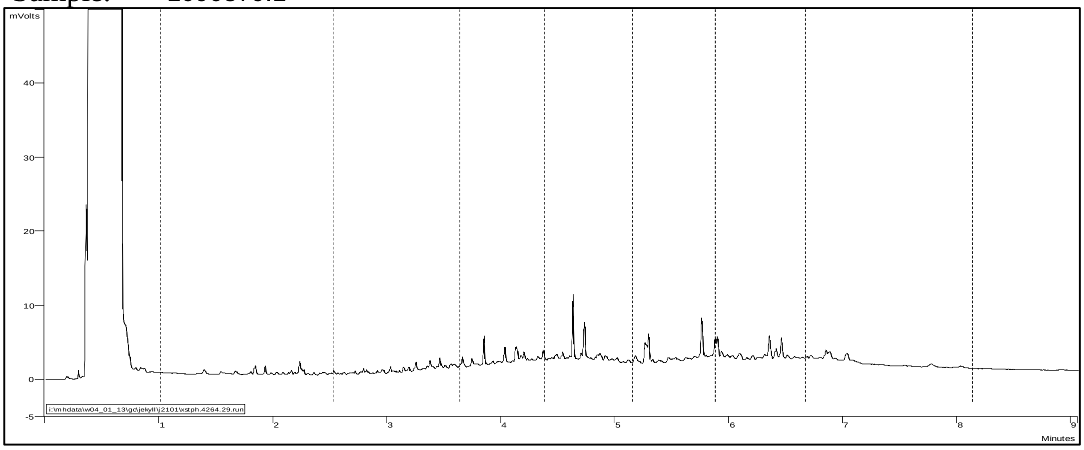
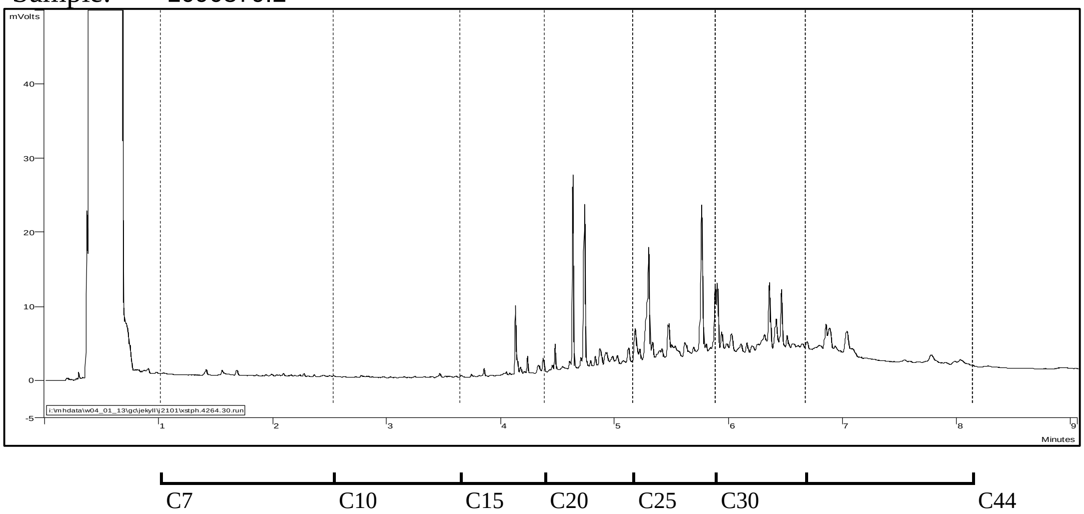
Martin Cowell - BSc (Chem)
Client Services Manager - Environmental Division

Submission #44770

Sample: 1090879.1



Sample: 1090879.2



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ANALYSIS REPORT

SPv1

Client:	Pattle Delamore Partners Ltd	**Lab No:**	1091690
Contact:	Chris Foote	**Date Registered:**	22-Jan-2013
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	07-Feb-2013
	PO Box 9528	**Quote No:**	51293
	Newmarket	**Order No:**	
	AUCKLAND 1149	**Client Reference:**	A02579800
		Submitted By:	Paul Churchill

Sample Type: Sediment

Sample Name:		TBC SS 001 21-Jan-2013	LAK SS 001 21-Jan-2013 10:00 am	LAK SS 002 21-Jan-2013 10:15 am		
Lab Number:		1091690.1	1091690.2	1091690.3		
Individual Tests						
Dry Matter	g/100g as rcvd	82	68	32	-	-
Total Recoverable Phosphorus	mg/kg dry wt	1,430	1,000	660	-	-
pH*	pH Units	7.1	7.4	7.1	-	-
Total Organic Carbon*	g/100g dry wt	3.0	3.0	32 #1	-	-
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	4	6	< 4	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.11	0.23	< 0.19	-	-
Total Recoverable Chromium	mg/kg dry wt	41	43	16	-	-
Total Recoverable Copper	mg/kg dry wt	71	94	63	-	-
Total Recoverable Lead	mg/kg dry wt	86	40	65	-	-
Total Recoverable Nickel	mg/kg dry wt	103	69	24	-	-
Total Recoverable Zinc	mg/kg dry wt	240	1,200	510	-	-
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.05	< 0.07	< 0.18	-	-
Toluene	mg/kg dry wt	< 0.05	2.8	0.27	-	-
Ethylbenzene	mg/kg dry wt	< 0.05	< 0.07	< 0.18	-	-
m&p-Xylene	mg/kg dry wt	< 0.10	< 0.13	< 0.4	-	-
o-Xylene	mg/kg dry wt	< 0.05	0.09	< 0.18	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.06	< 0.07	< 0.15	-	-
Acenaphthylene	mg/kg dry wt	< 0.06	< 0.07	< 0.15	-	-
Anthracene	mg/kg dry wt	< 0.06	< 0.07	< 0.15	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.06	0.11	< 0.15	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.06	0.10	< 0.15	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.06	0.15	< 0.15	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	0.10	0.28	0.18	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.06	< 0.07	< 0.15	-	-
Chrysene	mg/kg dry wt	< 0.06	0.10	< 0.15	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.06	< 0.07	< 0.15	-	-
Fluoranthene	mg/kg dry wt	0.09	0.25	0.19	-	-
Fluorene	mg/kg dry wt	< 0.06	< 0.07	< 0.15	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.06	0.08	< 0.15	-	-
Naphthalene	mg/kg dry wt	< 0.3	< 0.4	< 0.8	-	-
Phenanthrene	mg/kg dry wt	< 0.06	0.22	< 0.15	-	-
Pyrene	mg/kg dry wt	0.11	0.55	0.28	-	-
Total Petroleum Hydrocarbons in Soil						

Sample Type: Sediment						
Sample Name:		TBC SS 001 21-Jan-2013	LAK SS 001 21-Jan-2013 10:00 am	LAK SS 002 21-Jan-2013 10:15 am		
Lab Number:		1091690.1	1091690.2	1091690.3		
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 9	< 10	53	-	-
C10 - C14	mg/kg dry wt	< 20	26	158	-	-
C15 - C36	mg/kg dry wt	1,100	1,040	1,070	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	1,100	1,060	1,290	-	-

Analyst's Comments

[#1] It should be noted that the matrix of the sample caused peak distortion for the total organic carbon analysis.The sample was analysed in duplicate and the result reported is the average of both samples, with the entirety of the distorted peak included.

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

Appendix No.2 - Particle Size Report

Appendix No.3 - Sieve Analysis Report

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Samples
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-3
Soil Prep Dry & Sieve for Agriculture	Air dried at 35°C and sieved, <2mm fraction.	-	1-3
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	1-3
TPH + PAH + BTEX profile	Sonication extraction, SPE cleanup, GC & GC-MS analysis	-	1-3
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1-3
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-3
Particle size analysis*	Malvern Laser Sizer particle size analysis. Subcontracted to Earth Sciences Department, Waikato University, Hamilton.	-	1-3
Total Recoverable Phosphorus	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	1-3
pH*	1:2 (v/v) soil : water slurry followed by potentiometric determination of pH.	0.1 pH Units	1-3
Total Organic Carbon*	Acid pretreatment to remove carbonates if present, neutralisation, Elementar Combustion Analyser.	0.05 g/100g dry wt	1-3

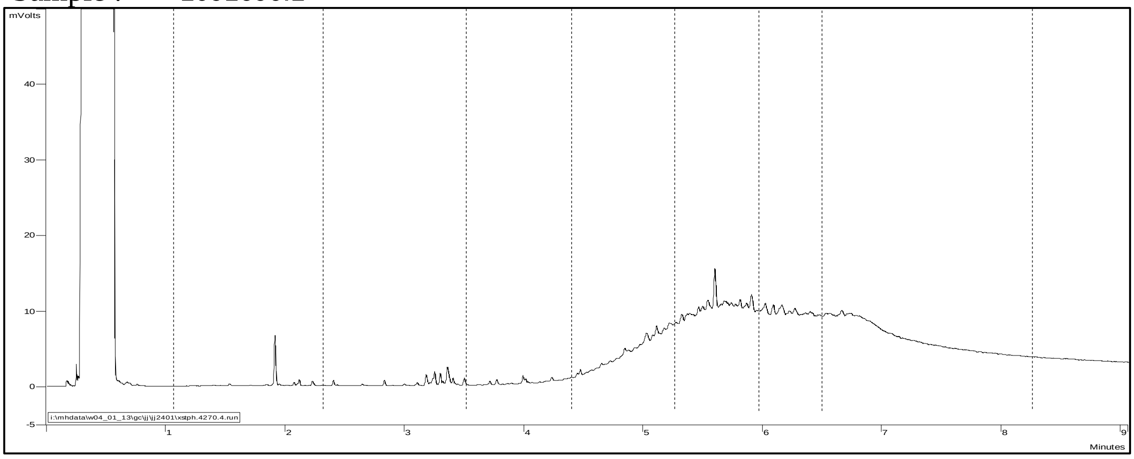
These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

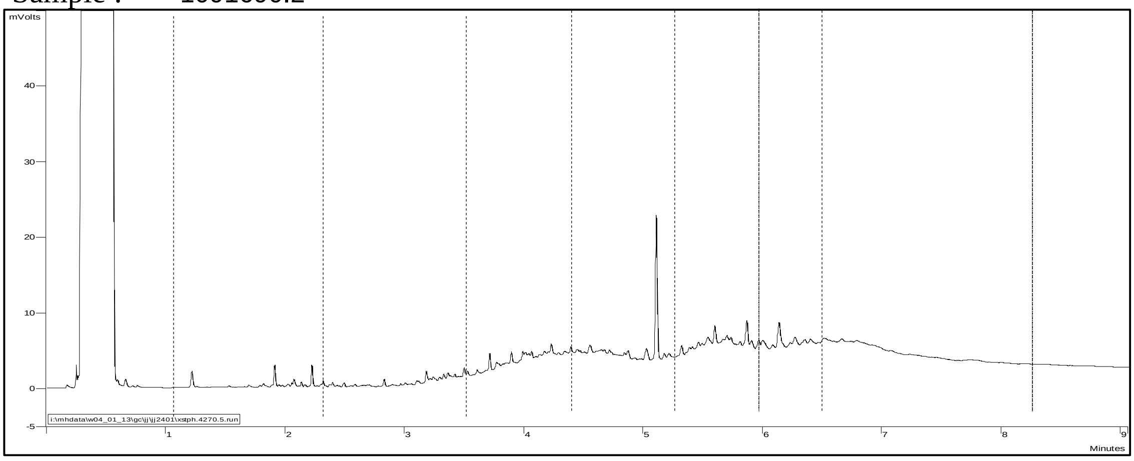
Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

Submission #44770

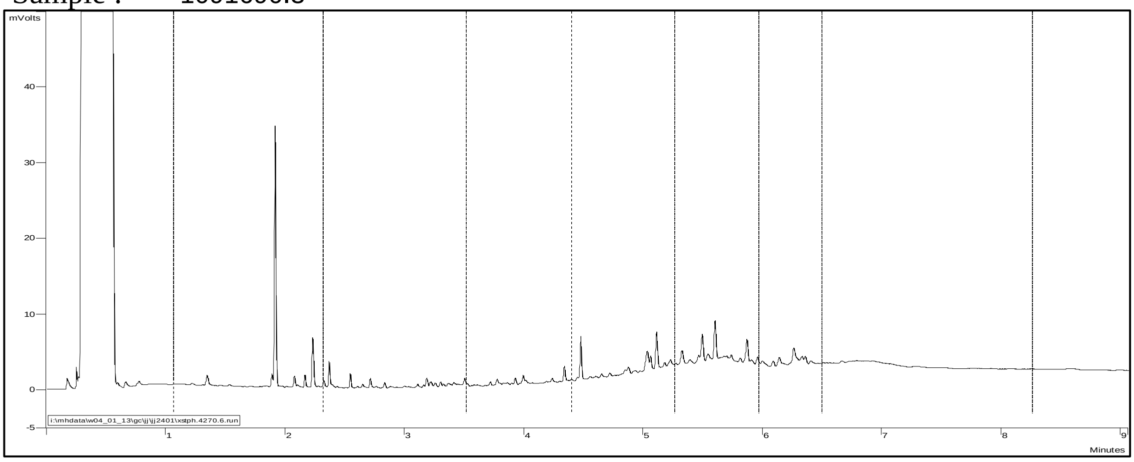
Sample : 1091690.1



Sample : 1091690.2



Sample : 1091690.3



C7 C10 C15 C20 C25 C30 C34 C44

Submission #44770

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ANALYSIS REPORT

SPv2

Client:	Pattle Delamore Partners Ltd	**Lab No:**	1096998
Contact:	H Easton	**Date Registered:**	06-Feb-2013
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	14-Feb-2013
	PO Box 9528	**Quote No:**	51293
	Newmarket	**Order No:**	
	AUCKLAND 1149	**Client Reference:**	A02579800
		Submitted By:	Chris Foote

Sample Type: Sediment

Sample Name:		BRN SS01a 05-Feb-2013	BRN SS02a 05-Feb-2013	SLVSS02a 05-Feb-2013	HBKSS01a 05-Feb-2013	
Lab Number:		1096998.1	1096998.2	1096998.3	1096998.4	
Individual Tests						
Dry Matter	g/100g as rcvd	38	26	54	30	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	0.16	0.89	-	-	-
Acenaphthylene	mg/kg dry wt	0.23	0.74	-	-	-
Anthracene	mg/kg dry wt	0.99	3.9	-	-	-
Benzo[a]anthracene	mg/kg dry wt	9.8	55	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	14.9	63	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	22	93	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	18.0	79	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	9.8	46	-	-	-
Chrysene	mg/kg dry wt	12.7	71	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	1.83	9.0	-	-	-
Fluoranthene	mg/kg dry wt	27	157	-	-	-
Fluorene	mg/kg dry wt	0.42	1.60	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	18.6	65	-	-	-
Naphthalene	mg/kg dry wt	< 0.7	< 0.9	-	-	-
Phenanthrene	mg/kg dry wt	8.1	56	-	-	-
Pyrene	mg/kg dry wt	24	132	-	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	-	-	< 30	720	-
C10 - C14	mg/kg dry wt	-	-	790	29,000	-
C15 - C36	mg/kg dry wt	-	-	26,000	280,000	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	-	-	27,000	310,000	-

Analyst's Comments

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Samples
Polycyclic Aromatic Hydrocarbons Screening in Soil	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis (modified US EPA 8270). Tested on as received sample.	-	1-2
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample	-	3-4

Sample Type: Sediment			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1-4

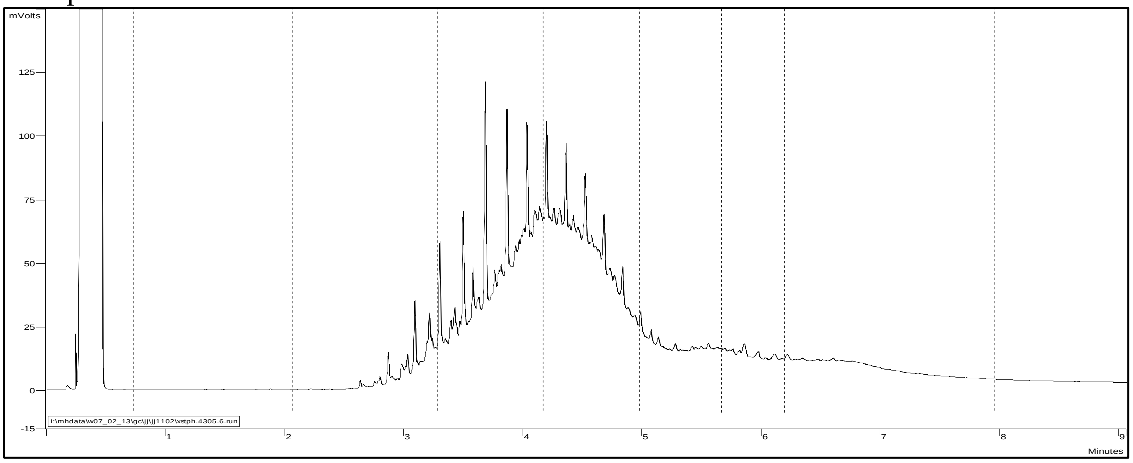
These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

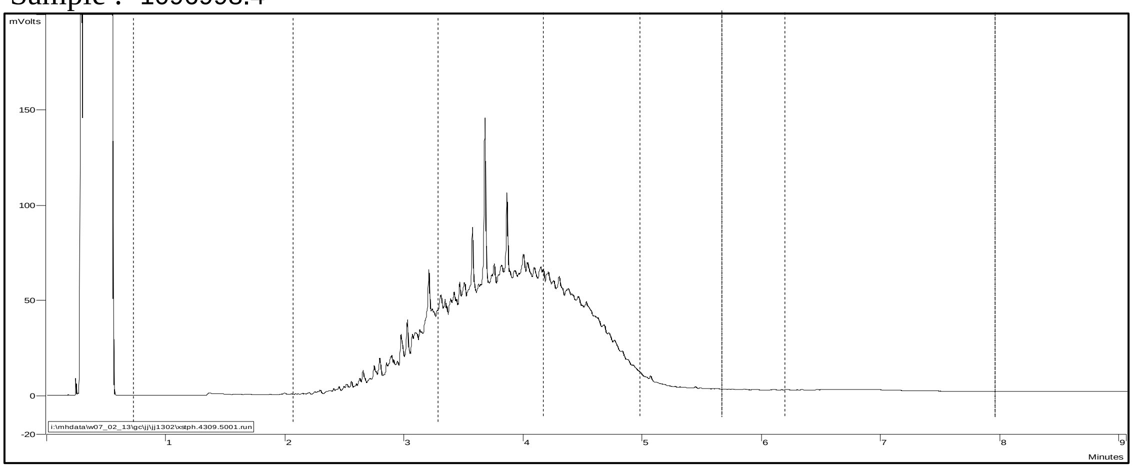
Peter Robinson MSc (Hons), PhD, FNZIC
Client Services Manager - Environmental Division

Submission #44770

Sample : 1096998.3



Sample : 1096998.4



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Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	1106358 SPv3
Contact:	Chris Foote	**Date Registered:**	01-Mar-2013
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	21-Mar-2013
	PO Box 9528	**Quote No:**	51293
	Newmarket	**Order No:**	
	AUCKLAND 1149	**Client Reference:**	A02579800
		Submitted By:	H Easton

Amended Report

This report replaces an earlier report issued on the 15 Mar 2013 at 10:33 am
Following a request from the client, pH has been added to samples 1 and 2.

Sample Type: Sediment

Sample Name:		AMU SS01 28-Feb-2013	ABG SS01 28-Feb-2013			
Lab Number:		1106358.1	1106358.2			
Individual Tests						
Dry Matter	g/100g as rcvd	21	20	-	-	-
Total Recoverable Phosphorus	mg/kg dry wt	2,100	1,560	-	-	-
pH*	pH Units	6.7	7.4	-	-	-
Total Organic Carbon*	g/100g dry wt	13.5	22	-	-	-
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	6	4	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	1.21	0.65	-	-	-
Total Recoverable Chromium	mg/kg dry wt	94	22	-	-	-
Total Recoverable Copper	mg/kg dry wt	96	69	-	-	-
Total Recoverable Lead	mg/kg dry wt	44	60	-	-	-
Total Recoverable Nickel	mg/kg dry wt	33	22	-	-	-
Total Recoverable Zinc	mg/kg dry wt	380	440	-	-	-
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.5	< 0.5	-	-	-
Toluene	mg/kg dry wt	39	8.5	-	-	-
Ethylbenzene	mg/kg dry wt	0.9	< 0.5	-	-	-
m&p-Xylene	mg/kg dry wt	< 0.9	< 1.0	-	-	-
o-Xylene	mg/kg dry wt	< 0.5	< 0.5	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.11	< 0.12	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.11	< 0.12	-	-	-
Anthracene	mg/kg dry wt	< 0.11	< 0.12	-	-	-
Benzo[a]anthracene	mg/kg dry wt	0.13	< 0.12	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.12	< 0.12	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.23	< 0.12	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	0.17	< 0.12	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.11	< 0.12	-	-	-
Chrysene	mg/kg dry wt	0.17	< 0.12	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.11	< 0.12	-	-	-
Fluoranthene	mg/kg dry wt	0.38	< 0.12	-	-	-
Fluorene	mg/kg dry wt	< 0.11	< 0.12	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.11	< 0.12	-	-	-
Naphthalene	mg/kg dry wt	< 0.6	< 0.6	-	-	-
Phenanthrene	mg/kg dry wt	0.35	< 0.12	-	-	-

Sample Type: Sediment						
Sample Name:		AMU SS01 28-Feb-2013	ABG SS01 28-Feb-2013			
Lab Number:		1106358.1	1106358.2			
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Pyrene	mg/kg dry wt	0.37	< 0.12	-	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	820	< 40	-	-	-
C10 - C14	mg/kg dry wt	240	< 80	-	-	-
C15 - C36	mg/kg dry wt	3,400	1,420	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	4,500	1,420	-	-	-

Sample Type: Aqueous						
Sample Name:		AMU SW01 28-Feb-2013	AMU SW02 28-Feb-2013	AMU SW03 28-Feb-2013	ABG SW01 28-Feb-2013	ABG SW02 28-Feb-2013
Lab Number:		1106358.3	1106358.4	1106358.5	1106358.6	1106358.7
Individual Tests						
pH	pH Units	6.2	7.2	7.7	4.6	7.3
Electrical Conductivity (EC)	mS/m	33.0	14.6	14.5	51.4	17.2
Total Suspended Solids	g/m^3	380	7	< 3	320	25
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.0013	< 0.0010	< 0.0010	0.0018	0.0010
Dissolved Cadmium	g/m^3	0.00042	0.00006	< 0.00005	0.00022	< 0.00005
Dissolved Chromium	g/m^3	0.0016	< 0.0005	< 0.0005	0.0011	< 0.0005
Dissolved Copper	g/m^3	0.042	0.0020	0.0032	0.035	0.0013
Dissolved Lead	g/m^3	0.00113	0.00017	0.00167	0.0034	0.00020
Dissolved Nickel	g/m^3	0.0034	< 0.0005	< 0.0005	0.0034	< 0.0005
Dissolved Zinc	g/m^3	0.37	0.032	0.0041	0.35	0.0174
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m^3	0.0020	< 0.0011	< 0.0011	0.0028	0.0012
Total Cadmium	g/m^3	0.00065	0.000073	< 0.000053	0.00044	< 0.000053
Total Chromium	g/m^3	0.0065	0.00076	< 0.00053	0.0056	< 0.00053
Total Copper	g/m^3	0.070	0.0032	0.0162	0.064	0.0020
Total Lead	g/m^3	0.0163	0.00139	0.0039	0.024	0.00104
Total Nickel	g/m^3	0.0068	< 0.00053	< 0.00053	0.0062	< 0.00053
Total Zinc	g/m^3	0.55	0.039	0.0043	0.67	0.023
BTEX in Water by Headspace GC-MS						
Benzene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
m&p-Xylene	g/m^3	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Acenaphthylene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Anthracene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[a]anthracene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[a]pyrene (BAP)	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[g,h,i]perylene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[k]fluoranthene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Chrysene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Dibenzo[a,h]anthracene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Fluoranthene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Fluorene	g/m^3	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Indeno(1,2,3-c,d)pyrene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Naphthalene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Phenanthrene	g/m^3	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Pyrene	g/m^3	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002

Sample Type: Aqueous

Sample Name: / Lab Number:		AMU SW01 28-Feb-2013 1106358.3	AMU SW02 28-Feb-2013 1106358.4	AMU SW03 28-Feb-2013 1106358.5	ABG SW01 28-Feb-2013 1106358.6	ABG SW02 28-Feb-2013 1106358.7
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m^3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m^3	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36)	g/m^3	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7

Sample Name: / Lab Number:		ABG SW03 28-Feb-2013 1106358.8	AMU-A 28-Feb-2013 1106358.9			
Individual Tests						
pH	pH Units	7.7	7.8	-	-	-
Electrical Conductivity (EC)	mS/m	16.9	14.5	-	-	-
Total Suspended Solids	g/m^3	< 3	< 3	-	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.0011	< 0.0010	-	-	-
Dissolved Cadmium	g/m^3	< 0.00005	< 0.00005	-	-	-
Dissolved Chromium	g/m^3	< 0.0005	< 0.0005	-	-	-
Dissolved Copper	g/m^3	0.0009	0.0031	-	-	-
Dissolved Lead	g/m^3	0.00112	0.00159	-	-	-
Dissolved Nickel	g/m^3	< 0.0005	< 0.0005	-	-	-
Dissolved Zinc	g/m^3	0.0051	0.0041 #1	-	-	-
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m^3	0.0012	< 0.0011	-	-	-
Total Cadmium	g/m^3	< 0.000053	< 0.000053	-	-	-
Total Chromium	g/m^3	< 0.00053	< 0.00053	-	-	-
Total Copper	g/m^3	0.00125	0.0153	-	-	-
Total Lead	g/m^3	0.00184	0.0041	-	-	-
Total Nickel	g/m^3	< 0.00053	< 0.00053	-	-	-
Total Zinc	g/m^3	0.0060	0.0040 #1	-	-	-
BTEX in Water by Headspace GC-MS						
Benzene	g/m^3	< 0.0010	< 0.0010	-	-	-
Toluene	g/m^3	< 0.0010	< 0.0010	-	-	-
Ethylbenzene	g/m^3	< 0.0010	< 0.0010	-	-	-
m&p-Xylene	g/m^3	< 0.002	< 0.002	-	-	-
o-Xylene	g/m^3	< 0.0010	< 0.0010	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m^3	< 0.00010	< 0.00010	-	-	-
Acenaphthylene	g/m^3	< 0.00010	< 0.00010	-	-	-
Anthracene	g/m^3	< 0.00010	< 0.00010	-	-	-
Benzo[a]anthracene	g/m^3	< 0.00010	< 0.00010	-	-	-
Benzo[a]pyrene (BAP)	g/m^3	< 0.00010	< 0.00010	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m^3	< 0.00010	< 0.00010	-	-	-
Benzo[g,h,i]perylene	g/m^3	< 0.00010	< 0.00010	-	-	-
Benzo[k]fluoranthene	g/m^3	< 0.00010	< 0.00010	-	-	-
Chrysene	g/m^3	< 0.00010	< 0.00010	-	-	-
Dibenzo[a,h]anthracene	g/m^3	< 0.00010	< 0.00010	-	-	-
Fluoranthene	g/m^3	< 0.00010	< 0.00010	-	-	-
Fluorene	g/m^3	< 0.0002	< 0.0002	-	-	-
Indeno(1,2,3-c,d)pyrene	g/m^3	< 0.00010	< 0.00010	-	-	-
Naphthalene	g/m^3	< 0.0005	< 0.0005	-	-	-
Phenanthrene	g/m^3	< 0.0004	< 0.0004	-	-	-
Pyrene	g/m^3	< 0.0002	< 0.0002	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m^3	< 0.10	< 0.10	-	-	-
C10 - C14	g/m^3	< 0.2	< 0.2	-	-	-
C15 - C36	g/m^3	< 0.4	< 0.4	-	-	-

Sample Type: Aqueous						
Sample Name:		ABG SW03 28-Feb-2013	AMU-A 28-Feb-2013			
Lab Number:		1106358.8	1106358.9			
Total Petroleum Hydrocarbons in Water						
Total hydrocarbons (C7 - C36)	g/m^3	< 0.7	< 0.7	-	-	-

Analyst's Comments

Supplement to test report issued 14/3/2013

#1 It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

Appendix No.2 - Total Petroleum Hydrocarbon Chromatograms

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Samples
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-2
Soil Prep Dry & Sieve for Agriculture	Air dried at 35°C and sieved, <2mm fraction.	-	1-2
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	1-2
TPH + PAH + BTEX profile	Sonication extraction, SPE cleanup, GC & GC-MS analysis	-	1-2
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1-2
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-2
Total Recoverable Phosphorus	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	1-2
pH*	1:2 (v/v) soil : water slurry followed by potentiometric determination of pH.	0.1 pH Units	1-2
Total Organic Carbon*	Acid pretreatment to remove carbonates if present, neutralisation, Elementar Combustion Analyser.	0.05 g/100g dry wt	1-2

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Samples
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm filtration, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	-	3-9
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn	Nitric acid digestion, ICP-MS, trace level	-	3-9
BTEX in Water by Headspace GC-MS	Headspace GC-MS analysis, US EPA 8260B	-	3-9
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq	Liquid / liquid extraction, SPE (if required), GC-MS SIM analysis	-	3-9
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines	-	3-9
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 21st ed. 2005.	-	3-9
pH	pH meter. APHA 4500-H^+ B 21st ed. 2005.	0.1 pH Units	3-9
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21st ed. 2005.	0.1 mS/m	3-9
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21st ed. 2005.	3 g/m^3	3-9

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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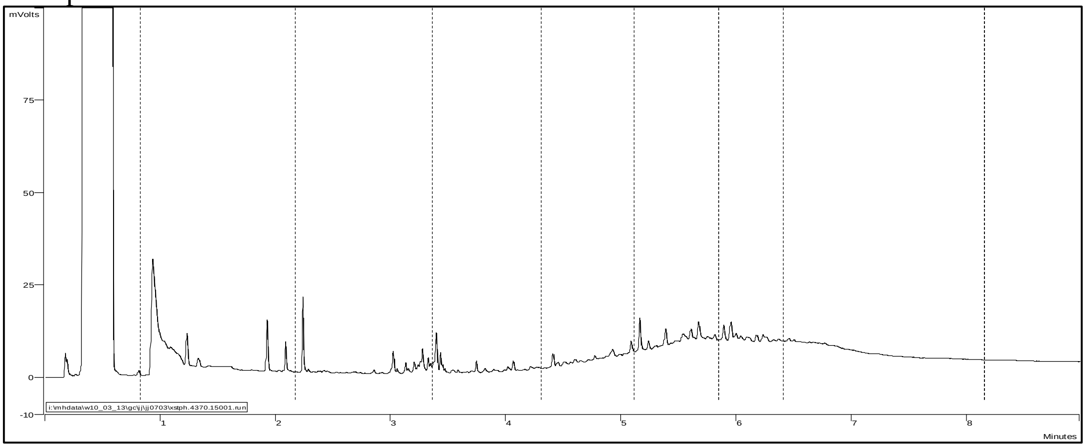
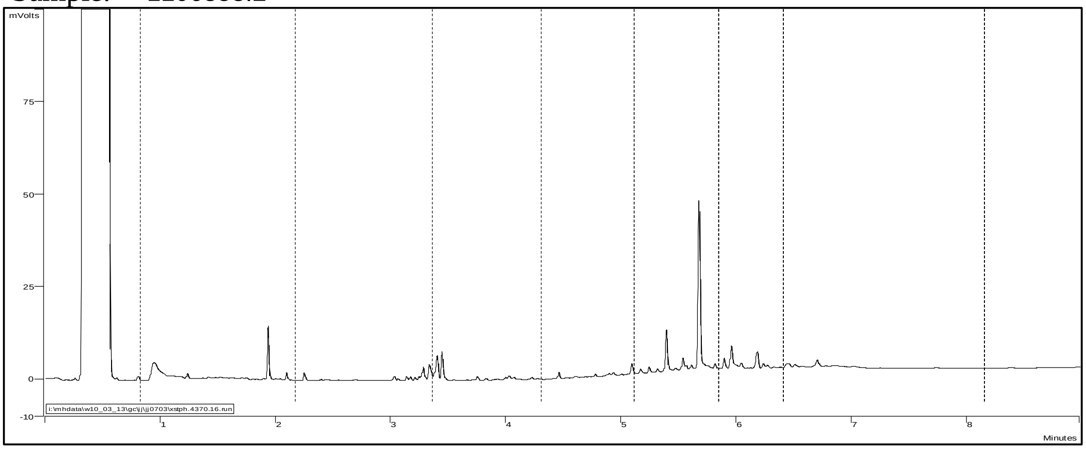
Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

Submission #44770

Sample: 1106358.1



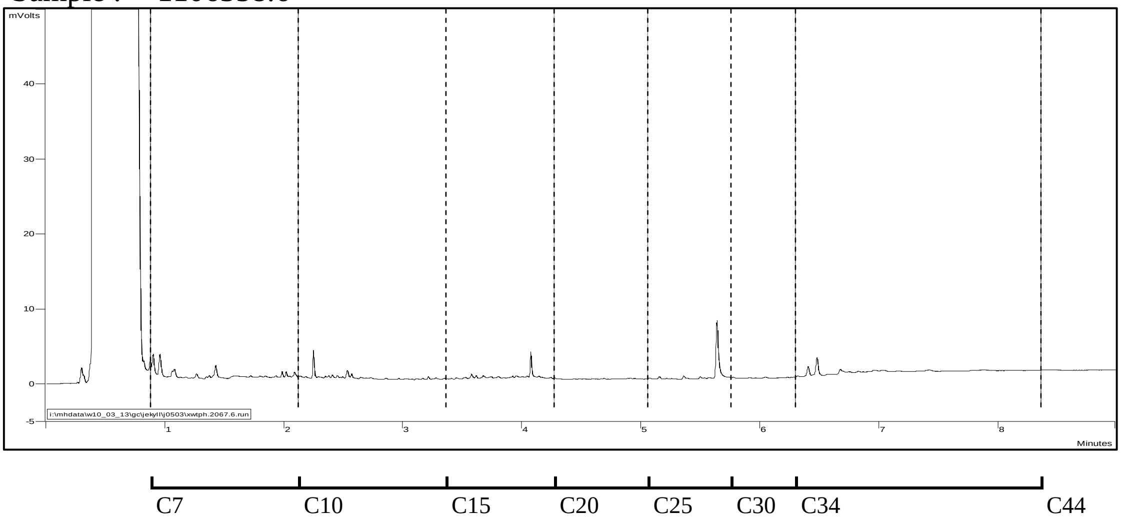
Sample: 1106358.2



C7 C10 C15 C20 C25 C30 C34 C44

Submission #44770

Sample : 1106358.6



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ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	1111033 SPv1
Contact:	H Easton	**Date Registered:**	14-Mar-2013
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	20-Mar-2013
	PO Box 9528	**Quote No:**	51293
	Newmarket	**Order No:**	
	AUCKLAND 1149	**Client Reference:**	A02579800
		Submitted By:	Chris Foote

Sample Type: Aqueous

Sample Name:		SYL SW 001	SYL SW 002	SYL SW 003	SYL SW 004	SYL SW 005
Lab Number:		1111033.1	1111033.2	1111033.3	1111033.4	1111033.5
Individual Tests						
pH	pH Units	6.8	7.2	7.7	7.3	7.6
Electrical Conductivity (EC)	mS/m	31.7	15.8	15.7	25.4	17.5
Total Suspended Solids	g/m³	850	6	< 3	92	51
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	0.0012	< 0.0010	< 0.0010	0.0013	< 0.0010
Dissolved Cadmium	g/m³	0.00015	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved Chromium	g/m³	0.0008	< 0.0005	< 0.0005	0.0009	< 0.0005
Dissolved Copper	g/m³	0.030	0.0011	0.0007	0.0146	0.0006
Dissolved Lead	g/m³	0.00092	0.00043	0.00024	0.00060	0.00013
Dissolved Nickel	g/m³	0.0040	< 0.0005	< 0.0005	0.0019	0.0006
Dissolved Zinc	g/m³	0.41	0.036	< 0.0010	0.076	0.197
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m³	0.0024	< 0.0011	< 0.0011	0.0019	0.0043
Total Cadmium	g/m³	0.00028	< 0.000053	0.000063	0.000122	0.000120
Total Chromium	g/m³	0.0059	0.00064	< 0.00053	0.0039	0.0186
Total Copper	g/m³	0.056	0.0020	0.0024	0.034	0.036
Total Lead	g/m³	0.0176	0.00125	0.0023	0.0109	0.059
Total Nickel	g/m³	0.0085	< 0.00053	0.00058	0.0046	0.0186
Total Zinc	g/m³	0.73	0.047	0.0050	0.26	1.78
BTEX in Water by Headspace GC-MS						
Benzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
m&p-Xylene	g/m³	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Acenaphthylene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[a]anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[a]pyrene (BAP)	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[g,h,i]perylene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[k]fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Chrysene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Dibenzo[a,h]anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010

Sample Type: Aqueous						
Sample Name:		SYL SW 001	SYL SW 002	SYL SW 003	SYL SW 004	SYL SW 005
Lab Number:		1111033.1	1111033.2	1111033.3	1111033.4	1111033.5
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Fluorene	g/m³	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Indeno(1,2,3-c,d)pyrene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Naphthalene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Phenanthrene	g/m³	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Pyrene	g/m³	< 0.0002	< 0.0002	< 0.0002	0.0006	< 0.0002
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m³	< 0.4	< 0.4	< 0.4	2.9	< 0.4
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	< 0.7	2.9	< 0.7

Sample Name:		SYL SW 006 13-Mar-2013	SYL SW 007 13-Mar-2013	SYL SW A 13-Mar-2013		
Lab Number:		1111033.6	1111033.7	1111033.8		
Individual Tests						
pH	pH Units	8.0	8.9	8.4	-	-
Electrical Conductivity (EC)	mS/m	18.3	16.0	16.3	-	-
Total Suspended Solids	g/m³	4	8	9	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	0.0012	0.0012	0.0012	-	-
Dissolved Cadmium	g/m³	< 0.00005	< 0.00005	< 0.00005	-	-
Dissolved Chromium	g/m³	< 0.0005	< 0.0005	< 0.0005	-	-
Dissolved Copper	g/m³	0.0046	0.0013	0.0012	-	-
Dissolved Lead	g/m³	0.00014	0.00021	0.00020	-	-
Dissolved Nickel	g/m³	< 0.0005	< 0.0005	< 0.0005	-	-
Dissolved Zinc	g/m³	0.0193	0.057	0.059	-	-
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m³	< 0.0011	0.0015	0.0013	-	-
Total Cadmium	g/m³	< 0.000053	< 0.000053	< 0.000053	-	-
Total Chromium	g/m³	0.00072	0.00087	0.00088	-	-
Total Copper	g/m³	0.0061	0.0032	0.0030	-	-
Total Lead	g/m³	0.00100	0.00120	0.00115	-	-
Total Nickel	g/m³	0.00059	< 0.00053	0.00062	-	-
Total Zinc	g/m³	0.055	0.152	0.155	-	-
BTEX in Water by Headspace GC-MS						
Benzene	g/m³	< 0.0010	< 0.0010	< 0.0010	-	-
Toluene	g/m³	< 0.0010	0.0048	0.0049	-	-
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010	-	-
m&p-Xylene	g/m³	< 0.002	< 0.002	< 0.002	-	-
o-Xylene	g/m³	< 0.0010	< 0.0010	< 0.0010	-	-
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Acenaphthylene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Benzo[a]anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Benzo[a]pyrene (BAP)	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Benzo[g,h,i]perylene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Benzo[k]fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Chrysene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Dibenzo[a,h]anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Fluorene	g/m³	< 0.0002	< 0.0002	< 0.0002	-	-
Indeno(1,2,3-c,d)pyrene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Naphthalene	g/m³	< 0.0005	< 0.0005	< 0.0005	-	-

Sample Type: Aqueous						
Sample Name:		SYL SW 006 13-Mar-2013	SYL SW 007 13-Mar-2013	SYL SW A 13-Mar-2013		
Lab Number:		1111033.6	1111033.7	1111033.8		
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Phenanthrene	g/m^3	< 0.0004	< 0.0004	< 0.0004	-	-
Pyrene	g/m^3	0.0005	< 0.0002	0.0002	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m^3	< 0.10	< 0.10	< 0.10	-	-
C10 - C14	g/m^3	< 0.2	< 0.2	< 0.2	-	-
C15 - C36	g/m^3	2.5	0.4	< 0.4	-	-
Total hydrocarbons (C7 - C36)	g/m^3	2.5	< 0.7	< 0.7	-	-

Analyst's Comments

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Samples
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm filtration, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	-	1-8
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn	Nitric acid digestion, ICP-MS, trace level	-	1-8
BTEX in Water by Headspace GC-MS	Headspace GC-MS analysis, US EPA 8260B	-	1-8
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq	Liquid / liquid extraction, SPE (if required), GC-MS SIM analysis	-	1-8
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines	-	1-8
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 21st ed. 2005.	-	1-8
pH	pH meter. APHA 4500-H^+ B 21st ed. 2005.	0.1 pH Units	1-8
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21st ed. 2005.	0.1 mS/m	1-8
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21st ed. 2005.	3 g/m^3	1-8

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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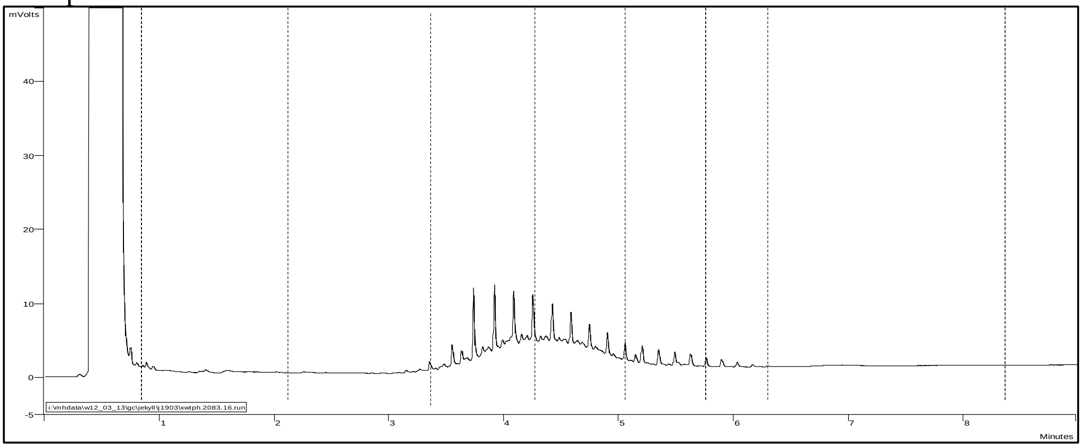
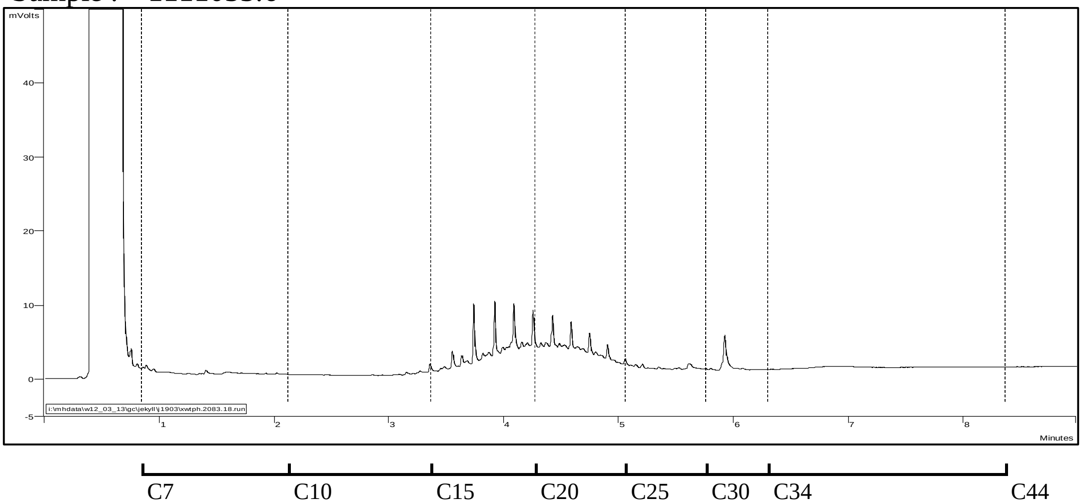
Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

Submission #44770

Sample : 1111033.4



Sample : 1111033.6



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ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	1111585 SPv1
Contact:	H Easton	**Date Registered:**	15-Mar-2013
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	25-Mar-2013
	PO Box 9528	**Quote No:**	53670
	Newmarket	**Order No:**	
	AUCKLAND 1149	**Client Reference:**	A02579800
		Submitted By:	Chris Foote

Sample Type: Aqueous

Sample Name:		HBK SW 001	HBK SW 002	HBK SW 003	HBK SW 004	HBK SW 005
Lab Number:		1111585.1	1111585.2	1111585.3	1111585.4	1111585.5
Individual Tests						
pH	pH Units	7.0	7.4	8.0	7.0	7.3
Electrical Conductivity (EC)	mS/m	33.2	16.0	15.7	51.6	35.4
Total Suspended Solids	g/m^3	970	15	< 3	310	163
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	0.0012	< 0.0010	0.0011	< 0.0010	< 0.0010
Dissolved Cadmium	g/m^3	0.00035	< 0.00005	< 0.00005	0.00005	< 0.00005
Dissolved Chromium	g/m^3	0.0016	< 0.0005	0.0006	0.0009	0.0007
Dissolved Copper	g/m^3	0.021	0.0011	0.0025	0.0054	0.0014
Dissolved Lead	g/m^3	0.00196	0.00010	0.00020	0.00058	0.00044
Dissolved Nickel	g/m^3	0.0031	< 0.0005	< 0.0005	0.0036	0.0035
Dissolved Zinc	g/m^3	0.62	0.045	0.0073	0.054	0.34
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m^3	0.0025	< 0.0011	< 0.0011	0.0013	< 0.0011
Total Cadmium	g/m^3	0.00061	< 0.000053	< 0.000053	0.000113	0.000081
Total Chromium	g/m^3	0.0082	0.00082	0.00063	0.0031	0.00106
Total Copper	g/m^3	0.048	0.0021	0.0087	0.0199	0.0040
Total Lead	g/m^3	0.033	0.00130	0.00076	0.0188	0.0027
Total Nickel	g/m^3	0.0080	< 0.00053	< 0.00053	0.0055	0.0052
Total Zinc	g/m^3	1.29	0.059	0.0100	0.24	0.78
BTEX in Water by Headspace GC-MS						
Benzene	g/m^3	< 0.0010	< 0.0010	< 0.0010	0.0042	0.0015
Toluene	g/m^3	< 0.0010	< 0.0010	< 0.0010	0.050	0.0083
Ethylbenzene	g/m^3	< 0.0010	< 0.0010	< 0.0010	0.0018	0.0028
m&p-Xylene	g/m^3	< 0.002	< 0.002	< 0.002	0.021	< 0.002
o-Xylene	g/m^3	< 0.0010	< 0.0010	< 0.0010	0.0154	0.0115
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.0007	< 0.00010
Acenaphthylene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.0007	< 0.00010
Anthracene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.0007	< 0.00010
Benzo[a]anthracene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.0007	< 0.00010
Benzo[a]pyrene (BAP)	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.0007	< 0.00010
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.0007	< 0.00010
Benzo[g,h,i]perylene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.0007	< 0.00010
Benzo[k]fluoranthene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.0007	< 0.00010
Chrysene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.0007	< 0.00010
Dibenzo[a,h]anthracene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.0007	< 0.00010
Fluoranthene	g/m^3	< 0.00010	< 0.00010	< 0.00010	0.0017	< 0.00010

Sample Type: Aqueous						
Sample Name:		HBK SW 001	HBK SW 002	HBK SW 003	HBK SW 004	HBK SW 005
Lab Number:		1111585.1	1111585.2	1111585.3	1111585.4	1111585.5
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Fluorene	g/m³	< 0.0002	< 0.0002	< 0.0002	0.0025	< 0.0002
Indeno(1,2,3-c,d)pyrene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.0007	< 0.00010
Naphthalene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.004	< 0.0005
Phenanthrene	g/m³	< 0.0004	< 0.0004	< 0.0004	0.0046	< 0.0004
Pyrene	g/m³	< 0.0002	< 0.0002	< 0.0002	0.052	0.0006
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	< 0.10	1.5	0.18
C10 - C14	g/m³	< 0.2	< 0.2	< 0.2	240	< 0.2
C15 - C36	g/m³	< 0.4	< 0.4	< 0.4	3,400	1.7
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	< 0.7	3,700	1.9

Sample Name:		HBK SW 006	HBK SW 007	HBK SW A		
Lab Number:		1111585.6	1111585.7	1111585.8		
Individual Tests						
pH	pH Units	7.8	6.9	7.0	-	-
Electrical Conductivity (EC)	mS/m	17.8	32.8	33.0	-	-
Total Suspended Solids	g/m³	5	15	12	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	0.0010	< 0.0010	< 0.0010	-	-
Dissolved Cadmium	g/m³	< 0.00005	< 0.00005	< 0.00005	-	-
Dissolved Chromium	g/m³	< 0.0005	0.0007	0.0007	-	-
Dissolved Copper	g/m³	0.0024	0.0023	0.0023	-	-
Dissolved Lead	g/m³	0.00033	0.00041	0.00047	-	-
Dissolved Nickel	g/m³	< 0.0005	0.0033	0.0032	-	-
Dissolved Zinc	g/m³	0.040	0.166	0.169	-	-
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m³	< 0.0011	< 0.0011	< 0.0011	-	-
Total Cadmium	g/m³	< 0.000053	0.000090	0.000063	-	-
Total Chromium	g/m³	0.00055	0.00075	0.00118	-	-
Total Copper	g/m³	0.0036	0.0052	0.0057	-	-
Total Lead	g/m³	0.0028	0.0023	0.0023	-	-
Total Nickel	g/m³	0.00070	0.0048	0.0050	-	-
Total Zinc	g/m³	0.062	0.34	0.34	-	-
BTEX in Water by Headspace GC-MS						
Benzene	g/m³	< 0.0010	0.079	0.070	-	-
Toluene	g/m³	< 0.0010	1.44	1.24	-	-
Ethylbenzene	g/m³	< 0.0010	0.126	0.0067	-	-
m&p-Xylene	g/m³	< 0.002	0.81	0.69	-	-
o-Xylene	g/m³	< 0.0010	0.46	0.43	-	-
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m³	0.00017	0.00014	0.00013	-	-
Acenaphthylene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Benzo[a]anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Benzo[a]pyrene (BAP)	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Benzo[g,h,i]perylene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Benzo[k]fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Chrysene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Dibenzo[a,h]anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Fluoranthene	g/m³	0.00013	< 0.00010	< 0.00010	-	-
Fluorene	g/m³	0.0005	0.0006	0.0005	-	-
Indeno(1,2,3-c,d)pyrene	g/m³	< 0.00010	< 0.00010	< 0.00010	-	-
Naphthalene	g/m³	< 0.0005	< 0.0005	< 0.0005	-	-

Sample Type: Aqueous						
Sample Name:		HBK SW 006	HBK SW 007	HBK SW A		
Lab Number:		1111585.6	1111585.7	1111585.8		
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Phenanthrene	g/m^3	0.0005	< 0.0004	< 0.0004	-	-
Pyrene	g/m^3	0.0033	0.0012	0.0013	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m^3	< 0.10	2.9	2.6	-	-
C10 - C14	g/m^3	2.5	0.8	0.7	-	-
C15 - C36	g/m^3	41	5.4	5.3	-	-
Total hydrocarbons (C7 - C36)	g/m^3	44	9.0	8.6	-	-

Analyst's Comments

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

Appendix No.2 - Total Petroleum Hydrocarbon Chromatograms

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Samples
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm filtration, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	-	1-8
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn	Nitric acid digestion, ICP-MS, trace level	-	1-8
BTEX in Water by Headspace GC-MS	Headspace GC-MS analysis, US EPA 8260B	-	1-8
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq	Liquid / liquid extraction, SPE (if required), GC-MS SIM analysis	-	1-8
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines	-	1-8
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 21st ed. 2005.	-	1-8
pH	pH meter. APHA 4500-H^+ B 21st ed. 2005.	0.1 pH Units	1-8
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21st ed. 2005.	0.1 mS/m	1-8
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21st ed. 2005.	3 g/m^3	1-8

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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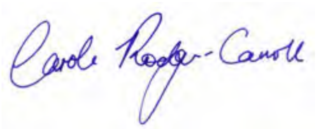
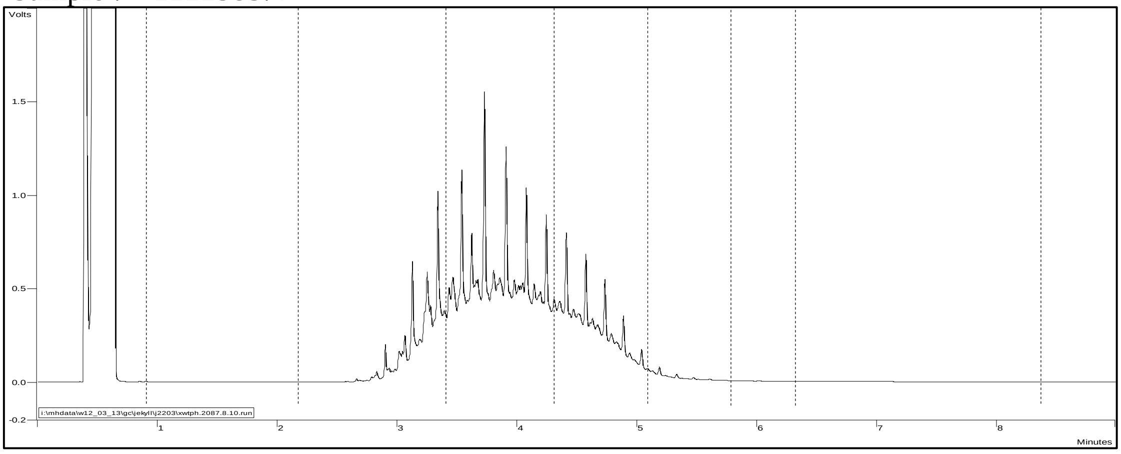


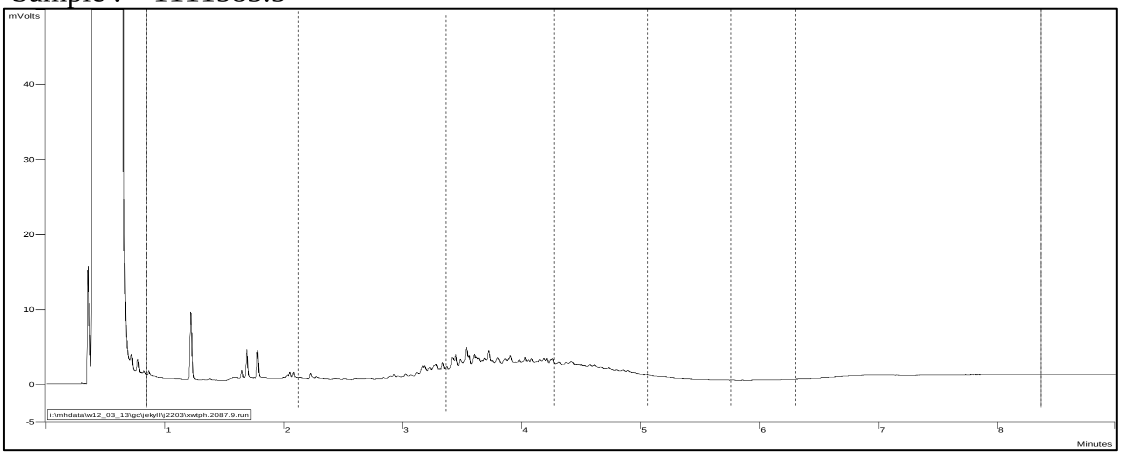
Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental Division

Submission #44770

Sample : 1111585.4



Sample : 1111585.5



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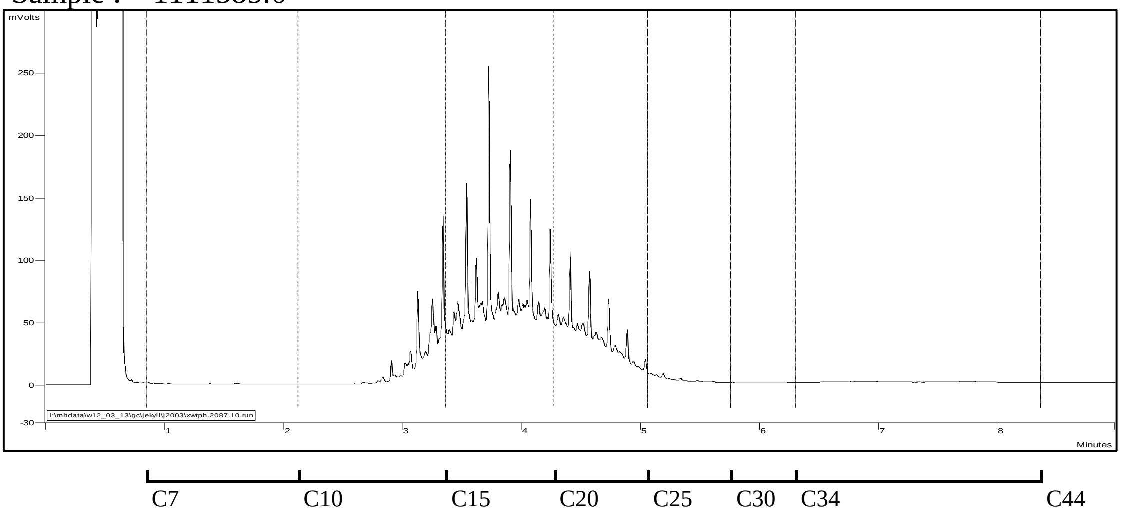
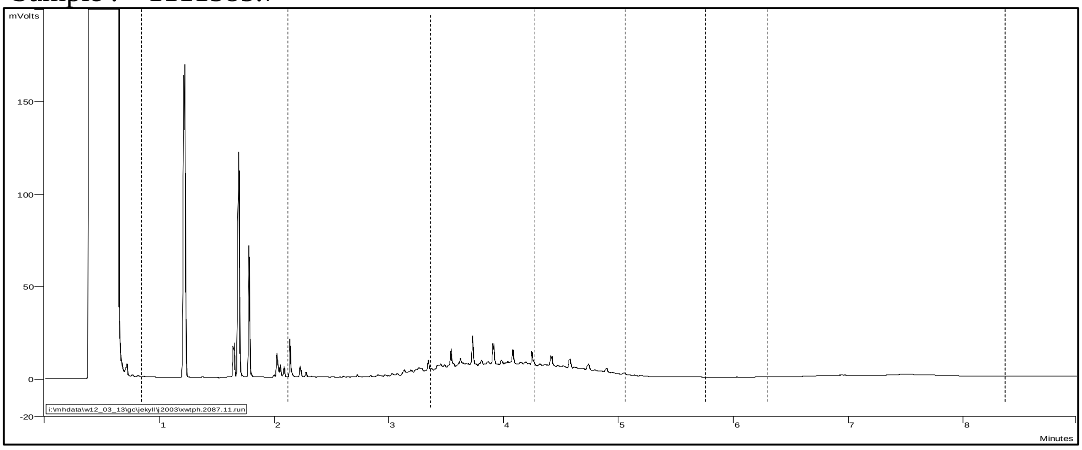
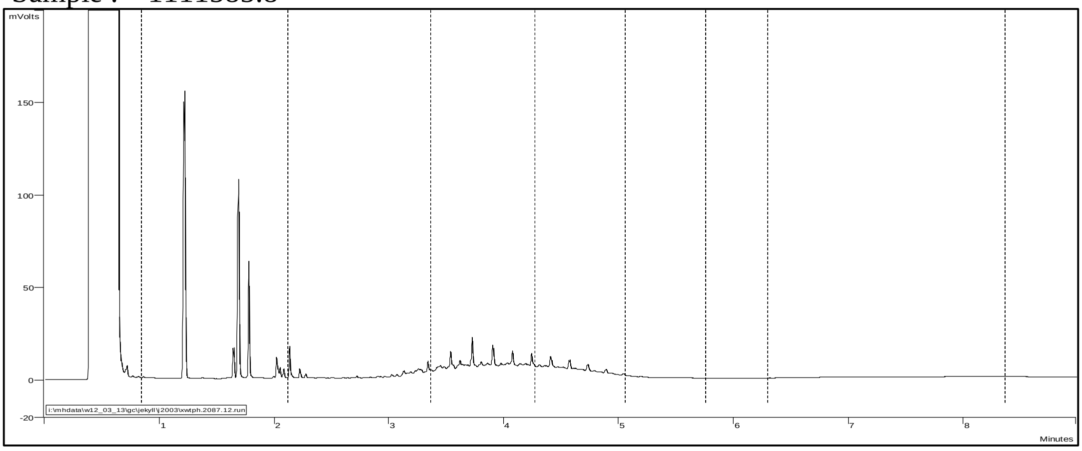


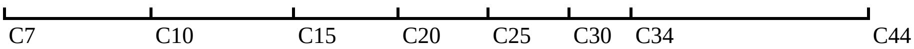
Submission #44770

Sample : 1111585.7



Sample : 1111585.8





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ANALYSIS REPORT

SPv1

Client:	Pattle Delamore Partners Ltd	**Lab No:**	1111669
Contact:	Chris Foote	**Date Registered:**	15-Mar-2013
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	22-Mar-2013
	PO Box 9528	**Quote No:**	53670
	Newmarket	**Order No:**	
	AUCKLAND 1149	**Client Reference:**	A02579800
		Submitted By:	Chris Foote

Sample Type: Aqueous

Sample Name:		BRN SW01 14-Mar-2013	BRN SW02 14-Mar-2013	BRN SW03 14-Mar-2013	BRN SW04 14-Mar-2013	BRN SW05 14-Mar-2013
Lab Number:		1111669.1	1111669.2	1111669.3	1111669.4	1111669.5
Individual Tests						
pH	pH Units	6.6	7.4	8.0	6.8	7.0
Electrical Conductivity (EC)	mS/m	31.5	16.3	15.4	117.6	15.0
Total Suspended Solids	g/m³	540	9	< 3	48	22
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	0.0014	0.0012	0.0011	< 0.0010	< 0.0010
Dissolved Cadmium	g/m³	0.00013	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved Chromium	g/m³	0.0009	< 0.0005	0.0007 #1	0.0007	< 0.0005
Dissolved Copper	g/m³	0.020	0.0014	0.0011	0.0094	0.0008
Dissolved Lead	g/m³	0.00112	0.00020	0.00059	0.00035	< 0.00010
Dissolved Nickel	g/m³	0.0015	< 0.0005	< 0.0005	0.0009	< 0.0005
Dissolved Zinc	g/m³	0.48	0.044	0.0014	0.165	0.0051
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m³	0.0029	0.0012	< 0.0011	0.0016	< 0.0011
Total Cadmium	g/m³	0.00021	< 0.000053	< 0.000053	0.000114	< 0.000053
Total Chromium	g/m³	0.0057	0.00078	< 0.00053 #1	0.0020	0.00062
Total Copper	g/m³	0.037	0.0024	0.0080	0.0172	0.00186
Total Lead	g/m³	0.024	0.00124	0.00190	0.0050	0.00031
Total Nickel	g/m³	0.0050	< 0.00053	< 0.00053	0.00197	< 0.00053
Total Zinc	g/m³	0.70	0.056	0.0029	0.57	0.0147
BTEX in Water by Headspace GC-MS						
Benzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
m&p-Xylene	g/m³	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Acenaphthylene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[a]anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[a]pyrene (BAP)	g/m³	0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	0.00030	0.00021	< 0.00010	0.00017	< 0.00010
Benzo[g,h,i]perylene	g/m³	0.00022	0.00017	< 0.00010	0.00021	< 0.00010
Benzo[k]fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Chrysene	g/m³	0.00019	0.00016	< 0.00010	< 0.00010	< 0.00010
Dibenzo[a,h]anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010

Sample Type: Aqueous						
Sample Name:		BRN SW01 14-Mar-2013	BRN SW02 14-Mar-2013	BRN SW03 14-Mar-2013	BRN SW04 14-Mar-2013	BRN SW05 14-Mar-2013
Lab Number:		1111669.1	1111669.2	1111669.3	1111669.4	1111669.5
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Fluoranthene	g/m³	0.00060	0.00054	< 0.00010	< 0.00010	< 0.00010
Fluorene	g/m³	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Indeno(1,2,3-c,d)pyrene	g/m³	0.00033	0.00023	< 0.00010	0.00022	< 0.00010
Naphthalene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Phenanthrene	g/m³	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Pyrene	g/m³	0.0003	0.0003	< 0.0002	< 0.0002	< 0.0002
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m³	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7

Sample Name:		BRN SW06 14-Mar-2013	BRN SW07 14-Mar-2013	HCR SW01 14-Mar-2013	HCR SW02 14-Mar-2013	HCR SW03 14-Mar-2013
Lab Number:		1111669.6	1111669.7	1111669.8	1111669.9	1111669.10
Individual Tests						
pH	pH Units	7.7	7.1	6.7	7.4	7.8
Electrical Conductivity (EC)	mS/m	18.4	16.1	26.1	15.9	15.6
Total Suspended Solids	g/m³	< 3	6	330	5	< 3
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	0.0011	< 0.0010	0.0013	0.0011 #1	0.0011
Dissolved Cadmium	g/m³	< 0.00005	< 0.00005	0.00005	< 0.00005	< 0.00005
Dissolved Chromium	g/m³	< 0.0005	< 0.0005	0.0007	< 0.0005	< 0.0005
Dissolved Copper	g/m³	0.0023	0.0016	0.0151	0.0013	0.0011
Dissolved Lead	g/m³	0.00013	0.00020	0.00057	< 0.00010	0.00018
Dissolved Nickel	g/m³	< 0.0005	< 0.0005	0.0014	< 0.0005	< 0.0005
Dissolved Zinc	g/m³	0.051	0.0151	0.30	0.031	0.053
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m³	0.0012	< 0.0011	0.0016	< 0.0011 #1	0.0011
Total Cadmium	g/m³	< 0.000053	< 0.000053	0.000096	< 0.000053	< 0.000053
Total Chromium	g/m³	< 0.00053	< 0.00053	0.0035	0.00056	0.00062
Total Copper	g/m³	0.0029	0.0030	0.030	0.0022	0.0110
Total Lead	g/m³	0.00043	0.00040	0.0114	0.00067	0.0036
Total Nickel	g/m³	< 0.00053	0.00068	0.0032	< 0.00053	< 0.00053
Total Zinc	g/m³	0.069	0.034	0.49	0.040	0.078
BTEX in Water by Headspace GC-MS						
Benzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
m&p-Xylene	g/m³	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Acenaphthylene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[a]anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[a]pyrene (BAP)	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[g,h,i]perylene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[k]fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Chrysene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Dibenzo[a,h]anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Fluorene	g/m³	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Indeno(1,2,3-c,d)pyrene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010

Sample Type: Aqueous						
	Sample Name:	BRN SW06 14-Mar-2013	BRN SW07 14-Mar-2013	HCR SW01 14-Mar-2013	HCR SW02 14-Mar-2013	HCR SW03 14-Mar-2013
	Lab Number:	1111669.6	1111669.7	1111669.8	1111669.9	1111669.10
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Naphthalene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Phenanthrene	g/m³	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Pyrene	g/m³	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m³	< 0.4	< 0.4	0.5	< 0.4	< 0.4
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7

	Sample Name:	HCR SW04 14-Mar-2013	HCR SW05 14-Mar-2013	HCR SW06 14-Mar-2013	HCR SW07 14-Mar-2013	
	Lab Number:	1111669.11	1111669.12	1111669.13	1111669.14	
Individual Tests						
pH	pH Units	7.6	7.3	7.8	7.0	-
Electrical Conductivity (EC)	mS/m	20.6	25.3	16.5	26.2	-
Total Suspended Solids	g/m³	76	21	< 3	18	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	< 0.0010	0.0029	0.0010	0.0020	-
Dissolved Cadmium	g/m³	< 0.00005	< 0.00005	< 0.00005	< 0.00005	-
Dissolved Chromium	g/m³	< 0.0005	0.0012 #1	< 0.0005	0.0011	-
Dissolved Copper	g/m³	0.0025	0.0056	0.0008	0.0061	-
Dissolved Lead	g/m³	0.00010	0.00105	< 0.00010	0.00147	-
Dissolved Nickel	g/m³	< 0.0005	0.0038	< 0.0005	0.0020	-
Dissolved Zinc	g/m³	0.0144	0.22	0.0052	0.150	-
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m³	0.0015	0.0037	0.0013	0.0022	-
Total Cadmium	g/m³	< 0.000053	< 0.000053	< 0.000053	< 0.000053	-
Total Chromium	g/m³	0.00129	0.00108 #1	< 0.00053	0.00146	-
Total Copper	g/m³	0.0098	0.0079	0.00152	0.0095	-
Total Lead	g/m³	0.0047	0.00166	0.00043	0.0021	-
Total Nickel	g/m³	0.00118	0.0046	< 0.00053	0.0023	-
Total Zinc	g/m³	0.114	0.30	0.0125	0.20	-
BTEX in Water by Headspace GC-MS						
Benzene	g/m³	< 0.0010	< 0.0010	< 0.0010	0.100	-
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	0.93	-
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010	0.065	-
m&p-Xylene	g/m³	< 0.002	< 0.002	< 0.002	0.66	-
o-Xylene	g/m³	< 0.0010	< 0.0010	< 0.0010	0.33	-
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m³	< 0.00010	< 0.00010	< 0.00010	0.00029	-
Acenaphthylene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	-
Anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	-
Benzo[a]anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	-
Benzo[a]pyrene (BAP)	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	-
Benzo[g,h,i]perylene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	-
Benzo[k]fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	-
Chrysene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	-
Dibenzo[a,h]anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	-
Fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	-
Fluorene	g/m³	< 0.0002	< 0.0002	< 0.0002	0.0008	-
Indeno(1,2,3-c,d)pyrene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	-
Naphthalene	g/m³	< 0.0005	< 0.0005	< 0.0005	0.0152	-
Phenanthrene	g/m³	< 0.0004	< 0.0004	< 0.0004	0.0006	-
Pyrene	g/m³	0.0003	0.0003	< 0.0002	0.0007	-

Sample Type: Aqueous

Sample Name:		HCR SW04 14-Mar-2013	HCR SW05 14-Mar-2013	HCR SW06 14-Mar-2013	HCR SW07 14-Mar-2013	
Lab Number:		1111669.11	1111669.12	1111669.13	1111669.14	
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m^3	< 0.10	< 0.10	< 0.10	2.2	-
C10 - C14	g/m^3	< 0.2	< 0.2	< 0.2	1.6	-
C15 - C36	g/m^3	< 0.4	< 0.4	< 0.4	1.1	-
Total hydrocarbons (C7 - C36)	g/m^3	< 0.7	< 0.7	< 0.7	4.9	-

Analyst's Comments

[#1] It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms
Total Petroleum Hydrocarbon Chromatograms

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Samples
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm filtration, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	-	1-14
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn	Nitric acid digestion, ICP-MS, trace level	-	1-14
BTEX in Water by Headspace GC-MS	Headspace GC-MS analysis, US EPA 8260B	-	1-14
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq	Liquid / liquid extraction, SPE (if required), GC-MS SIM analysis	-	1-14
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines	-	1-14
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 21st ed. 2005.	-	1-14
pH	pH meter. APHA 4500-H^+ B 21st ed. 2005.	0.1 pH Units	1-14
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21st ed. 2005.	0.1 mS/m	1-14
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21st ed. 2005.	3 g/m^3	1-14

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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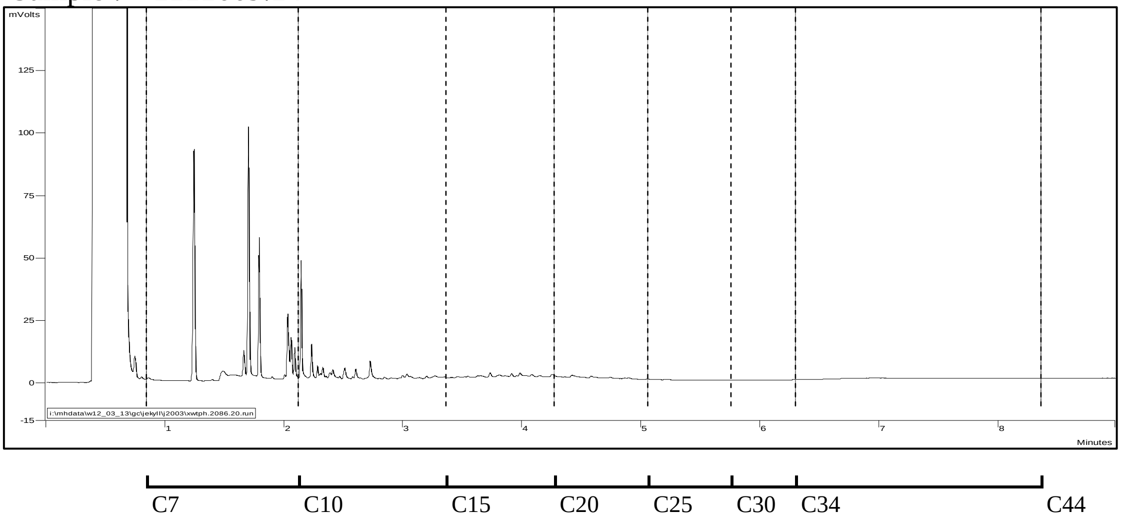
Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental Division

Submission #44770

Sample : 1111669.14



Submission #44770

Hill Laboratories

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ANALYSIS REPORT

SPv1

Client:	Pattle Delamore Partners Ltd	**Lab No:**	1116799
Contact:	H Easton	**Date Registered:**	28-Mar-2013
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	08-Apr-2013
	PO Box 9528	**Quote No:**	53670
	Newmarket	**Order No:**	
	AUCKLAND 1149	**Client Reference:**	A02579800
		Submitted By:	Paul Churchill

Sample Type: Aqueous

Sample Name:		HBK SW 006a 26-Mar-2013	HBK SW 007a 26-Mar-2013	HBK SW 008a 26-Mar-2013	HBK SW 009a 26-Mar-2013	HBK SW 010a 26-Mar-2013
Lab Number:		1116799.1	1116799.2	1116799.3	1116799.4	1116799.5
Individual Tests						
pH	pH Units	7.5	7.0	-	-	-
Electrical Conductivity (EC)	mS/m	20.1	22.6	-	-	-
Total Suspended Solids	g/m³	7	10	20	10	7
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	< 0.0010	< 0.0010	-	-	-
Dissolved Cadmium	g/m³	< 0.00005	< 0.00005	-	-	-
Dissolved Chromium	g/m³	< 0.0005	0.0015	-	-	-
Dissolved Copper	g/m³	0.0013	0.0031	-	-	-
Dissolved Lead	g/m³	0.00022	0.00058	-	-	-
Dissolved Nickel	g/m³	< 0.0005	0.0024	-	-	-
Dissolved Zinc	g/m³	0.0198	0.122	-	-	-
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m³	< 0.0011	< 0.0011	-	-	-
Total Cadmium	g/m³	< 0.000053	< 0.000053	-	-	-
Total Chromium	g/m³	0.00055	0.0021	-	-	-
Total Copper	g/m³	0.0030	0.0060	-	-	-
Total Lead	g/m³	0.00177	0.00174	-	-	-
Total Nickel	g/m³	< 0.00053	0.0030	-	-	-
Total Zinc	g/m³	0.035	0.21	-	-	-
BTEX in Water by Headspace GC-MS						
Benzene	g/m³	< 0.0010	0.0060	-	-	-
Toluene	g/m³	< 0.0010	0.124	-	-	-
Ethylbenzene	g/m³	< 0.0010	0.0138	-	-	-
m&p-Xylene	g/m³	< 0.002	0.189	-	-	-
o-Xylene	g/m³	< 0.0010	0.119	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m³	< 0.00010	< 0.00010	-	-	-
Acenaphthylene	g/m³	< 0.00010	< 0.00010	-	-	-
Anthracene	g/m³	0.00012	< 0.00010	-	-	-
Benzo[a]anthracene	g/m³	< 0.00010	< 0.00010	-	-	-
Benzo[a]pyrene (BAP)	g/m³	< 0.00010	< 0.00010	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	< 0.00010	< 0.00010	-	-	-
Benzo[g,h,i]perylene	g/m³	< 0.00010	< 0.00010	-	-	-
Benzo[k]fluoranthene	g/m³	< 0.00010	< 0.00010	-	-	-
Chrysene	g/m³	< 0.00010	< 0.00010	-	-	-
Dibenzo[a,h]anthracene	g/m³	< 0.00010	< 0.00010	-	-	-

Sample Type: Aqueous						
Sample Name:		HBK SW 006a 26-Mar-2013	HBK SW 007a 26-Mar-2013	HBK SW 008a 26-Mar-2013	HBK SW 009a 26-Mar-2013	HBK SW 010a 26-Mar-2013
Lab Number:		1116799.1	1116799.2	1116799.3	1116799.4	1116799.5
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Fluoranthene	g/m³	0.00011	< 0.00010	-	-	-
Fluorene	g/m³	< 0.0002	< 0.0002	-	-	-
Indeno(1,2,3-c,d)pyrene	g/m³	< 0.00010	< 0.00010	-	-	-
Naphthalene	g/m³	< 0.0005	< 0.0005	-	-	-
Phenanthrene	g/m³	< 0.0004	< 0.0004	-	-	-
Pyrene	g/m³	0.0025	0.0015	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	0.43	< 0.10	< 0.10	0.26
C10 - C14	g/m³	1.3	0.4	< 0.2	1.4	0.2
C15 - C36	g/m³	32	4.1	< 0.4	30	2.0
Total hydrocarbons (C7 - C36)	g/m³	33	5.0	< 0.7	31	2.5

Sample Name:		HBK SW Aa 26-Mar-2013				
Lab Number:		1116799.6				
Individual Tests						
pH	pH Units	6.9	-	-	-	-
Electrical Conductivity (EC)	mS/m	22.6	-	-	-	-
Total Suspended Solids	g/m³	9	-	-	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	< 0.0010	-	-	-	-
Dissolved Cadmium	g/m³	< 0.00005	-	-	-	-
Dissolved Chromium	g/m³	0.0015	-	-	-	-
Dissolved Copper	g/m³	0.0035	-	-	-	-
Dissolved Lead	g/m³	0.00059	-	-	-	-
Dissolved Nickel	g/m³	0.0023	-	-	-	-
Dissolved Zinc	g/m³	0.129	-	-	-	-
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m³	< 0.0011	-	-	-	-
Total Cadmium	g/m³	< 0.000053	-	-	-	-
Total Chromium	g/m³	0.00140	-	-	-	-
Total Copper	g/m³	0.0053	-	-	-	-
Total Lead	g/m³	0.00167	-	-	-	-
Total Nickel	g/m³	0.0026	-	-	-	-
Total Zinc	g/m³	0.20	-	-	-	-
BTEX in Water by Headspace GC-MS						
Benzene	g/m³	0.0063	-	-	-	-
Toluene	g/m³	0.130	-	-	-	-
Ethylbenzene	g/m³	0.0150	-	-	-	-
m&p-Xylene	g/m³	0.20	-	-	-	-
o-Xylene	g/m³	0.127	-	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m³	< 0.00010	-	-	-	-
Acenaphthylene	g/m³	< 0.00010	-	-	-	-
Anthracene	g/m³	< 0.00010	-	-	-	-
Benzo[a]anthracene	g/m³	< 0.00010	-	-	-	-
Benzo[a]pyrene (BAP)	g/m³	< 0.00010	-	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	< 0.00010	-	-	-	-
Benzo[g,h,i]perylene	g/m³	< 0.00010	-	-	-	-
Benzo[k]fluoranthene	g/m³	< 0.00010	-	-	-	-
Chrysene	g/m³	< 0.00010	-	-	-	-
Dibenzo[a,h]anthracene	g/m³	< 0.00010	-	-	-	-
Fluoranthene	g/m³	< 0.00010	-	-	-	-
Fluorene	g/m³	< 0.0002	-	-	-	-
Indeno(1,2,3-c,d)pyrene	g/m³	< 0.00010	-	-	-	-

Sample Type: Aqueous						
Sample Name:		HBK SW Aa 26-Mar-2013				
Lab Number:		1116799.6				
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Naphthalene	g/m^3	< 0.0005	-	-	-	-
Phenanthrene	g/m^3	< 0.0004	-	-	-	-
Pyrene	g/m^3	0.0015	-	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m^3	0.45	-	-	-	-
C10 - C14	g/m^3	0.4	-	-	-	-
C15 - C36	g/m^3	4.7	-	-	-	-
Total hydrocarbons (C7 - C36)	g/m^3	5.6	-	-	-	-

Analyst's Comments

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

Appendix No.2 - Total Petroleum Hydrocarbon Chromatograms

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Samples
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm filtration, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	-	1-2, 6
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn	Nitric acid digestion, ICP-MS, trace level	-	1-2, 6
BTEX in Water by Headspace GC-MS	Headspace GC-MS analysis, US EPA 8260B	-	1-2, 6
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq	Liquid / liquid extraction, SPE (if required), GC-MS SIM analysis	-	1-2, 6
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines	-	1-6
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 21st ed. 2005.	-	1-2, 6
pH	pH meter. APHA 4500-H^+ B 21st ed. 2005.	0.1 pH Units	1-2, 6
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21st ed. 2005.	0.1 mS/m	1-2, 6
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21st ed. 2005.	3 g/m^3	1-6

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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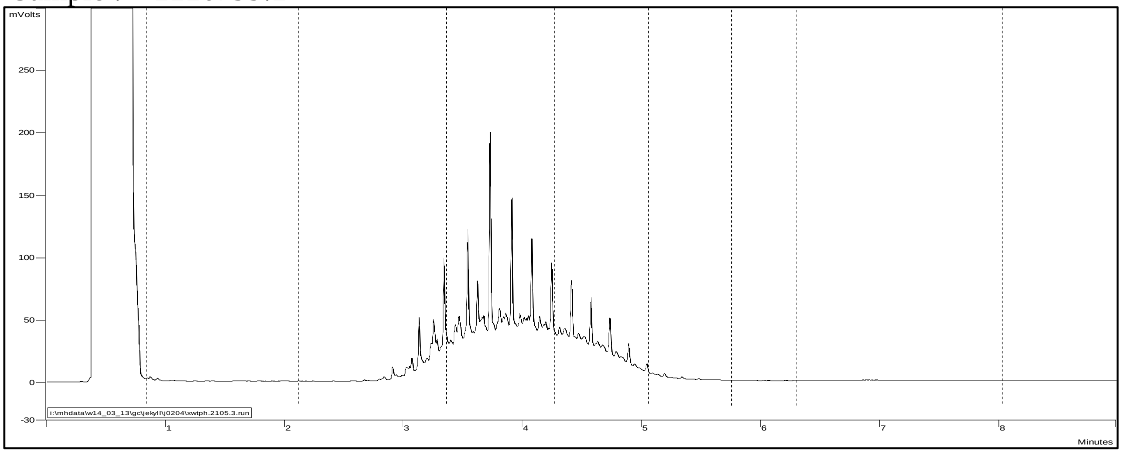
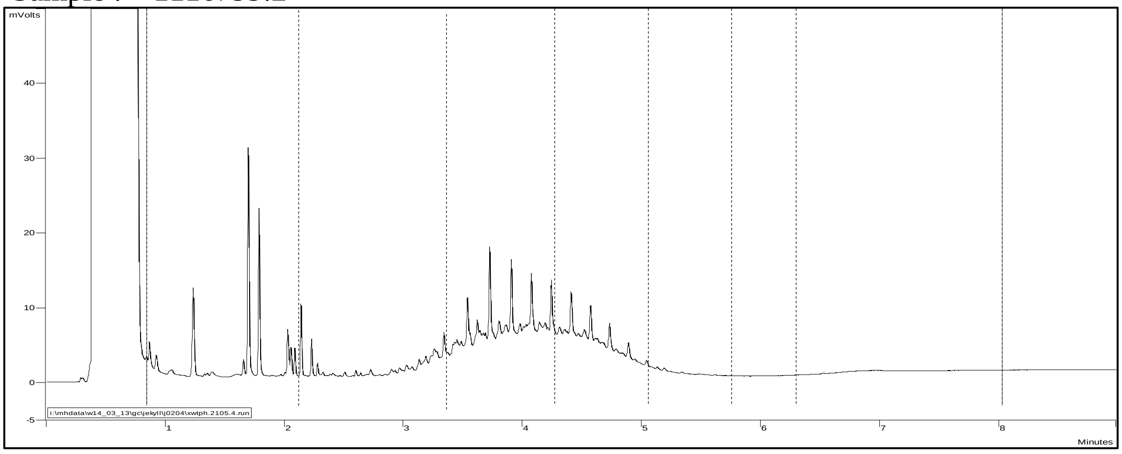
Client Services Manager - Environmental Division

Submission #44770

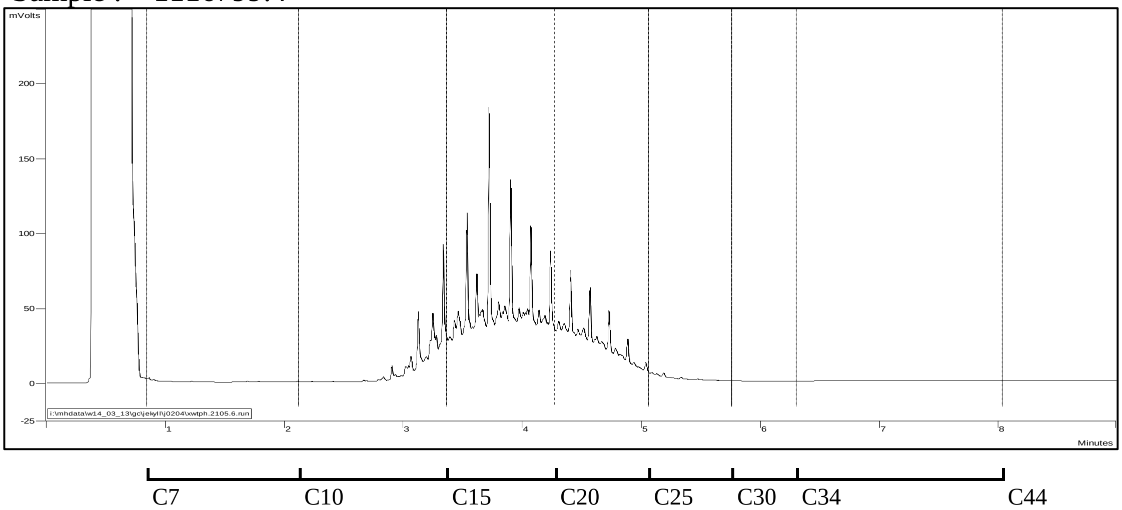
Sample : 1116799.1



Sample : 1116799.2

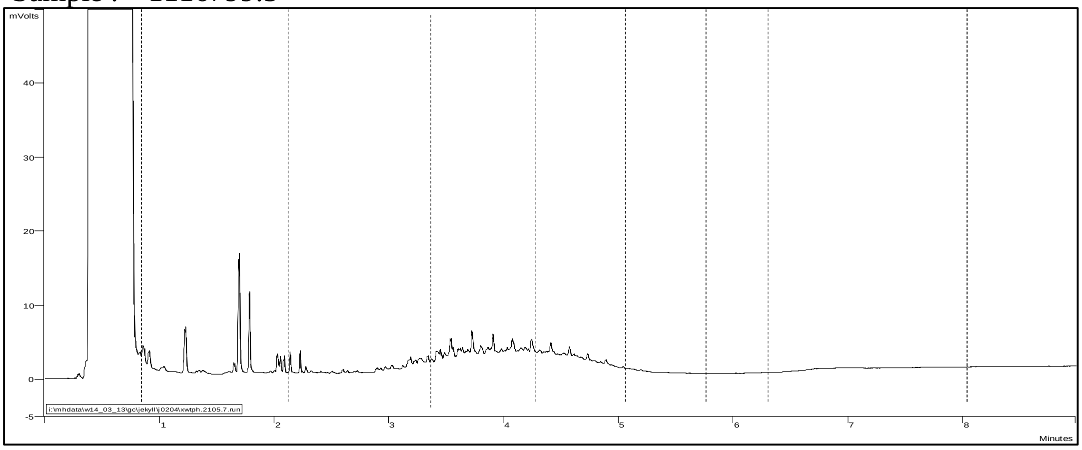


Sample : 1116799.4

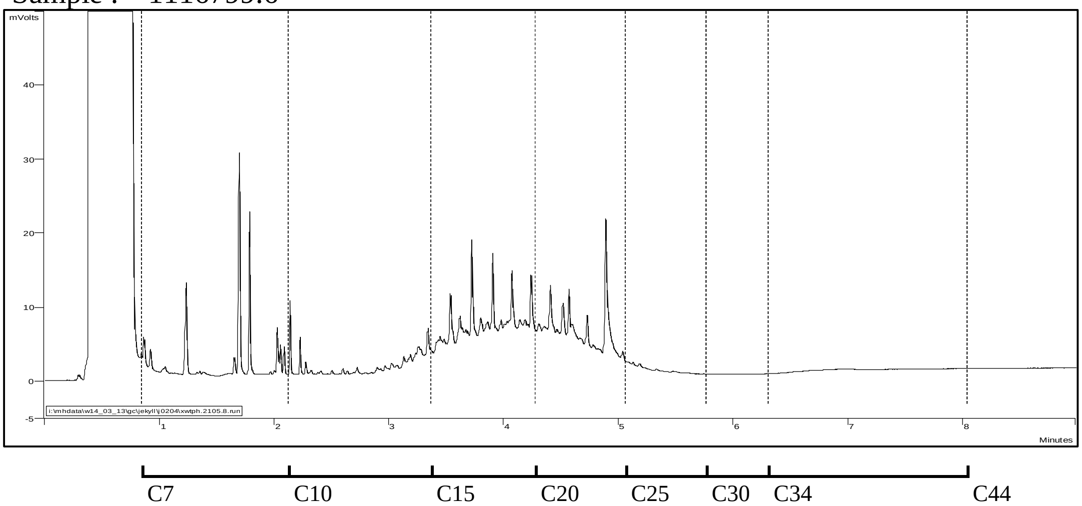


Submission #44770

Sample : 1116799.5



Sample : 1116799.6



Submission #44770

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ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	1116808 SPv1
Contact:	H Easton	**Date Registered:**	28-Mar-2013
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	08-Apr-2013
	PO Box 9528	**Quote No:**	53670
	Newmarket	**Order No:**	
	AUCKLAND 1149	**Client Reference:**	A02579800
		Submitted By:	Paul Churchill

Sample Type: Aqueous

Sample Name:		LAK SW 007 27-Mar-2013	LAK SW 008 27-Mar-2013	LAK SW 009 27-Mar-2013	LAK SW 010 27-Mar-2013	
Lab Number:		1116808.1	1116808.2	1116808.3	1116808.4	
Individual Tests						
pH	pH Units	7.2	-	-	-	-
Electrical Conductivity (EC)	mS/m	17.0	-	-	-	-
Total Suspended Solids	g/m³	9	5	18	17	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	< 0.0010	-	-	-	-
Dissolved Cadmium	g/m³	< 0.00005	-	-	-	-
Dissolved Chromium	g/m³	< 0.0005	-	-	-	-
Dissolved Copper	g/m³	0.0018	-	-	-	-
Dissolved Lead	g/m³	0.00013	-	-	-	-
Dissolved Nickel	g/m³	< 0.0005	-	-	-	-
Dissolved Zinc	g/m³	0.039	-	-	-	-
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m³	0.0012	-	-	-	-
Total Cadmium	g/m³	< 0.000053	-	-	-	-
Total Chromium	g/m³	0.00056	-	-	-	-
Total Copper	g/m³	0.0030	-	-	-	-
Total Lead	g/m³	0.00067	-	-	-	-
Total Nickel	g/m³	< 0.00053	-	-	-	-
Total Zinc	g/m³	0.055	-	-	-	-
BTEX in Water by Headspace GC-MS						
Benzene	g/m³	< 0.0010	-	-	-	-
Toluene	g/m³	0.0010	-	-	-	-
Ethylbenzene	g/m³	< 0.0010	-	-	-	-
m&p-Xylene	g/m³	< 0.002	-	-	-	-
o-Xylene	g/m³	< 0.0010	-	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m³	< 0.00010	-	-	-	-
Acenaphthylene	g/m³	< 0.00010	-	-	-	-
Anthracene	g/m³	< 0.00010	-	-	-	-
Benzo[a]anthracene	g/m³	< 0.00010	-	-	-	-
Benzo[a]pyrene (BAP)	g/m³	< 0.00010	-	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	< 0.00010	-	-	-	-
Benzo[g,h,i]perylene	g/m³	< 0.00010	-	-	-	-
Benzo[k]fluoranthene	g/m³	< 0.00010	-	-	-	-
Chrysene	g/m³	< 0.00010	-	-	-	-
Dibenzo[a,h]anthracene	g/m³	< 0.00010	-	-	-	-

Sample Type: Aqueous

Sample Name:		LAK SW 007 27-Mar-2013	LAK SW 008 27-Mar-2013	LAK SW 009 27-Mar-2013	LAK SW 010 27-Mar-2013	
Lab Number:		1116808.1	1116808.2	1116808.3	1116808.4	
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Fluoranthene	g/m^3	< 0.00010	-	-	-	-
Fluorene	g/m^3	< 0.0002	-	-	-	-
Indeno(1,2,3-c,d)pyrene	g/m^3	< 0.00010	-	-	-	-
Naphthalene	g/m^3	< 0.0005	-	-	-	-
Phenanthrene	g/m^3	< 0.0004	-	-	-	-
Pyrene	g/m^3	0.0002	-	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m^3	< 0.10	< 0.10	< 0.10	< 0.10	-
C10 - C14	g/m^3	< 0.2	< 0.2	0.4	< 0.2	-
C15 - C36	g/m^3	0.6	0.9	2.3	< 0.4	-
Total hydrocarbons (C7 - C36)	g/m^3	< 0.7	0.9	2.7	< 0.7	-

Analyst's Comments

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Samples
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm filtration, ICP-MS, trace level. APHA 3125 B 21^{st} ed. 2005.	-	1
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn	Nitric acid digestion, ICP-MS, trace level	-	1
BTEX in Water by Headspace GC-MS	Headspace GC-MS analysis, US EPA 8260B	-	1
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq	Liquid / liquid extraction, SPE (if required), GC-MS SIM analysis	-	1
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines	-	1-4
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 21^{st} ed. 2005.	-	1
pH	pH meter. APHA 4500-H^+ B 21^{st} ed. 2005.	0.1 pH Units	1
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21^{st} ed. 2005.	0.1 mS/m	1
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21^{st} ed. 2005.	3 g/m^3	1-4

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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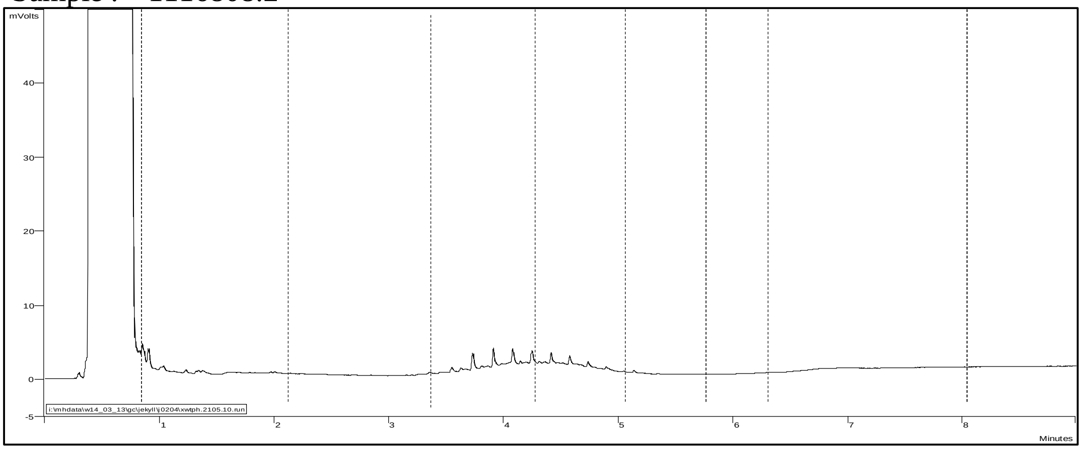
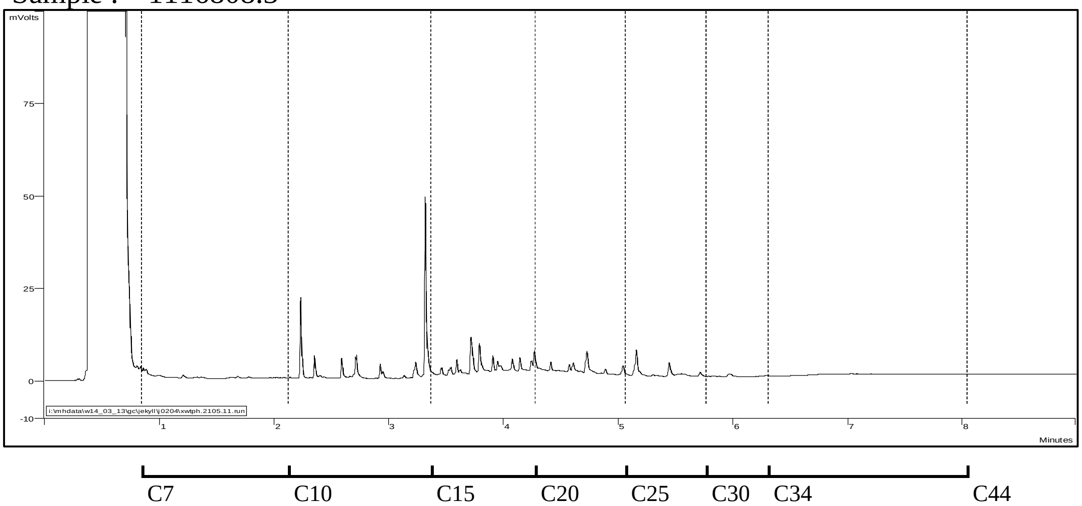
Client Services Manager - Environmental Division

Submission #44770

Sample : 1116808.2



Sample : 1116808.3



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ANALYSIS REPORT

Client:	Pattle Delamore Partners Ltd	**Lab No:**	1116817 SPv1
Contact:	H Easton	**Date Registered:**	28-Mar-2013
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	08-Apr-2013
	PO Box 9528	**Quote No:**	53670
	Newmarket	**Order No:**	
	AUCKLAND 1149	**Client Reference:**	A02579800
		Submitted By:	Paul Churchill

Sample Type: Aqueous

Sample Name:		LAK SW 001	LAK SW 002	LAK SW 003	LAK SW 004	LAK SW 005
Lab Number:		1116817.1	1116817.2	1116817.3	1116817.4	1116817.5
Individual Tests						
pH	pH Units	8.0	8.0	7.9	7.9	7.1
Electrical Conductivity (EC)	mS/m	18.2	16.7	15.7	17.7	17.2
Total Suspended Solids	g/m^3	49	18	3	9	15
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.0013
Dissolved Cadmium	g/m^3	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved Chromium	g/m^3	0.0007	0.0006	0.0008	0.0007	0.0014
Dissolved Copper	g/m^3	0.0018	0.0006	0.0017	0.0026	0.0080
Dissolved Lead	g/m^3	0.00012	< 0.00010	0.00023	0.00020	0.00094
Dissolved Nickel	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0011
Dissolved Zinc	g/m^3	0.0135	0.0065	0.0033	0.0147	0.55
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m^3	< 0.0011	< 0.0011	< 0.0011	< 0.0011	0.0017
Total Cadmium	g/m^3	< 0.000053	< 0.000053	< 0.000053	< 0.000053	< 0.000053
Total Chromium	g/m^3	0.00177	0.00117	0.00081	0.00118	0.0021
Total Copper	g/m^3	0.0086	0.00137	0.0173	0.0042	0.0126
Total Lead	g/m^3	0.0032	0.00069	0.00192	0.00109	0.0023
Total Nickel	g/m^3	0.00105	< 0.00053	< 0.00053	< 0.00053	0.00138
Total Zinc	g/m^3	0.087	0.0188	0.0124	0.039	0.72
BTEX in Water by Headspace GC-MS						
Benzene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.0052
Ethylbenzene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
m&p-Xylene	g/m^3	< 0.002	< 0.002	< 0.002	< 0.002	0.002
o-Xylene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.0014
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Acenaphthylene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Anthracene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[a]anthracene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[a]pyrene (BAP)	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[g,h,i]perylene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[k]fluoranthene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Chrysene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Dibenzo[a,h]anthracene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Fluoranthene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010

Sample Type: Aqueous						
	Sample Name:	LAK SW 001	LAK SW 002	LAK SW 003	LAK SW 004	LAK SW 005
	Lab Number:	1116817.1	1116817.2	1116817.3	1116817.4	1116817.5
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Fluorene	g/m³	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Indeno(1,2,3-c,d)pyrene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Naphthalene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Phenanthrene	g/m³	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Pyrene	g/m³	< 0.0002	< 0.0002	< 0.0002	0.0003	0.0004
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2	0.6
C15 - C36	g/m³	< 0.4	< 0.4	< 0.4	2.6	2.7
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	< 0.7	2.6	3.3

	Sample Name:	LAK SW 006				
	Lab Number:	1116817.6				
Individual Tests						
pH	pH Units	7.9	-	-	-	-
Electrical Conductivity (EC)	mS/m	16.7	-	-	-	-
Total Suspended Solids	g/m³	3	-	-	-	-
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	< 0.0010	-	-	-	-
Dissolved Cadmium	g/m³	< 0.00005	-	-	-	-
Dissolved Chromium	g/m³	< 0.0005	-	-	-	-
Dissolved Copper	g/m³	0.0010	-	-	-	-
Dissolved Lead	g/m³	< 0.00010	-	-	-	-
Dissolved Nickel	g/m³	< 0.0005	-	-	-	-
Dissolved Zinc	g/m³	0.0076	-	-	-	-
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m³	< 0.0011	-	-	-	-
Total Cadmium	g/m³	< 0.000053	-	-	-	-
Total Chromium	g/m³	0.00066	-	-	-	-
Total Copper	g/m³	0.00131	-	-	-	-
Total Lead	g/m³	0.00025	-	-	-	-
Total Nickel	g/m³	< 0.00053	-	-	-	-
Total Zinc	g/m³	0.0140	-	-	-	-
BTEX in Water by Headspace GC-MS						
Benzene	g/m³	< 0.0010	-	-	-	-
Toluene	g/m³	< 0.0010	-	-	-	-
Ethylbenzene	g/m³	< 0.0010	-	-	-	-
m&p-Xylene	g/m³	< 0.002	-	-	-	-
o-Xylene	g/m³	< 0.0010	-	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m³	< 0.00010	-	-	-	-
Acenaphthylene	g/m³	< 0.00010	-	-	-	-
Anthracene	g/m³	< 0.00010	-	-	-	-
Benzo[a]anthracene	g/m³	< 0.00010	-	-	-	-
Benzo[a]pyrene (BAP)	g/m³	< 0.00010	-	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	< 0.00010	-	-	-	-
Benzo[g,h,i]perylene	g/m³	< 0.00010	-	-	-	-
Benzo[k]fluoranthene	g/m³	< 0.00010	-	-	-	-
Chrysene	g/m³	< 0.00010	-	-	-	-
Dibenzo[a,h]anthracene	g/m³	< 0.00010	-	-	-	-
Fluoranthene	g/m³	< 0.00010	-	-	-	-
Fluorene	g/m³	< 0.0002	-	-	-	-
Indeno(1,2,3-c,d)pyrene	g/m³	< 0.00010	-	-	-	-
Naphthalene	g/m³	< 0.0005	-	-	-	-

Sample Type: Aqueous						
	Sample Name:	LAK SW 006				
	Lab Number:	1116817.6				
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Phenanthrene	g/m^3	< 0.0004	-	-	-	-
Pyrene	g/m^3	< 0.0002	-	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m^3	< 0.10	-	-	-	-
C10 - C14	g/m^3	< 0.2	-	-	-	-
C15 - C36	g/m^3	< 0.4	-	-	-	-
Total hydrocarbons (C7 - C36)	g/m^3	< 0.7	-	-	-	-

Analyst's Comments

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Samples
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm filtration, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	-	1-6
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn	Nitric acid digestion, ICP-MS, trace level	-	1-6
BTEX in Water by Headspace GC-MS	Headspace GC-MS analysis, US EPA 8260B	-	1-6
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq	Liquid / liquid extraction, SPE (if required), GC-MS SIM analysis	-	1-6
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines	-	1-6
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 21st ed. 2005.	-	1-6
pH	pH meter. APHA 4500-H^+ B 21st ed. 2005.	0.1 pH Units	1-6
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21st ed. 2005.	0.1 mS/m	1-6
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21st ed. 2005.	3 g/m^3	1-6

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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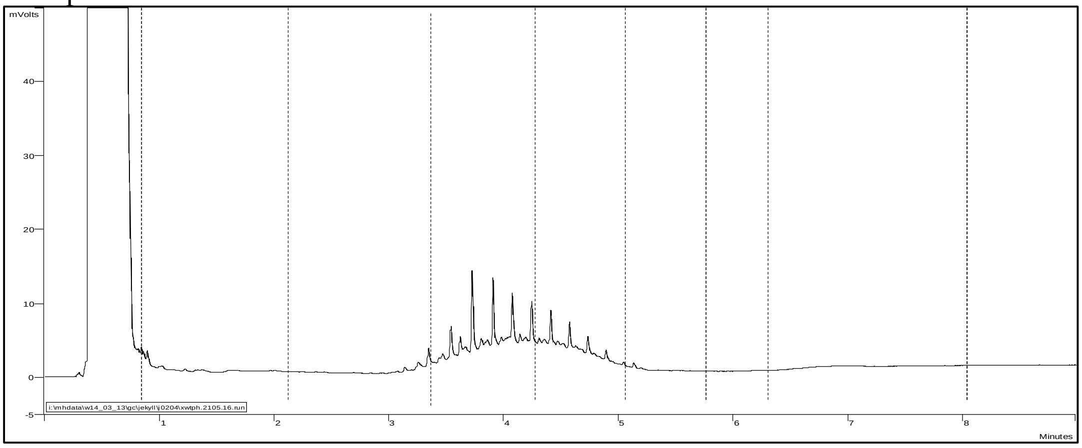
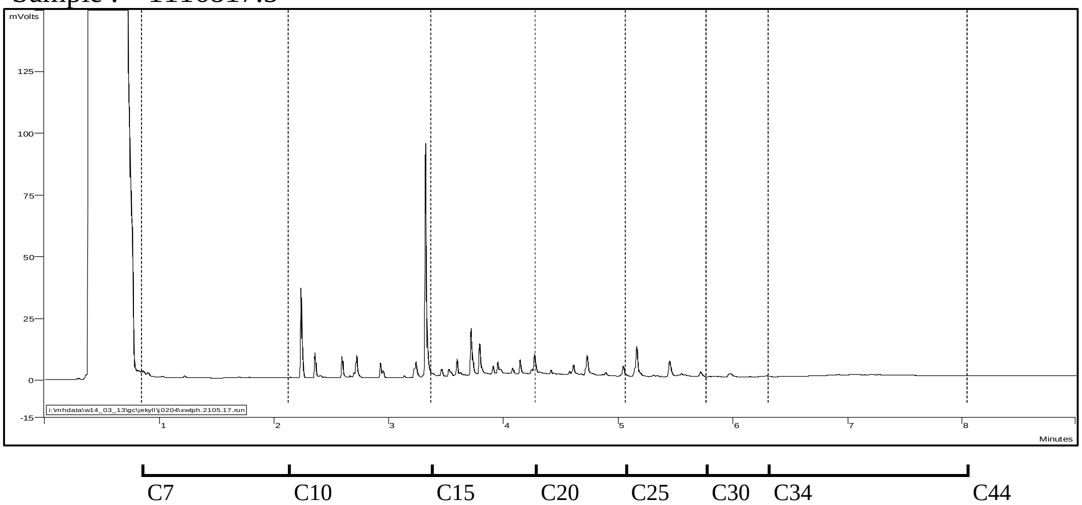
Peter Robinson MSc (Hons), PhD, FNZIC
Client Services Manager - Environmental Division

Submission #44770

Sample : 1116817.4



Sample : 1116817.5



Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

SPv1

Client:	Pattle Delamore Partners Ltd	**Lab No:**	1116854
Contact:	H Easton	**Date Registered:**	28-Mar-2013
	C/- Pattle Delamore Partners Ltd	**Date Reported:**	08-Apr-2013
	PO Box 9528	**Quote No:**	53670
	Newmarket	**Order No:**	
	AUCKLAND 1149	**Client Reference:**	A02579800
		Submitted By:	Paul Churchill

Sample Type: Aqueous

Sample Name:		HBK SW 001a	HBK SW 002a	HBK SW 003a	HBK SW 004a	HBK SW 005a
Lab Number:		1116854.1	1116854.2	1116854.3	1116854.4	1116854.5
Individual Tests						
pH	pH Units	7.5	7.7	8.2	7.2	7.2
Electrical Conductivity (EC)	mS/m	16.4	15.7	15.6	36.6	18.5
Total Suspended Solids	g/m³	30	10	< 3	18	8
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Dissolved Cadmium	g/m³	0.00008	< 0.00005	< 0.00005	0.00005	< 0.00005
Dissolved Chromium	g/m³	< 0.0005	0.0005	0.0006	0.0008	0.0012
Dissolved Copper	g/m³	0.0022	0.0006	0.0006	0.0050	0.0026
Dissolved Lead	g/m³	0.00016	< 0.00010	0.00013	0.00050	0.00050
Dissolved Nickel	g/m³	< 0.0005	< 0.0005	< 0.0005	0.0013	0.0022
Dissolved Zinc	g/m³	0.086	0.020	0.0031	0.040	0.25
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Arsenic	g/m³	0.0011	< 0.0011	< 0.0011	0.0012	< 0.0011
Total Cadmium	g/m³	0.000154	< 0.000053	< 0.000053	0.000105	< 0.000053
Total Chromium	g/m³	0.00182	0.00093	0.033	0.00179	0.00177
Total Copper	g/m³	0.0057	0.00087	0.0027	0.0120	0.0041
Total Lead	g/m³	0.0056	0.00089	0.00033	0.0048	0.00085
Total Nickel	g/m³	0.00129	< 0.00053	0.0027	0.00183	0.0028
Total Zinc	g/m³	0.21	0.035	0.0033	0.110	0.35
BTEX in Water by Headspace GC-MS						
Benzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m³	< 0.0010	0.0030	< 0.0010	0.0070	0.0035
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010	0.0010	0.0018
m&p-Xylene	g/m³	< 0.002	< 0.002	< 0.002	0.004	0.012
o-Xylene	g/m³	< 0.0010	< 0.0010	< 0.0010	0.0025	0.0052
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Acenaphthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Acenaphthylene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[a]anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[a]pyrene (BAP)	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[g,h,i]perylene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Benzo[k]fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Chrysene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Dibenzo[a,h]anthracene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Fluoranthene	g/m³	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010

Sample Type: Aqueous						
	Sample Name:	HBK SW 001a	HBK SW 002a	HBK SW 003a	HBK SW 004a	HBK SW 005a
	Lab Number:	1116854.1	1116854.2	1116854.3	1116854.4	1116854.5
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq						
Fluorene	g/m^3	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Indeno(1,2,3-c,d)pyrene	g/m^3	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Naphthalene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Phenanthrene	g/m^3	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Pyrene	g/m^3	< 0.0002	< 0.0002	< 0.0002	0.0018	0.0009
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m^3	< 0.2	< 0.2	< 0.2	3.8	< 0.2
C15 - C36	g/m^3	< 0.4	< 0.4	< 0.4	72	1.5
Total hydrocarbons (C7 - C36)	g/m^3	< 0.7	< 0.7	< 0.7	76	1.5

Analyst's Comments

Appendix No.1 - Total Petroleum Hydrocarbon Chromatograms

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Samples
Heavy metals, dissolved, trace As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm filtration, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	-	1-5
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn	Nitric acid digestion, ICP-MS, trace level	-	1-5
BTEX in Water by Headspace GC-MS	Headspace GC-MS analysis, US EPA 8260B	-	1-5
Polycyclic Aromatic Hydrocarbons Screening in Water, By Liq/Liq	Liquid / liquid extraction, SPE (if required), GC-MS SIM analysis	-	1-5
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines	-	1-5
Total Digestion	Boiling nitric acid digestion. APHA 3030 E 21st ed. 2005.	-	1-5
pH	pH meter. APHA 4500-H^+ B 21st ed. 2005.	0.1 pH Units	1-5
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21st ed. 2005.	0.1 mS/m	1-5
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21st ed. 2005.	3 g/m^3	1-5

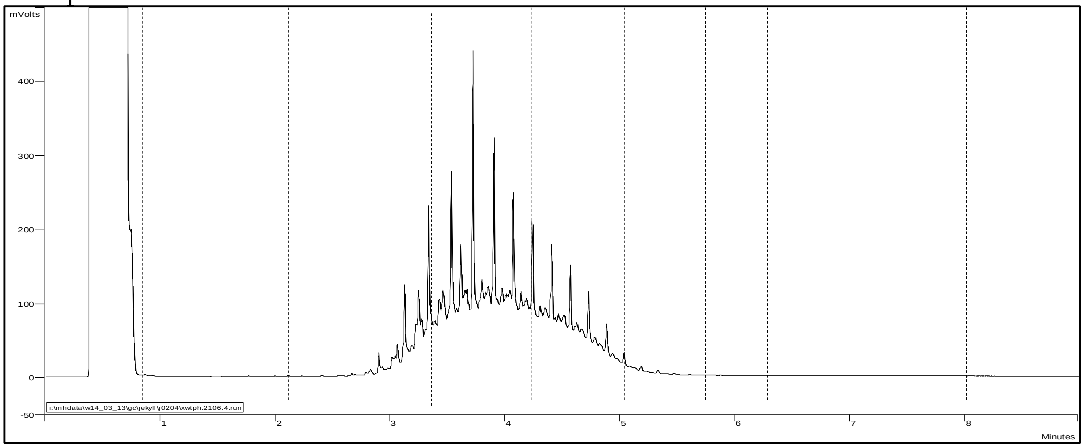
These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

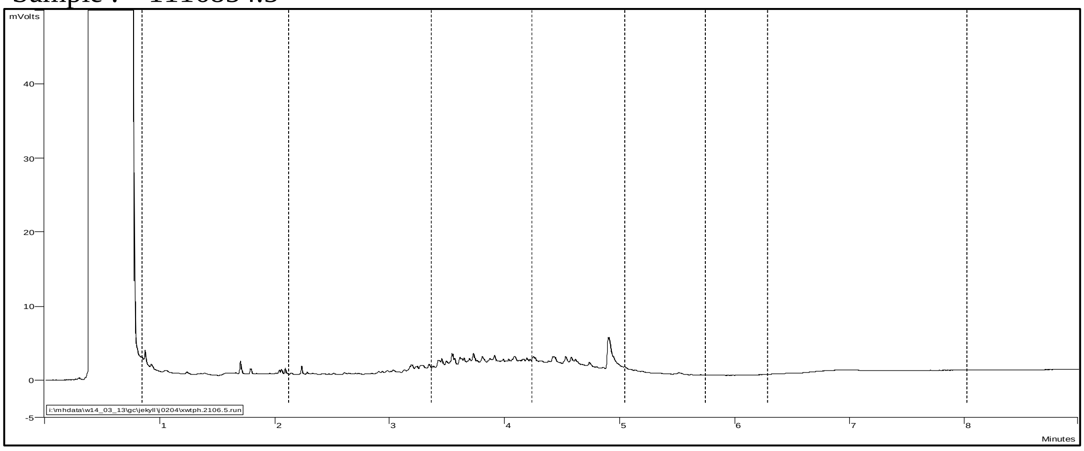
Peter Robinson MSc (Hons), PhD, FNZIC
Client Services Manager - Environmental Division

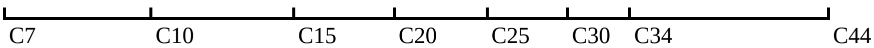
Submission #44770

Sample : 1116854.4



Sample : 1116854.5





Submission #44770

Appendix D

Malvern Mastersizer 2000 Reports

Submission #44770

WAIKATO
Te Whare Wānanga o Waikato

The University of Waikato
Private Bag 3105
Hamilton, New Zealand

MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name: BROWNS ROAD FORECOURT

Sample Source & type:

Sample bulk lot ref: 2013008/1

SOP Name: Marine Sediment

Measured by: rodgers

Result Source: Edited

Measured: Wednesday, 30 January 2013 11:44:10 a.m.

Analysed: Wednesday, 30 January 2013 11:44:12 a.m.

Particle Name: Marine Sediment

Particle RI: 1.500

Dispersant Name: Water

Accessory Name: Hydro 2000G (A)

Absorption: 0.2

Dispersant RI: 1.330

Analysis model: General purpose

Size range: 0.020 to 2000.000 um

Weighted Residual: 0.503 %

Sensitivity: Enhanced

Obscuration: 17.83 %

Result Emulation: Off

Concentration: 0.0846 %Vol

Specific Surface Area: 0.214 m²/g

Span : 3.404

Surface Weighted Mean D[3,2]: 28.004 um

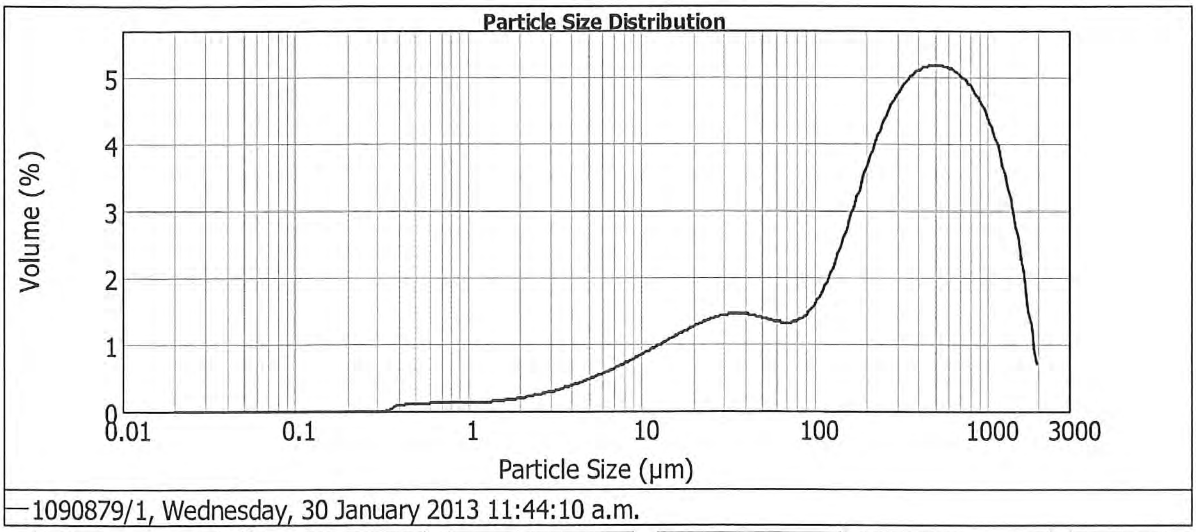
Uniformity: 1.04

Vol. Weighted Mean D[4,3]: 450.043 um

Result units: Volume

Standard Deviation 433.979 um

d(0.1): 17.756 um   d(0.5): 319.874 um   d(0.9): 1106.743 um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	0.980	0.71	37.000	16.52	105.000	26.06	300.000	48.00	840.000	81.90
0.060	0.00	2.000	1.39	44.000	18.16	125.000	28.16	350.000	52.88	1000.000	87.17
0.120	0.00	3.900	2.59	53.000	19.86	149.000	30.81	420.000	58.90	1190.000	91.89
0.240	0.00	7.800	4.95	63.000	21.38	177.000	34.06	500.000	64.77	1410.000	95.71
0.490	0.18	15.600	9.03	74.000	22.77	210.000	37.97	590.000	70.35	1680.000	98.57
0.700	0.44	31.000	14.85	88.000	24.30	250.000	42.60	710.000	76.50	2000.000	100.00

Operator notes:

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Te Whare Wānanga o Waikato

The University of Waikato
Private Bag 3105
Hamilton, New Zealand

MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name: BROWNS ROAD NON-FORECOURT
SOP Name: Marine Sediment
Measured: Wednesday, 30 January 2013 11:49:00 a.m.

Sample Source & type:

Measured by: rodgers
Analysed: Wednesday, 30 January 2013 11:49:02 a.m.

Sample bulk lot ref: 2013008/2
Result Source: Edited

Particle Name: Marine Sediment
Accessory Name: Hydro 2000G (A)
Analysis model: General purpose
Sensitivity: Enhanced

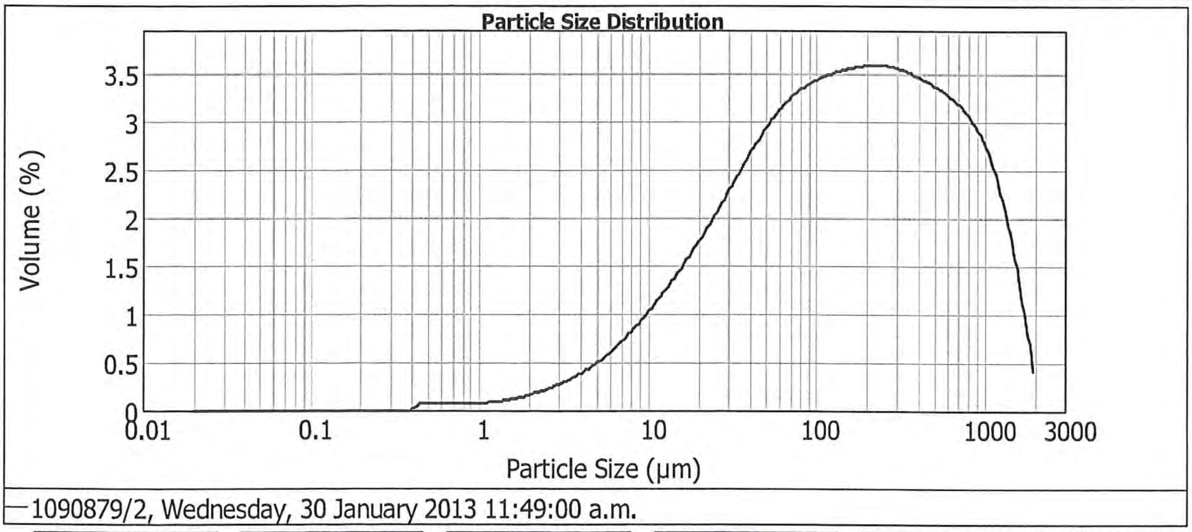
Particle RI: 1.500
Absorption: 0.2
Size range: 0.020 to 2000.000 um
Obscuration: 17.86 %

Dispersant Name: Water
Dispersant RI: 1.330
Weighted Residual: 0.148 %
Result Emulation: Off

Concentration: 0.0868 %Vol
Span : 5.875
Uniformity: 1.74
Result units: Volume

Specific Surface Area: 0.198 m²/g
Surface Weighted Mean D[3,2]: 30.334 um
Vol. Weighted Mean D[4,3]: 314.022 um
Standard Deviation 384.93 um

d(0.1): 16.229 um **d(0.5):** 148.911 um **d(0.9):** 891.046 um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	0.980	0.41	37.000	20.87	105.000	42.00	300.000	66.36	840.000	88.85
0.060	0.00	2.000	0.90	44.000	23.90	125.000	45.97	350.000	69.92	1000.000	92.15
0.120	0.00	3.900	2.01	53.000	27.41	149.000	50.01	420.000	74.06	1190.000	95.08
0.240	0.00	7.800	4.56	63.000	30.89	177.000	54.02	500.000	77.94	1410.000	97.42
0.490	0.07	15.600	9.62	74.000	34.28	210.000	58.02	590.000	81.54	1680.000	99.15
0.700	0.24	31.000	18.05	88.000	38.06	250.000	62.11	710.000	85.45	2000.000	100.00

Operator notes:

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ience and Engineering
The University of Waikato
Private Bag 3105
Hamilton, New Zealand

MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name: HIGHBROOK FORECOURT
Sample Source & type:
Sample bulk lot ref: 2013009/3

SOP Name: Marine Sediment
Measured by: rodgers
Result Source: Edited

Measured: Wednesday, 30 January 2013 4:02:33 p.m.
Analysed: Wednesday, 30 January 2013 4:02:35 p.m.

Particle Name: Marine Sediment
Particle RI: 1.500
Dispersant Name: Water

Accessory Name: Hydro 2000G (A)
Absorption: 0.2
Dispersant RI: 1.330

Analysis model: General purpose
Size range: 0.020 to 2000.000 um
Weighted Residual: 0.790 %

Sensitivity: Enhanced
Obscuration: 16.77 %
Result Emulation: Off

Concentration: 0.0193 %Vol
Specific Surface Area: 0.891 m²/g

Span : 4.718
Surface Weighted Mean D[3,2]: 6.731 um

Uniformity: 1.64
Vol. Weighted Mean D[4,3]: 50.692 um

Result units: Volume
Standard Deviation 76.487 um

d(0.1): 3.033 um **d(0.5):** 24.714 um **d(0.9):** 119.630 um

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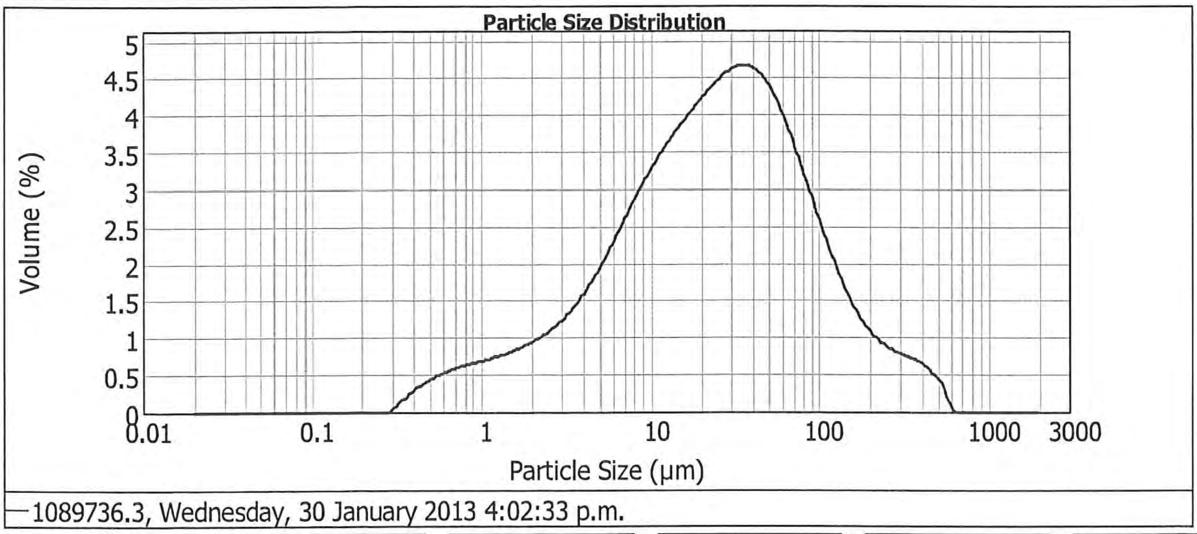

Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.050	0.00	0.980	3.38	37.000	62.13	105.000	88.08	300.000	97.48	840.000	100.00
0.060	0.00	2.000	7.07	44.000	67.38	125.000	90.58	350.000	98.24	1000.000	100.00
0.120	0.00	3.900	12.27	53.000	72.79	149.000	92.60	420.000	99.05	1190.000	100.00
0.240	0.00	7.800	21.97	63.000	77.45	177.000	94.17	500.000	99.66	1410.000	100.00
0.490	0.78	15.600	37.39	74.000	81.34	210.000	95.43	590.000	100.00	1680.000	100.00
0.700	1.98	31.000	56.75	88.000	84.98	250.000	96.50	710.000	100.00	2000.000	100.00

Operator notes:

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Private Bag 3105
Hamilton, New Zealand

MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name: HIGHBROOK NON-FORECOURT
Sample Source & type:
Sample bulk lot ref: 2013009/4

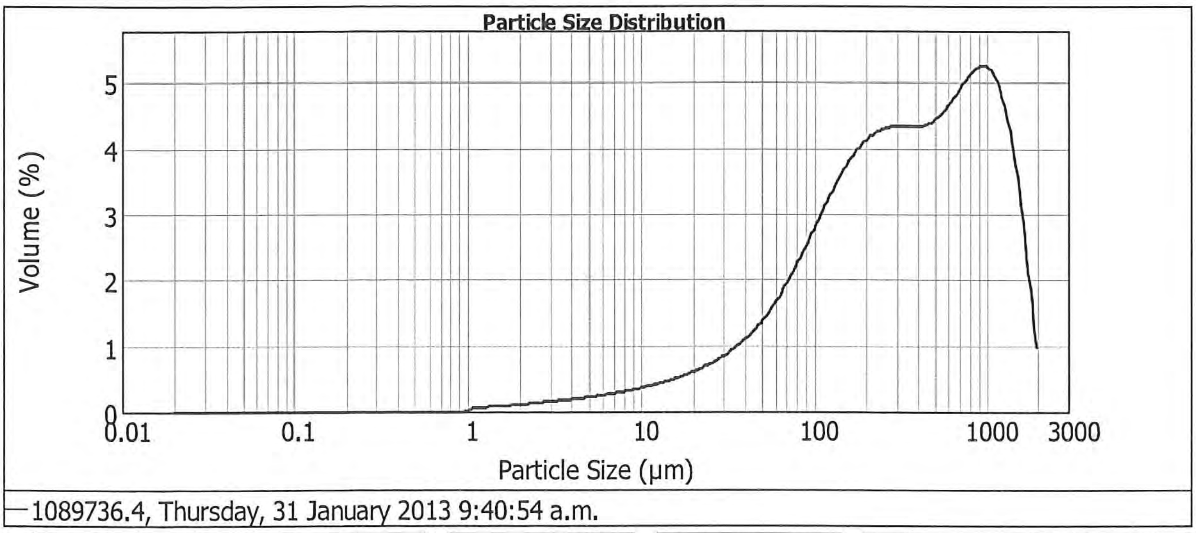
SOP Name: Marine Sediment
Measured by: rodgers
Result Source: Measurement

Measured: Thursday, 31 January 2013 9:40:54 a.m.
Analysed: Thursday, 31 January 2013 9:40:56 a.m.

Particle Name:	**Accessory Name:**	**Analysis model:**	**Sensitivity:**
Marine Sediment	Hydro 2000G (A)	General purpose	Enhanced
Particle RI:	**Absorption:**	**Size range:**	**Obscuration:**
1.500	0.2	0.020 to 2000.000 um	19.84 %
Dispersant Name:	**Dispersant RI:**	**Weighted Residual:**	**Result Emulation:**
Water	1.330	0.609 %	Off

Concentration:	**Span :**	**Uniformity:**	**Result units:**
0.2174 %Vol	3.473	1.07	Volume
Specific Surface Area:	**Surface Weighted Mean D[3,2]:**	**Vol. Weighted Mean D[4,3]:**	**Standard Deviation**
0.0836 m²/g	71.748 um	505.229 um	464.111 um

d(0.1): 49.083 um **d(0.5):** 339.462 um **d(0.9):** 1228.127 um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	0.980	0.00	37.000	7.85	105.000	20.14	300.000	46.50	840.000	77.18
0.060	0.00	2.000	0.34	44.000	9.10	125.000	23.67	350.000	50.86	1000.000	83.16
0.120	0.00	3.900	0.97	53.000	10.70	149.000	27.67	420.000	56.02	1190.000	89.00
0.240	0.00	7.800	2.05	63.000	12.49	177.000	31.98	500.000	60.99	1410.000	94.04
0.490	0.00	15.600	3.81	74.000	14.49	210.000	36.53	590.000	65.87	1680.000	97.98
0.700	0.00	31.000	6.77	88.000	17.05	250.000	41.36	710.000	71.62	2000.000	100.00

Operator notes:

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Hamilton, New Zealand

MALVERN INSTRUMENTS

MASTERSIZER 2000

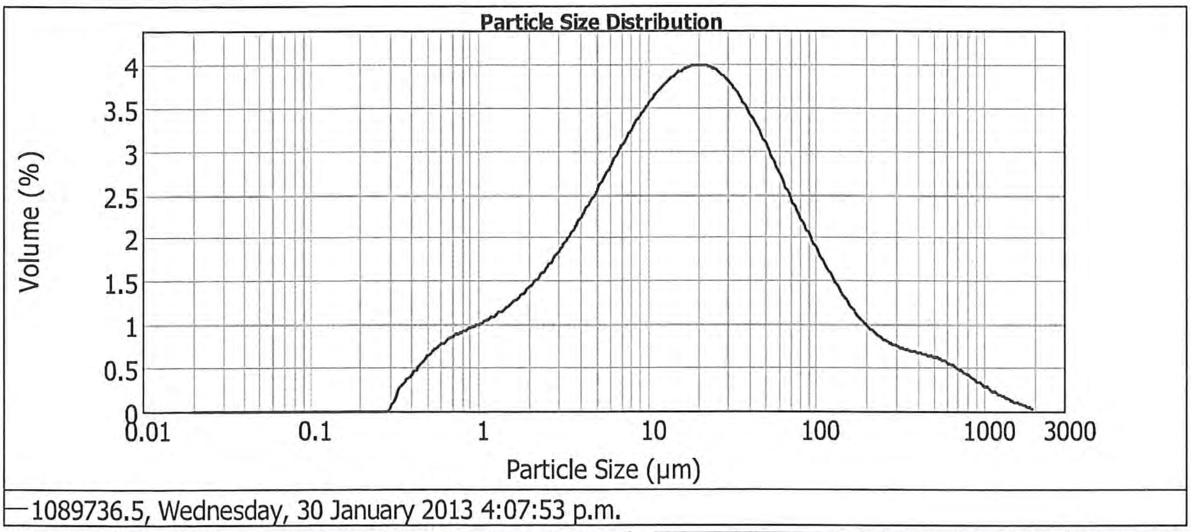
Result Analysis Report

Sample Name: HUNTERS CORNER FORECOURT	**SOP Name:** Marine Sediment	**Measured:** Wednesday, 30 January 2013 4:07:53 p.m.
Sample Source & type:	**Measured by:** rodgers	**Analysed:** Wednesday, 30 January 2013 4:07:55 p.m.
Sample bulk lot ref: 2013009/5	**Result Source:** Edited	

Particle Name: Marine Sediment	**Accessory Name:** Hydro 2000G (A)	**Analysis model:** General purpose	**Sensitivity:** Enhanced
Particle RI: 1.500	**Absorption:** 0.2	**Size range:** 0.020 to 2000.000 um	**Obscuration:** 19.42 %
Dispersant Name: Water	**Dispersant RI:** 1.330	**Weighted Residual:** 0.691 %	**Result Emulation:** Off

Concentration: 0.0171 %Vol	**Span :** 7.817	**Uniformity:** 3.29	**Result units:** Volume
Specific Surface Area: 1.2 m²/g	**Surface Weighted Mean D[3,2]:** 5.004 um	**Vol. Weighted Mean D[4,3]:** 65.147 um	**Standard Deviation** 156.259 um

d(0.1): 1.913 um **d(0.5):** 17.723 um **d(0.9):** 140.454 um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	0.980	4.92	37.000	68.64	105.000	86.99	300.000	94.93	840.000	98.98
0.060	0.00	2.000	10.41	44.000	72.54	125.000	88.89	350.000	95.66	1000.000	99.37
0.120	0.00	3.900	18.15	53.000	76.38	149.000	90.52	420.000	96.48	1190.000	99.64
0.240	0.00	7.800	30.34	63.000	79.57	177.000	91.87	500.000	97.21	1410.000	99.83
0.490	1.16	15.600	46.71	74.000	82.23	210.000	93.00	590.000	97.86	1680.000	99.95
0.700	2.90	31.000	64.39	88.000	84.75	250.000	94.00	710.000	98.50	2000.000	100.00

Operator notes:

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ence and Engineering
The University of Waikato
Private Bag 3105
Hamilton, New Zealand

MALVERN INSTRUMENTS MASTERSIZER 2000

Result Analysis Report

Sample Name:
HUNTERS CORNER, NON-FORECOURT

Sample Source & type:

Sample bulk lot ref:
2013009/6

SOP Name:
Marine Sediment

Measured by:
rodgers

Result Source:
Measurement

Measured:
Thursday, 31 January 2013 9:46:56 a.m.

Analysed:
Thursday, 31 January 2013 9:46:58 a.m.

Particle Name: Marine Sediment
Particle RI: 1.500
Dispersant Name: Water

Accessory Name: Hydro 2000G (A)
Absorption: 0.2
Dispersant RI: 1.330

Analysis model: General purpose
Size range: 0.020 to 2000.000 um
Weighted Residual: 0.633 %

Sensitivity: Enhanced
Obscuration: 17.28 %
Result Emulation: Off

Concentration: 0.1907 %Vol
Span : 3.132
Uniformity: 1
Result units: Volume

Specific Surface Area: 0.0816 m²/g
Surface Weighted Mean D[3,2]: 73.550 um
Vol. Weighted Mean D[4,3]: 551.141 um
Standard Deviation 492.366 um

d(0.1): 38.003 um **d(0.5):** 403.189 um **d(0.9):** 1300.991 um

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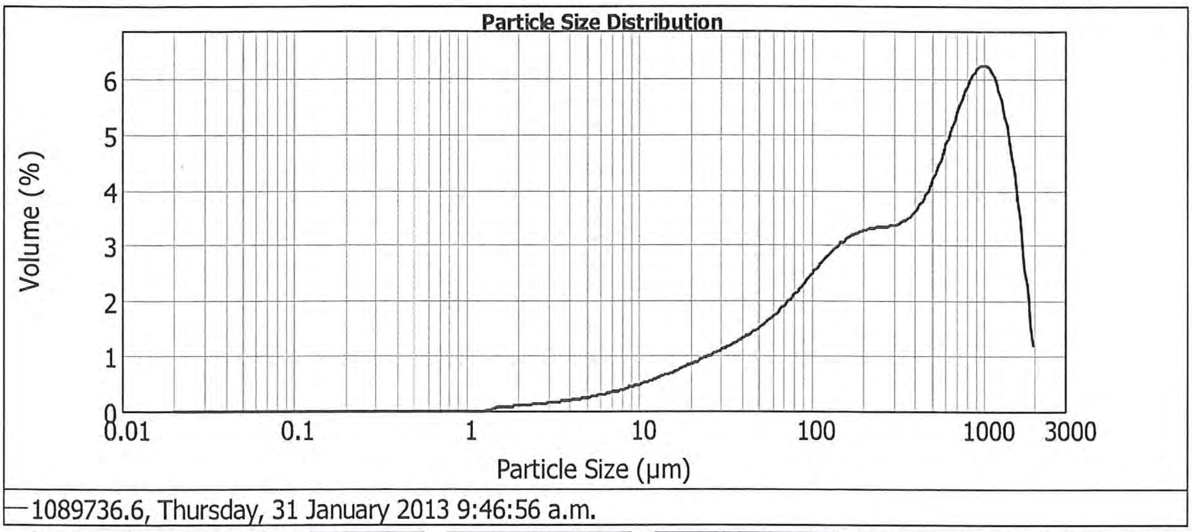


Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.050	0.00	0.980	0.00	37.000	9.78	105.000	22.04	300.000	43.33	840.000	72.58
0.060	0.00	2.000	0.17	44.000	11.27	125.000	25.09	350.000	46.75	1000.000	79.62
0.120	0.00	3.900	0.76	53.000	13.06	149.000	28.45	420.000	50.97	1190.000	86.64
0.240	0.00	7.800	1.99	63.000	14.93	177.000	31.96	500.000	55.40	1410.000	92.76
0.490	0.00	15.600	4.36	74.000	16.89	210.000	35.59	590.000	60.15	1680.000	97.55
0.700	0.00	31.000	8.41	88.000	19.28	250.000	39.36	710.000	66.28	2000.000	100.00

Operator notes:

WAIKATO
Te Whare Wānanga o Waikato

Faculty of Science and Engineering
The University of Waikato
Private Bag 3105
Hamilton, New Zealand

MALVERN INSTRUMENTS

MASTERSIZER 2000

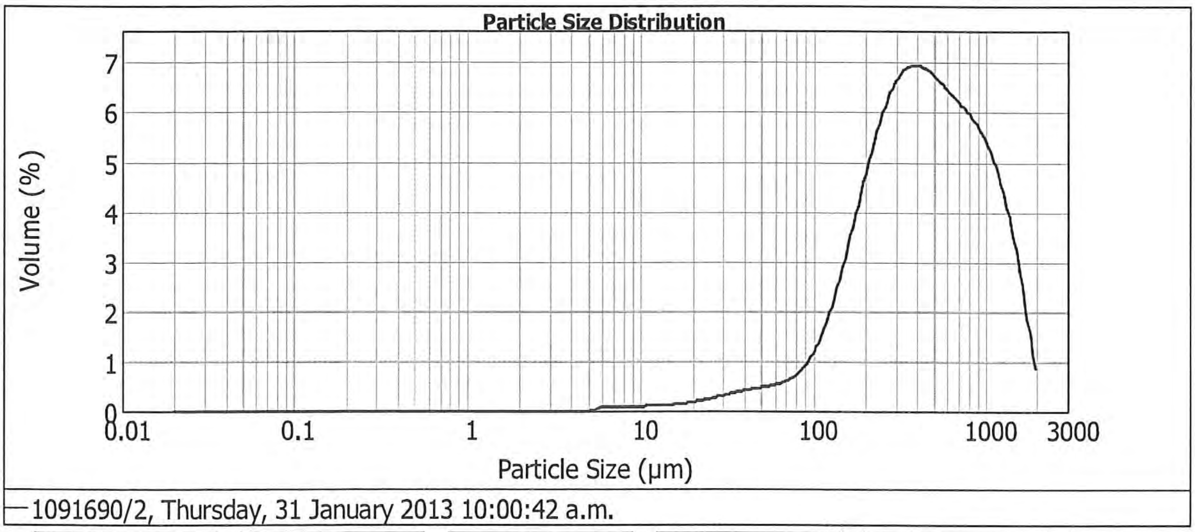
Result Analysis Report

Sample Name: LAKESIDE FORECOURT	**SOP Name:** Marine Sediment	**Measured:** Thursday, 31 January 2013 10:00:42 a.m.
Sample Source & type:	**Measured by:** rodgers	**Analysed:** Thursday, 31 January 2013 10:00:44 a.m.
Sample bulk lot ref: 2013010/2	**Result Source:** Measurement	

Particle Name: Marine Sediment	**Accessory Name:** Hydro 2000G (A)	**Analysis model:** General purpose	**Sensitivity:** Enhanced
Particle RI: 1.500	**Absorption:** 0.2	**Size range:** 0.020 to 2000.000 um	**Obscuration:** 13.41 %
Dispersant Name: Water	**Dispersant RI:** 1.330	**Weighted Residual:** 0.342 %	**Result Emulation:** Off

Concentration: 0.4634 %Vol	**Span :** 2.414	**Uniformity:** 0.734	**Result units:** Volume
Specific Surface Area: 0.0262 m²/g	**Surface Weighted Mean D[3,2]:** 229.434 um	**Vol. Weighted Mean D[4,3]:** 559.208 um	**Standard Deviation** 416.161 um

d(0.1): 142.391 um **d(0.5):** 434.043 um **d(0.9):** 1189.962 um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	0.980	0.00	37.000	1.94	105.000	6.21	300.000	33.43	840.000	77.73
0.060	0.00	2.000	0.00	44.000	2.41	125.000	8.05	350.000	40.26	1000.000	84.19
0.120	0.00	3.900	0.00	53.000	2.97	149.000	10.82	420.000	48.52	1190.000	90.00
0.240	0.00	7.800	0.17	63.000	3.54	177.000	14.65	500.000	56.31	1410.000	94.72
0.490	0.00	15.600	0.61	74.000	4.15	210.000	19.66	590.000	63.45	1680.000	98.24
0.700	0.00	31.000	1.53	88.000	4.99	250.000	25.92	710.000	71.10	2000.000	100.00

Operator notes:

Submission #44770

WAIKATO
Te Whare Wānanga o Waikato

Faculty of Science and Engineering
The University of Waikato
Private Bag 3105
Hamilton, New Zealand

MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
LAKESIDE NON-FORECOURT

SOP Name:
Marine Sediment

Measured:
Thursday, 31 January 2013 10:08:37 a.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Thursday, 31 January 2013 10:08:39 a.m.

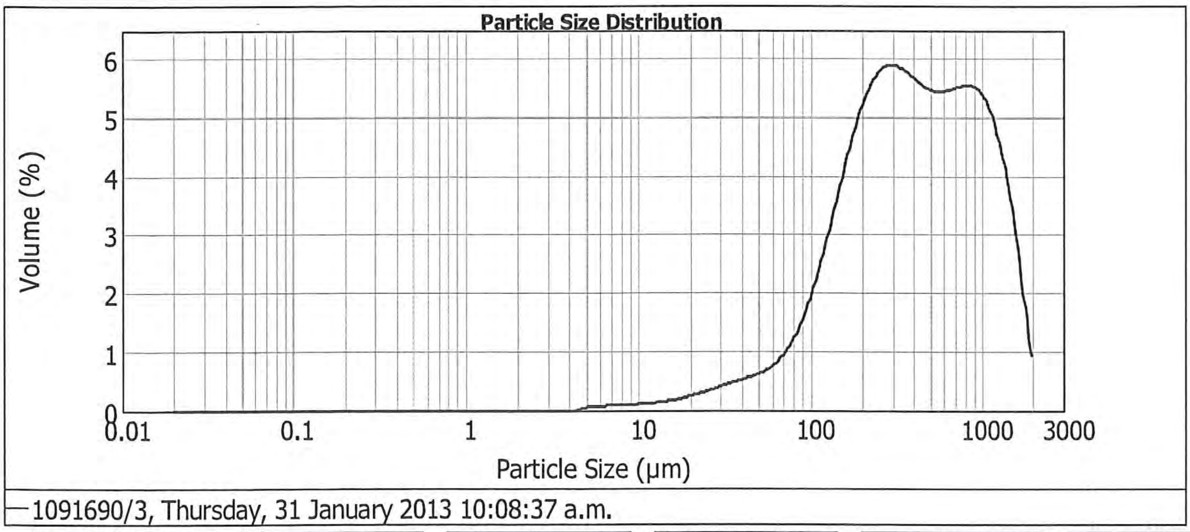
Sample bulk lot ref:
2013010/3

Result Source:
Measurement

Particle Name: Marine Sediment	**Accessory Name:** Hydro 2000G (A)	**Analysis model:** General purpose	**Sensitivity:** Enhanced
Particle RI: 1.500	**Absorption:** 0.2	**Size range:** 0.020 to 2000.000 um	**Obscuration:** 15.60 %
Dispersant Name: Water	**Dispersant RI:** 1.330	**Weighted Residual:** 0.366 %	**Result Emulation:** Off

Concentration: 0.4553 %Vol	**Span :** 2.800	**Uniformity:** 0.855	**Result units:** Volume
Specific Surface Area: 0.0313 m²/g	**Surface Weighted Mean D[3,2]:** 191.855 um	**Vol. Weighted Mean D[4,3]:** 540.516 um	**Standard Deviation** 436.717 um

d(0.1): 111.226 um **d(0.5):** 393.716 um **d(0.9):** 1213.556 um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	0.980	0.00	37.000	2.59	105.000	9.16	300.000	39.69	840.000	77.22
0.060	0.00	2.000	0.00	44.000	3.19	125.000	12.01	350.000	45.59	1000.000	83.48
0.120	0.00	3.900	0.00	53.000	3.93	149.000	15.88	420.000	52.38	1190.000	89.38
0.240	0.00	7.800	0.25	63.000	4.75	177.000	20.69	500.000	58.67	1410.000	94.32
0.490	0.00	15.600	0.79	74.000	5.71	210.000	26.34	590.000	64.55	1680.000	98.09
0.700	0.00	31.000	2.06	88.000	7.12	250.000	32.71	710.000	71.15	2000.000	100.00

Operator notes:

WAIKATO
Te Whare Wānanga o Waikato
...ence and Engineering
The University of Waikato
Private Bag 3105
Hamilton, New Zealand

MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
SYLVIA PARK FORECOURT

Sample Source & type:

Sample bulk lot ref:
2013009/2

SOP Name:
Marine Sediment

Measured by:
rodgers

Result Source:
Measurement

Measured:
Thursday, 31 January 2013 9:32:14 a.m.

Analysed:
Thursday, 31 January 2013 9:32:16 a.m.

Particle Name:
Marine Sediment

Particle RI:
1.500

Dispersant Name:
Water

Accessory Name:
Hydro 2000G (A)

Absorption:
0.2

Dispersant RI:
1.330

Analysis model:
General purpose

Size range:
0.020 to 2000.000 um

Weighted Residual:
0.615 %

Sensitivity:
Enhanced

Obscuration:
14.23 %

Result Emulation:
Off

Concentration:
0.2325 %Vol

Span :
2.670

Uniformity:
0.853

Result units:
Volume

Specific Surface Area:
0.0545 m²/g

Surface Weighted Mean D[3,2]:
110.049 um

Vol. Weighted Mean D[4,3]:
599.794 um

Standard Deviation
493.672 um

d(0.1): 58.971 um **d(0.5):** 479.912 um **d(0.9):** 1340.439 um

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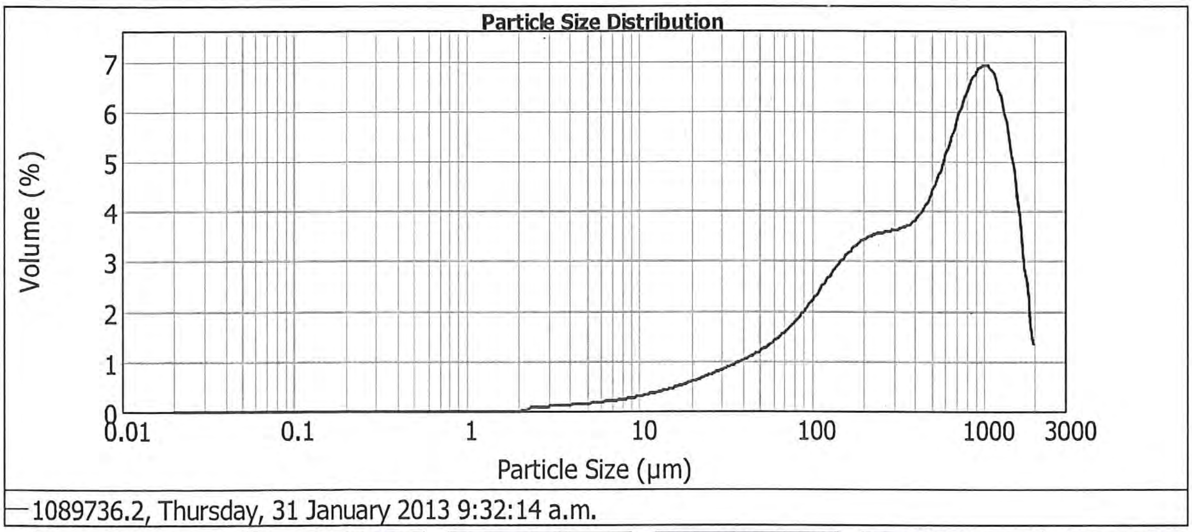


Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	0.980	0.00	37.000	6.52	105.000	16.69	300.000	38.32	840.000	69.54
0.060	0.00	2.000	0.00	44.000	7.67	125.000	19.50	350.000	41.99	1000.000	77.29
0.120	0.00	3.900	0.33	53.000	9.09	149.000	22.74	420.000	46.48	1190.000	85.08
0.240	0.00	7.800	1.09	63.000	10.60	177.000	26.27	500.000	51.14	1410.000	91.90
0.490	0.00	15.600	2.59	74.000	12.22	210.000	30.04	590.000	56.16	1680.000	97.26
0.700	0.00	31.000	5.47	88.000	14.25	250.000	34.05	710.000	62.70	2000.000	100.00

Operator notes:

WAIKATO
Te Whare Wānanga o Waikato

...ence and Engineering
The University of Waikato
Private Bag 3105
Hamilton, New Zealand

MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
SYLVIA PARK NON-FORECOURT

Sample Source & type:

Sample bulk lot ref:
2013009/1

SOP Name:
Marine Sediment

Measured by:
rodgers

Result Source:
Measurement

Measured:
Thursday, 31 January 2013 9:17:30 a.m.

Analysed:
Thursday, 31 January 2013 9:17:32 a.m.

Particle Name:
Marine Sediment

Particle RI:
1.500

Dispersant Name:
Water

Accessory Name:
Hydro 2000G (A)

Absorption:
0.2

Dispersant RI:
1.330

Analysis model:
General purpose

Size range:
0.020 to 2000.000 um

Weighted Residual:
0.303 %

Sensitivity:
Enhanced

Obscuration:
23.18 %

Result Emulation:
Off

Concentration:
0.0961 %Vol

Specific Surface Area:
0.262 m²/g

Span :
6.008

Surface Weighted Mean D[3,2]:
22.889 um

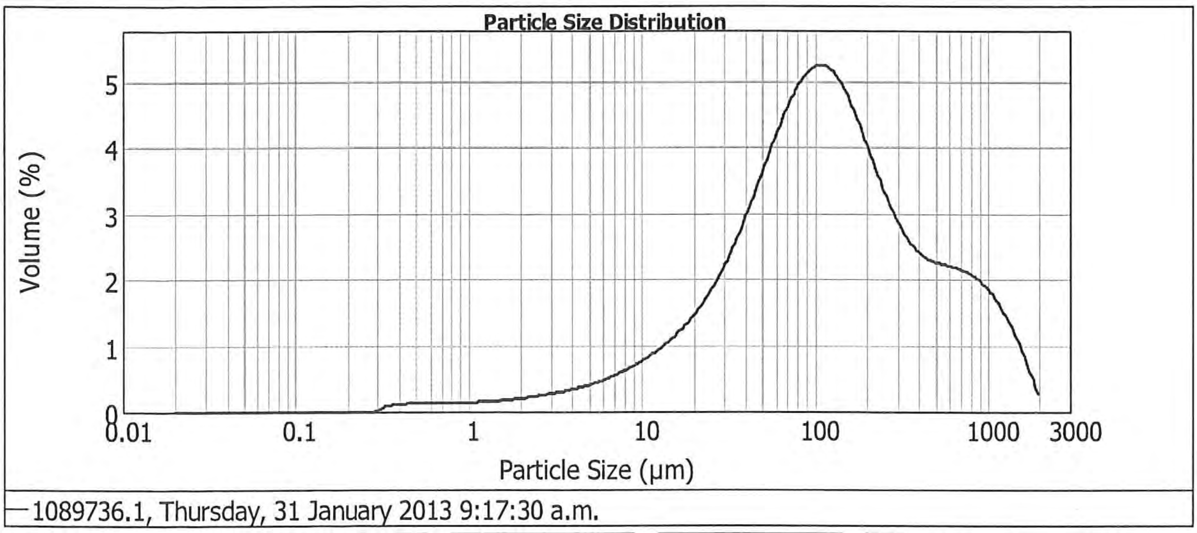
Uniformity:
1.71

Vol. Weighted Mean D[4,3]:
245.070 um

Result units:
Volume

Standard Deviation
332.831 um

d(0.1): 18.457 um **d(0.5):** 113.295 um **d(0.9):** 699.109 um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	0.980	0.90	37.000	18.80	105.000	47.39	300.000	76.89	840.000	92.52
0.060	0.00	2.000	1.65	44.000	22.16	125.000	53.35	350.000	79.63	1000.000	94.74
0.120	0.00	3.900	2.78	53.000	26.43	149.000	59.14	420.000	82.56	1190.000	96.71
0.240	0.00	7.800	4.81	63.000	31.02	177.000	64.38	500.000	85.18	1410.000	98.27
0.490	0.30	15.600	8.64	74.000	35.81	210.000	69.04	590.000	87.58	1680.000	99.43
0.700	0.61	31.000	15.93	88.000	41.40	250.000	73.18	710.000	90.22	2000.000	100.00

Operator notes:

Submission #44772

FEDERATED FARMERS OF NEW ZEALAND

Federated Farmers of New Zealand

Submission on Christchurch City Council
- Draft stormwater and land drainage bylaw 2022
- Draft water supply and wastewater bylaw 2022

8 February 2022

0800 327 646 | FEDFARM.ORG.NZ

Submission on Christchurch City Council Draft stormwater and land drainage bylaw 2022 and Draft water supply and wastewater bylaw 2022

Name of submitter: Federated Farmers of New Zealand

Contact: **Eleanor Linscott**
Senior Policy Advisor

[redacted]

Address for service: Federated Farmers of New Zealand
PO Box 5242
Dunedin 9016

This is feedback on Christchurch City Council's proposed changes in the draft Water Supply, Wastewater and Stormwater Bylaw review.

1. Introduction

1.1 Federated Farmers of New Zealand (FFNZ) is a primary sector organisation with a long and proud history of representing the needs and interests of New Zealand farmers, as well as many rural businesses and communities.

1.2 Christchurch City Council area includes a significant number of FFNZ members that live and farm on Banks Peninsula that are potentially impacted by these proposed bylaw changes.

1.3 FFNZ appreciates the opportunity to provide feedback on the Water Supply, Wastewater and Stormwater Bylaw review

2. Draft Water Supply and Wastewater Bylaw 2022

2.1 Issue 3: Potential contamination of source water from aerial spraying of chemicals for agricultural or firefighting purposes. Draft Bylaw 9(6)

2.2 If aerial spraying for "fertilisers, herbicides or pesticides" is an activity that is already occurring in the area then a suitable information/education process will be necessary to make sure all landowners understand what is required by the new bylaw. Clarity is required on what the actual process a landowner must follow to notify the Council of aerial spraying – as these activities are weather dependant - and timing is critical.

2.3 The new draft bylaw states that "any person intending to undertake the aerial application of any chemical in the vicinity of a community drinking water protection zone…must notify the Council of the activity…as soon as practicable for the application of any fire-fighting chemical". For aerial spraying for firefighting purposes has to occur in an urgent timeframe – and even having the lesser requirement of "as soon as practicable" does not seem to fit. The purpose of the draft bylaws is to lessen the risk of contamination – however the way this is drafted allows the contamination to occur – as urgency required for reacting to fire is paramount. Perhaps a more proactive approach for these events is planned/coordinated – that is, for areas within the drinking water protection zones where fire fighting chemicals may be applied, a check is in place that Council are informed sooner to minimise the risk of contamination.

2.4 Issue 5: The practical issues of cost and site space required to implement the mandatory requirements for rainwater storage tanks in restricted-supply areas of Banks Peninsula. There are multiple requirements for various water storage tanks under a range of regulatory tools.

2.5 Clarity would be helpful on what a community water supply is - there is no definition. There are a lot of variable community water systems on the Peninsula, so clarity in regard to what this term means would be helpful.

3 Draft Stormwater and Land Drainage Bylaw

3.1 Issue 4: Inadequately managed drainage from artesian springs and wells.

3.2 Environment Canterbury under its Land and Water Plan covers artesian water. How is this bylaw aligned with the landowner requirements under the Regional Council?

Clarity is required in terms of whether this bylaw is intended to apply to rural land, and properties on a slope (where it is extremely difficult to manage water flow).

3.3 Issue 5: Setbacks for activities near waterways

3.4 The restricted activities include "any structure in, on… or within three metres of any waterway". Does "any structure" include farm fences for keeping stock, or temporary fences like electric fences?

3.5 FFNZ would like to be heard in support of our submission.

Christchurch City Council

9 February 2022

Beckenham Service Centre
03 941 6633
66 Colombo Street, Beckenham
PO Box 73027
Christchurch 8154
ccc.govt.nz

Hannah Ballantyne
Engagement Advisor
hannah.ballantyne@ccc.govt.nz
Christchurch City Council
53 Hereford Street
Christchurch 8154

Hello,

Submission on Water Supply, Wastewater and Stormwater Bylaw Review

The Waihoro Spreydon-Cashmere Community Board appreciates the opportunity to provide a submission on the Council's Water Supply, Wastewater and Stormwater Bylaw Review.

The Board's statutory role is, "to represent, and act as an advocate for, the interests of its community" (Local Government Act 2002, section 52). The Board provides this submission in its capacity as a representative of the communities in the Spreydon-Cashmere area.

Overall, we strongly support the bylaws' aim to provide clean drinking water and avoid contaminants that harm the environment, particularly sediment.

Sediment is an ongoing issue that negatively impacts waterways in our hilly Board area, including Cashmere Stream and the Opawaho Heathcote River. We applaud the proposal to require an Erosion and Sediment Control Plan for earthworks where this is not otherwise required through a building or resource consent. We expect that there is budget for appropriate resourcing to monitor this, particularly after large storm events.

We would also like to acknowledge the outstanding work that our community continues to carry out to control sediment and protect our waterways, such as the Opawaho Heathcote River Network and Cashmere Stream Working Group.

The Board would like to speak to its submission.

Yours sincerely,

Karolin Potter

Karolin Potter
Chairperson, Waihoro / Spreydon-Cashmere Community Board

SUMMIT ROAD SOCIETY

a passion for the Port Hills

The Summit Road Society was formed in 1948 to further the vision of Harry Ell to preserve and protect the Port Hills and provide for public access. We own and manage four reserves on the Port Hills and lead the backyard and community project 'Predator Free Port Hills'.

Thank you for the opportunity to comment on the Water Supply, Wastewater and Stormwater Bylaw review. The Summit Road Society has a particular interest in protecting and restoring the streams of the Port Hills. Protection and enhancement of these streams helps restore habitat for native flora and fauna and reduce erosion. Sedimentation from the Port Hills is a major source of pollution into the Ōpawaho/Heathcote River, Whakaraupō/Lyttelton Harbour and Ihutai/Avon-Heathcote Estuary.

The Society has been actively working to protect and restore native flora and fauna on our four reserves, Ohinetahi above Governors Bay, Omahu and the adjacent Gibraltar Rock above Tai Tapu, and Linda Woods Reserve in Heathcote. All four reserves have a number of streams. Most recently, we have embarked on a long term programme to restore a lowland podocarp forest to Avoca Valley. Due to historical deforestation, there is little vegetation to hold or slow runoff. Rainfall falls out of the system within a matter of hours. Stormwater runoff carries sediment from the eroding land into the stream and to the lower catchment, resulting in problems with sedimentation. This affects the water quality in the lower sections of the stream and in turn the Ōpawaho-Heathcote River and Ihutai (the estuary). By restoring the bush to the Avoca Valley catchment, we can help restore water to the stream, create habitat for native fauna, support mahinga kai values, reduce erosion and sediment run-off, provide recreational benefits for the community and support carbon sequestration.

It is vital that such restoration efforts are part of a wider programme of work and that the bylaws work to support the community's vision for healthy waterways. We are in full support of measures to protect and restore our waterways, including the need for education campaigns with the public.

With regards to the Draft Stormwater and Land Drainage Bylaw 2022:

- Clause 19 Prohibited substances. We support this clause and advocate for increased education to raise awareness of this issue.
- Clauses 22 & 23 Requirements for earthworks. We support the requirement for Erosion and Sediment Control Plans for earthworks and the requirement that control measures are in place before and after earthworks and until the site is stabilised.

We also support appropriate resourcing to achieve the objectives of these bylaws, including education of the public and ongoing restoration efforts.

PO Box 37-115, Christchurch 8245 www.summitroadsociety.org.nz [redacted]

Styx Living Laboratory Trust Submission on the Draft 2022 Water Supply, Wastewater and Stormwater Bylaws

[redacted]

Thank you for the opportunity to make a submission on the Draft 2022 Water Supply, Wastewater and Stormwater Bylaws. The Styx Living Laboratory Trust thanks the Christchurch City Council (CCC) for their considerable efforts preparing these draft bylaws.

This submission has been prepared by members of the Styx Living Laboratory Trust.

Summary of the Styx Living Laboratory Trust

The Styx Living Laboratory Trust (SLLT), is a local river care group, which was established in 2000 to achieve Vision 3 (Develop a "living laboratory" that focuses on both learning and research) of the CCC`s, `Styx Vision 2000 – 2040.' The Trust has since encompassed a role of guardianship and advocacy for the waterway and the biodiversity of the surrounding land as a living part of the Canterbury landscape.

Arising from the eastern edge of Christchurch Airport, and discharging 30 km away into the Brooklands Lagoon, the Pūharakekenui (Styx) River and its tributaries are a spring fed river ecosystem skirting the Northwest edge of the Christchurch urban area. The Pūharakekenui is approximately 25 km in length and the entire catchment covers an area of approximately 7000 ha. The Pūharakekenui is home to many species of freshwater fish, wetland birds and is an important source of mahinga kai for Ngāi Tūāhuriri.

We, the trustees and volunteers, are advocates for maintaining water quality and other values (including drainage, ecology, landscape, culture, recreation, and heritage values) in the river. We care deeply about our water and want it to remain clean, healthy, biodiverse and available for future generations to use and enjoy.

Our Whāinga(Objective) is achieving *Vision 3* in the CCC document called "Vision 2000-2040 – The Styx" i.e. developing a "Living Laboratory" by:

a. Raising awareness and understanding of the Pūharakekenui (Styx) River catchment and its environs including its ecology, drainage, landscape, culture, heritage and recreation values;

b. Promoting the use of the Pūharakekenui (Styx) River Catchment as a collective resource for environmental and social research, and to maximise opportunities for community involvement in research and learning;

c. Working collaboratively with other organisations or people to form partnerships to achieve the above objective and using memoranda of understanding where appropriate;

d. Assisting other people and other organisations to achieve the remaining Visions in "Vision 2000 – 2040 – "The Styx" namely:

Vision 1 – achieving a viable spring fed ecosystem

Vision 2 –creating a "Source to Sea Experience"

Vision 4 – establishing The Styx as "a place to be"

Vision 5 – Fostering Partnerships

STYX LIVING LABORATORY TRUST
PŪHARAKEKENUI

General Comments on the draft Bylaws

We (SLLT) are advocates for protecting the health and values of the Pūharakekenui and as such we generally ***strongly support*** all initiatives which reduce contaminants, pollution, sediment and assist with establishing the Pūharakekenui as a viable spring-fed river ecosystem.

Hence, SLLT ***supports*** the separation of the bylaws into Water Supply and Wastewater, and Stormwater and Land Drainage and ***supports*** the general intent of these two bylaws.

SLLT generally ***supports*** all clauses in these bylaws and ***strongly supports*** the following clauses:

Draft Stormwater and Land Drainage Bylaw 2022

- **Clause 10 - Requirement for on-site stormwater management**
  SLLT ***contends*** that CCC having the power to retrofit stormwater monitoring devices and introduce specific site management practices has the potential to improve the quality of stormwater being discharged into the system.

- **Clause 11 - Managing drainage from artesian springs and wells on private land**
  SLLT ***recommends*** that this clause requires that the incidence and location of artesian springs are to be notified to the CCC and that this clause prevents action not directly approved by CCC to cap, interfere with or divert the natural flow of an artesian spring.

- **Clause 15 - Restricted activities related to waterways**
  SLLT ***strongly supports*** the increase of the setback distance for structures and the setback for earthworks from a waterway.

- **Clauses 22 & 23 - Requirements for earthworks**
  Sediment is a significant issue in the Pūharakekenui and the SLLT ***supports*** all initiatives taken to reduce sedimentation, in particular the requirement for an Erosion and Sediment Control Plan. SLLT ***notes*** that there must be CCC resources available to monitor and enforce compliance with Earthwork Requirements and ***seeks*** clarification on the definition of a 'suitably qualified person.'

Thank you for the opportunity to provide a submission on the Draft 2022 Water Supply, Wastewater and Stormwater Bylaws. SLLT would like the opportunity to present our submission and provide further detail/comments.

Submission #44793

Environment Canterbury
Regional Council
Kaunihera Taiao ki Waitaha

Customer Services
P. 03 353 9007 or 0800 324 636

200 Tuam Street

PO Box 345
Christchurch 8140

www.ecan.govt.nz/contact

9 February 2022

Attention: Hannah Ballantyne, Engagement Advisor
Christchurch City Council
PO Box 73016
Christchurch 8140

Tēnā koutou

Environment Canterbury submission:
Draft Water Supply and Wastewater Bylaw 2022
Draft Stormwater and Land Drainage Bylaw 2022

Thank you for the opportunity to provide comment on the proposals contained in the above two Draft Bylaws. Environment Canterbury's submission on both Draft Bylaws is attached.

Our submission includes general comments on the proposed changes and responses to the specific proposed solutions to issues raised in the documents.

We welcome the opportunity to continue to work with the Christchurch City Council to meet its obligations under the Comprehensive Stormwater Network Discharge Consent.

Environment Canterbury does not wish to speak to the Hearing Panel.

For all enquiries on the submissions please contact:
Anita Fulton
Senior Strategy Advisor
[redacted]

Yours sincerely

Dr Stefanie Rixecker
Chief Executive

Encl: Submission on Draft Water Supply and Wastewater Bylaw 2022
Submission on Draft Stormwater and Land Drainage Bylaw 2022
Our ref:
Your ref:
Contact:

Submission to the Christchurch City Council

Draft Stormwater and Land Drainage Bylaw 2022

Introduction

1. Environment Canterbury supports Christchurch City Council's (the Council) proposed approach to split the current bylaw into two new bylaws to help meet its obligations under the Comprehensive Stormwater Network Discharge Consent (CSNDC).

2. Environment Canterbury welcomes the opportunity to comment on the key changes proposed by the *Draft Stormwater and Land Drainage Bylaw 2022* (the Draft Bylaw).

3. In general, Environment Canterbury agrees with the overall intent of the Draft Bylaw to reduce contaminants entering the environment and improve the quality of stormwater discharged from the stormwater network into local waterways and to ground.

4. Environment Canterbury recommends specific reference in the Draft Bylaw to engagement with mana whenua and consideration of the hierarchy of obligations under Te Mana o te Wai in managing stormwater and land drainage.

5. Environment Canterbury supports the development of an approvals process and improved clarity for requirements to discharge via the stormwater network. This supports giving effect to the policies under the Land and Water Regional Plan and requirements under the CSNDC.

Specific comments on the Draft Bylaw

Clause 6: Approval required for stormwater connections and discharge

Clause 7: Review of connection and discharge approval

6. Environment Canterbury strongly support clauses 6 & 7 which sets up a robust approval and review mechanism.

Clause 9: Stormwater quality standards

7. We support the Council specifying stormwater quality standards for discharges to the network. In line with the content of the proposed Stormwater Management Plans for the Huritīni/Halswell River and Ōpāwaho/Heathcote River catchments and the CSNDC, we ask that these standards be set now.

8. Clause 9(4) states two matters that the Council may require the occupier of a property or premise to adopt to reduce or prevent contaminants from entering the stormwater network, and further refers to "<u>This may include, but is not limited to</u>". Sub-clauses (a) and (b) are supported; however, Environment Canterbury would also

support the inclusion of a further option to cease stormwater discharges to the stormwater network altogether.

Clause 10: Requirement for on-site stormwater management

9. Clause 10 appears to have the same intent as Clause 9(4). For clarity, it would make sense to merge the requirements under Clause 9(4) with those of Clause 10.

Clause 11: Managing drainage from artesian springs and wells on private land

10. Environment Canterbury submits that activities such as groundwater takes and discharges beyond site boundaries are regional council responsibilities under the Resource Management Act 1991 (RMA). Environment Canterbury would support if this clause instead referred to the discharges of spring water to the stormwater network, which could then be included as a restricted activity under Clause (13).

Clause 15: Restricted activities related to waterways

11. Environment Canterbury supports restricting activities around waterways; however, the Council will need to ensure that restrictions are consistent with, and do not conflict with, the Canterbury Land and Water Regional Plan and any other regional plan and bylaw requirements. Further, it is submitted that the Draft Bylaw must not restrict Environment Canterbury operations such as waterway and stop bank maintenance.

12. Clause 15(2) includes an “or” between Sub-clauses (b) and (c), which suggests that if erosion and sediment control measures are in place, covering a waterway is acceptable to the Council, and that (a) and (b) do not need to be considered. Environment Canterbury supports increasing naturalisation of waterways and would not support increased covering or removal of surface water bodies.

Clause19: Prohibited substances must not enter the network

13. Environment Canterbury notes that the explanatory note for prohibited substances includes (but is not limited to) sediment. The Sediment Discharge Management Plan[1] Table 2 Scenario requirement and response table states that the Draft Bylaw includes “… a clause enabling the setting of stormwater quality standards, which could include setting a total suspended solids (TSS) concentration of no greater than 50 mg/L for sites undertaking earthworks”. The Draft Bylaw Clauses 22 and 23 under Requirements for Earthworks makes no reference to such a clause. We support, in principle, sediment being listed as a prohibited substance; however, there will need to be consistency between the Draft Bylaw, the Sediment Discharge Management Plan, and the Stormwater Management Plans required to be prepared under the CSNDC.

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[1] The Sediment Discharge Management Plan is a management plan required to be prepared under the CSNDC to set out reasonably practicable processes and practices to be implemented to manage discharges and stormwater from development sites into the stormwater network.

14. Environment Canterbury submits that there is a need for clear communication between the Council, the industry and wider public on the relevant requirements in the Draft Bylaw, including the fact that sediment is now considered a prohibited substance.

15. Environment Canterbury notes that detergents and soap are also among contaminants listed as prohibited substances. While we support efforts to reduce pollutants entering the stormwater system and waterways, the approach will require a strong community engagement and education component to be effective in creating behaviour change.

Clauses 22 & 23: Requirements for Earthworks

16. Environment Canterbury supports the general intent of Clauses 22 and 23. However, the following is noted.

17. As outlined above, Environment Canterbury would support the inclusion of a clause enabling the Council to impose discharge limits for TSS.

18. Clause 22(4) refers to making the erosion and sediment control plans (ESCPs) available to the Council “on request”. Environment Canterbury submits that ESCPs should be provided to the Council by default as the CSNDC requires the preparation of ESCPs for all development sites. If the Council does not hold those plans readily available, this might impact on, or prolong a response to, compliance monitoring of a site by Council inspectors, as well as Environment Canterbury’s ability to request ESCPs under Condition 42 of the CSNDC.

19. The measures outlined under Clause 23 are supported. However, Environment Canterbury submits that additional sub-clauses be included to require maintenance of the erosion and sediment control measures, as well as regular inspection of the measures, including following rainfall, and removal and appropriate disposal of any accumulated sediment, debris, litter, etc.

Clause 27: Register of industrial and trade activities

20. Environment Canterbury fully supports the development of a register of industrial and trade activities.

Clause 28: Requirement to apply for an industrial stormwater discharge licence

21. Environment Canterbury fully supports the introduction of an Industrial Stormwater Discharge Licence as part of the Industrial Stormwater Audit Programme. This will assist with the arrangement to transfer industrial stormwater discharge consents issued from Environment Canterbury to the Council to manage under the Draft Bylaw as per the CSNDC.

Clause 35: Transitional arrangements for industrial stormwater dischargers

22. Clause 35(2)(a) refers to "the expiry of the resource consent". Environment Canterbury submits that this clause should also refer to the surrender of the resource consent, as this is an option for consent holders under Section 138 of the RMA. This is also consistent with Condition 3 of the CSNDC.

Other comments

23. Environment Canterbury requests that the Council provide Environment Canterbury with details on how it will plan to monitor and enforce this Draft Bylaw.

24. Under the definition of 'stormwater network' Environment Canterbury notes the definition of 'waterways', which includes 'watercourses', which in turn includes "*every river, stream, passage, and channel on or under the ground, whether natural or not, through which water flows, whether continuously or intermittently*"[2]. Environment Canterbury submits that the inclusion of waterways under the definition of stormwater network, as proposed, is outside the scope of what Environment Canterbury considers as the Council's stormwater network. We submit that Environment Canterbury be specifically consulted about this and the clauses on activities around waterways. Environment Canterbury currently oppose the definition as it appears in the Draft Bylaw.

25. The Draft Bylaw does not specify copper and zinc despite them being known as key stormwater contaminants that are an issue in urban waterways. Issue 3 covers "Contaminants entering the stormwater network causing damage or reduced functionality of the network and negative impacts on the environment (e.g. waterways)". The proposed solutions do not mention specific contaminants beyond sediment, which is covered separately by Issue 2 and Draft Bylaw clauses. A stormwater quality standard under Clause 9 could in future include controls on the use of certain building materials or vehicle parts (e.g. brake pads) and not be limited to only numerical limits such as a concentration of a contaminant in a discharge.

26. The Council will need to make it clear that additional permissions (e.g. regional resource consents or bylaw authorisations) may be required for certain activities such as works in and around waterways.

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[2] As defined in Section 2 of the Soil Conservation and Rivers Control Act 1941.

Submission to the Christchurch City Council

Draft Water Supply and Wastewater Bylaw 2022

Introduction

Introduction

1. Environment Canterbury supports Christchurch City Council's (the Council) proposed approach to split the current bylaw into two new bylaws to help meet its obligations under the Comprehensive Stormwater Network Discharge Consent.

2. Environment Canterbury welcomes the opportunity to comment on the key changes proposed by the *Draft Water Supply and Wastewater Bylaw 2022* (the Draft Bylaw).

3. In general, Environment Canterbury agrees with the overall intent of the Draft Bylaw to better protect the water supply network from contaminants and the wastewater network from damage, infiltration, and misuse.

4. Environment Canterbury recommends specific reference in the Draft Bylaw to engagement with mana whenua and consideration of the hierarchy of obligations under Te Mana o te Wai in managing water services.

Specific comments on the Draft Bylaw

5. Clause (7)(4) refers to "No person may plant any tree […] likely to cause a nuisance or damage to any part of the stormwater network". Should this read water supply system?

6. Clause (29)(1) refers to the water supply system and further sub-clause (4) refers to the stormwater network. Should this read wastewater system?

General comment on the Draft Bylaw

7. Environment Canterbury requests that the Council provide Environment Canterbury with details on how it will plan to monitor and enforce this Draft Bylaw.

8. Environment Canterbury supports the intent of Clause (31)(a); however, further clarification is required on whether this covers all unauthorised connections, whether they exist now or are new connections.

9. Environment Canterbury encourages the Council to undertake an educational campaign to identify any issues of concern (such as the connection of wastewater downpipes to the wastewater system), followed by an inspection of properties (like the recent campaign to prevent rubbish being placed in recycling bins).

Avon-Heathcote Estuary Ihutai Trust

http://www.estuary.org.nz/

Christchurch City Council

Water Supply, Wastewater and Stormwater Bylaw review 2022 Submission – February 2022

The Avon Heathcote Estuary Ihutai Trust

1. The Avon Heathcote Estuary Ihutai Trust (AHEIT, The Estuary Trust) is a charitable society registered in 2003. It was formed as a result of community requests over many years for the formation of an organisation that included committed representation from statutory bodies, tāngata whenua and other agencies.

2. The vision of the Trust is

Communities working together for

Clean Water

Open Space

Safe Recreation, and

Healthy Ecosystems that we can all enjoy and respect

Toi tū te taonga ā iwi

Toi tū te taonga ā Tāne

Toi tū te taonga ā Tangaroa

Toi tū te iwi

3. Further details about the Trust, it's Constitution, the Memorandum of Understanding between the Christchurch City Council, Environment Canterbury and the Trust, and the Trust's Estuary Management Plan, please visit our website at www.estuary.org.nz

Kit Doudney

Chairperson, AHEIT

[redacted]

Avon Heathcote Estuary Ihutai Submission

Water Supply, Wastewater and Stormwater Bylaw review 2022

2. PURPOSE (1) The purpose of this bylaw is to: manage and regulate the land, structures, and infrastructure associated with land drainage and the stormwater network; and protect the Council's land drainage infrastructure and stormwater network from misuse or damage. protect the public from nuisance and maintain public health and safety.

We Agree

3. OBJECTIVES (1) The objectives of this bylaw are to: prevent the unauthorised use of, or discharge into, the stormwater network; manage the volume of runoff and entry of contaminants into the stormwater network; enable the Council to meet relevant objectives, policies and standards for discharges from the stormwater network; define the obligations of the Council, installers, occupiers, and the public regarding the discharge of stormwater and management of the stormwater network; and manage the risk of flooding and protect land drainage infrastructure.

We Agree

6. Connections and Discharge

(4) The Council may grant approval to an applicant, and may impose conditions as part of the approval. Any conditions must be complied with in the exercise of the approval.

Response: Conditions must include water quality discharge standards

7. Review of Connection and discharge Approval

(1) The Council may, at any time, review a stormwater connection or stormwater discharge approval, and any associated conditions.

Response: All discharges must be monitored

9. The Council may, at any time, review a stormwater connection or stormwater discharge approval, and any associated conditions.

(1) The Council may, by resolution, specify standards for discharges to the stormwater network.

(2) A resolution under this clause may: specify standards generally, or for specific situations, activities or industries, or for types of property; apply to all of the district, or to any specifiedpart or parts of the district, i.e. a stormwater catchment; and apply immediately or come into force at a specified time.

(3) Once a standard comes into force, the occupier of any property or premises to which the standard applies, must comply with the standard.

(4) The Council may require the occupier of any property or premises to reduce or prevent contaminants from entering the stormwater network in quantities or concentrations that exceed a standard. This may include, but is not limited to: changing on-site practices; or installing a stormwater device or treatment process .

Response: The Council must specify specific standards for specific situations. Plus general standards for entire catchments

15 Restricted Activities Related to Waterways

No person may, without the Council's written approval under this bylaw: build or install, or allow to be built or installed, any structure in, on, over, or within three metres of any waterway;

and

No person may deposit any rubbish or other debris within or alongside any waterway, or in such a manner that it may enter any waterway way; or otherwise cause nuisance or damage

Response: Five to six metre set-back is preferable to the Trust Board

22 Erosion and Sediment Control Plans

(1) Any person intending to undertake earthworks must, before stripping vegetation or beginning earthworks, engage a suitably qualified person to prepare an Erosion and Sediment Control Plan that sets out how erosion and sediment from the site will be managed during the earthworks.

(2) The Erosion and Sediment Control Plan must set out how the site of the earthworks will be managed to: prevent earth or sediment from being washed off the site or otherwise carried in water onto neighbouring properties, roads, or into the stormwater network; stabilise land to prevent earth slipping onto neighbouring properties, roads, or into the stormwater network; stabilise entranceways and prevent earth or sediment from being spilled or tracked off the site by people or vehicles; and control or minimise dust.

(3) An Erosion and Sediment Control Plan must be prepared by a suitably qualified person and in accordance with Environment Canterbury's Erosion and Sediment Control Toolbox.

(4) Any person undertaking earthworks must make the Erosion and Sediment Control Plan available to the Council on request.

Response: Agree

(5) The site manager or person undertaking the earthworks must ensure the measures set out in the Erosion and Sediment Control Plan are implemented, monitored and fit for purpose.

Response: All site workers must have complete knowledge of the Erosion and Sediment Control Plan and have the tools and equipment immediately available.

23 Measurements Must be in Place before and during earthworks, and until the site is stabilised

(1) To ensure that any risk of sediment entering the stormwater network is minimised, a person undertaking earthworks must: put appropriate erosion and sediment control measures in place before beginning the earthworks; keep those erosion and sediment control measures in place until such time as the area disturbed by the earthworks has been stabilised, and the risk has sufficiently diminished; and remove and appropriately dispose of all erosion and sediment control measures once the site has been stabilised.

Response: We agree in part. The erosion land sediment controls must be inspected by the Christchurch City Council prior to commencement of works.

25 Maintenance or Repair of Private Stormwater Drains

(1) The customer owns the private stormwater drains within the customer's property and on the customer's side of the point of discharge, and is responsible for all repairs and associated costs. Explanatory note: Council owns and is responsible for maintenance of the public stormwater system including the pipe and the fittings up to the point of service connection.

Response: Agree in Part

Private stormwater drains must be inspected by CCC at regular intervals

(2) If the Council believes that stormwater drains on private property are damaged, blocked, or otherwise not in a satisfactory operating state, the Council **may** require the property owner to investigate the drain and rectify any issues, at the owner's cost.

Response: ……the Council must require the property owner to investigate the drain and rectify and issues,……

26 Maintenance of Private Stormwater Devices

(1) Where the Council has required an occupier to install a privately-owned stormwater device, the occupier must maintain the device in good operating condition. Explanatory note: A privately-owned stormwater device may have been required by the Council as part of a Building Consent or Resource Consent or as a condition of either a discharge approval, or an Industrial Stormwater Discharge Licence.

Response: Agree

(2) Any person with a privately-owned stormwater device must retain the operations and maintenance manual, as-built drawings, and maintenance records for the device; and make these available to the Council on request

Response: The Council must request the maintenance records at regular intervals.

29 Risk Classification and Licensing of Industrial Premises

(6) As part of the licensing process, the Council may impose conditions on the stormwater discharge from any premises. The occupier of a licensed industrial premises must comply with any conditions set out in their licence.

Response: CCC Must monitor all discharges from industrial premises and ensure that all are complied with.

We wish to be Heard.

With thanks,

Ann Kennedy and Kit Doudney

AHEIT