Chemical contaminants in Aotearoa

State of knowledge, management and risks

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Contents

List of acronyms

ANZECC	Australian and New Zealand Environment Conservation Council
ANZG	Australian and New Zealand Guidelines
BaP	Benzo-α-pyrene
CC	Chemical contaminants
CLM	Contaminant load model
DIA	Department of Internal Affairs
EC	Emerging contaminant
EOC	Emerging organic contaminant
GSC	Global stormwater consent
LAWA	Land, Air, Water, Aotearoa
MBIE	Ministry for Business, Innovation and Employment
MfE	Ministry for the Environment
MWW	Municipal wastewater
NEMS	National Environment Monitoring Standards
NOF	National Objectives Framework
NPSFM	National Policy Statement for Freshwater Management
OCP	Organochlorine pesticide
ONP	Organonitrogen pesticide
OPP	Organophosphorous pesticide
PAH	Polycyclic aromatic hydrocarbon
RMG	Resource managers group
SIG	Special interest group
SoE	State of the Environment
SVOC	Semi volatile organic compound
SW	Stormwater
TPH	Total petroleum hydrocarbons
TV	Trigger value
VOC	Volatile organic compound
WWTP	Wastewater treatment plant

Executive Summary

Introduction

This report provides a national-level summary of the chemical contaminants that Regional Councils/Unitary Authorities include in consent-based monitoring requirements and routine State of the Environment (SoE) monitoring programmes.

The investigation was conducted by Jacobs with the advice from Drs Louis Tremblay (Cawthron) and Mike Stewart (Streamlined Environmental Ltd), as part of the wider investigation that the Parliamentary Commissioner for the Environment is undertaking. The scope of this investigation is confined to council held records for consent and SoE data and includes only those monitoring records that specified the targeted metal/metalloid and organic chemical contaminants (CCs).

Snapshot of the investigation

Over 500 consent certificate documents relating to authorised discharge of municipal wastewater, stormwater and landfill leachate were received from councils. Screening of these identified that only 250 met the target criteria to be processed through this investigation, namely, the consent condition specified that a metal/metalloid and/or organic chemical contaminant was itemised in the consent wording. State of the Environment records were provided for coastal/estuarine sediment quality SoE programmes, groundwater SoE programmes, and rivers SoE programmes. Additional records were also provided for one-off or targeted investigations.

Chemical contaminants

For the 250 consents (across all discharge activities), copper, zinc and lead were the most frequently listed metallic CCs in consent conditions. A number of parameters were only listed on occasion in several consent conditions (antimony, molybdenum, selenium, thallium, vanadium, silver). For organic CCs there were very few chemicals that were regularly required to be monitored for across all discharge activities. Total Petroleum Hydrocarbons (TPH) were required to be monitored in between 50 and 75% of stormwater consents, but for wastewater consents, no organic CCs were required to be monitored in >25% of all the consents. This suggests there is little consistency in the suite of organic CCs required to be monitored under this discharge activity.

Few consents listed non-routine CCs (including emerging contaminants) in monitoring conditions. Of the 250 consents, only six consents referred to emerging contaminant monitoring, of these five were for discharges from municipal wastewater treatment plants, and one was for the discharge of stormwater from the Auckland Council Global Stormwater Consent. The wastewater consent requirements were generally referred to in the review clause of consents, rather than prescribing analyses within a defined period of time. These review clauses included references to steroid hormones, endocrine disruptors, pharmaceuticals and personal care products, flame retardants and industrial products.

Consent monitoring

Monitoring against trigger values (TVs) for specific CCs was a general feature across most consents - in the discharge, the receiving environment, or both. TVs for CCs were specified directly in consent conditions in approximately half of the landfill leachate (48%) and wastewater (59%) consents, and in a greater proportion (~74%) of the stormwater consents. Where TVs were listed in consent conditions, and monitoring data relevant to the consents was provided by councils, the TVs were being met with in ~62% of analysed results.

It was also apparent that there is potentially a considerable amount of information related to CCs for the key activities in this report that remains in the 'grey-literature' area, meaning that it is not readily discoverable or accessible. In particular, for wastewater discharge reconsenting, recent assessments have included analyses of EOCs. Whilst the results of these analyses are included in technical assessments supporting a consent application, they are not directly listed in the consent conditions themselves. Although this data is considered publicly available, it is not readily discoverable by assessing the consent conditions alone, thus remains as potentially a significant source of data for future assessments.

Regional State of the Environment monitoring

Coastal and groundwater SoE programmes generally included a wider suite of metal/metalloid CC compared with the river SoE programmes. For coastal and groundwater SOE programmes, up to 12 metal CC were included in routine analyses, and this was common across 12 councils. The groundwater suite was comprised of a wider suite of metal CCs compared with the rivers SoE programmes. In addition, environmental impacts on aquifers is addressed via the long-term National Pesticide Monitoring Programme, as well as other key indicators of anthropogenic stress (nutrients, faecal indicator bacteria).

Targeted / one-off investigations conducted by councils generally included a more diverse range of organic CC that were not listed in routine SoE programmes or consent monitoring records. These included analyses of extended herbicide/pesticide suites, anticoagulants, and organochlorine pesticides. In addition, councils also indicated other assessments undertaken as risk assessments and contaminant load model development as tools to identify risks of CCs to the environment. Examples of these included reviews of emerging contaminants, microplastics, endocrine disruptors, and extended suites of pesticides.

Linkages between consents and SoE monitoring

At a high level, coastal/estuarine benthic sediment SoE programmes have clear linkages to regional global stormwater discharge consents – this is evident in the narrative to identify the key drivers for justifying the long term monitoring programmes, as well as the incorporation of these monitoring networks in the scope of the consent conditions themselves. This approach has been adopted for main urban centres that have implemented recent widescale global stormwater discharge consents, which have included the SoE programmes, where possible, in the scope of the detailed stormwater monitoring plans.

There were indirect linkages between the municipal wastewater discharge consents to wider receiving environment monitoring programmes but limited to no evidence of linkages between landfill leachate discharge monitoring and SoE programmes.

Council approach to monitoring contaminants

Council approach to monitoring CCs has changed over time - newer consents have a requirement for monitoring a wider range of contaminants, leading to increased knowledge of contaminants and understanding of their potential effects. However, there are multiple barriers that councils have identified that prevent expansion of current monitoring programmes, and incorporation of CC into new consenting frameworks. Key examples of barriers to CC include:

- Lack of national guidance of relevant limits for many non-routine CC,
- Lack of knowledge within council of where (and whether) non-routine CC contaminants are an issue,
- High cost for both laboratory analysis and council staff costs spent doing monitoring and reporting.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to identify the range of current approaches to monitoring of chemical contaminants in consented landfill leachate, wastewater and stormwater discharges across New Zealand and provide a high level analysis of data gathered under those consents in accordance with the scope of services set out in the contract between Jacobs and the Parliamentary Commissioner for the Environment ('the Client'). That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client and Regional Councils across New Zealand and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

For this project a significant reliance is placed on the Regional Councils to provide information regarding consented discharges and the associated data that they hold. Due to timeline requirements for the delivery of this work by a set end date and resource pressures in councils the full range of all data from across New Zealand is not included within this report.

This report has been prepared on behalf of, and for the exclusive use of, the Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

1.1 Background

Chemical contaminants (CCs) are already being monitored within Aotearoa New Zealand's aquatic environment including estuarine and freshwater ecosystems. Routine monitoring has largely focussed on traditional suites of trace metals, hydrocarbons, legacy pesticides and nutrients, for which there are extensive guidelines and management practices prescribed. Other non-routine/non-traditional CCs are also being increasingly included in both consent-based and long term network-based monitoring programmes – these may include industrial, agricultural, and domestic sources that are not currently managed under standard receiving environment guideline processes, such as the Australia New Zealand Guidelines for Marine and Freshwater (ANZG 2018, formerly known as ANZECC 2000)[1]. The 2019 Parliamentary Commissioner for the Environment (PCE) report *Focusing Aotearoa New Zealand's Environmental Reporting System for Both Rural and Urban Areas* identified a knowledge gap with respect to CCs.

A common theme that was identified in the 2019 PCE report is that the process of data management is inconsistent across regions, leading to widespread systematic issues of data discoverability, inconsistency in reporting, and the inability for knowledge gaps to be readily identified. Information about specific CCs found in leachates, stormwater, wastewater (grey and black water discharges) is limited, analytical protocols, and assessment methods (i.e. trigger values (TVs)) are different across discharge activities, and the data are not collated in a national database. These factors ultimately restrict the ability to assess if potential impacts of CCs entering the receiving environment are comparable across regions.

The consequence of these differences is the limitation to adequately assess the potential risk of relevant CCs to New Zealand's environment. For consent-based or location specific monitoring, this may lead to differences between regions, with differing expertise and skills, to assess these risks through an evidence-based approach. Importantly, these differences limit the ability of central government to develop appropriate policy and regulation to inform a consistent approach to assessing the effectiveness of risk management under current regulatory settings. Thus, it is not currently possible to readily assess the efficacy of regulations, or robustly identify what changes (if any) are needed.

1.2 Purpose of this Report

PCE wishes to gain a clearer understanding of the current state of knowledge of chemical contaminants in Aotearoa, and the effectiveness of existing risk management systems. The purpose of this report was to gather information on the following questions:

(1) What is the state of knowledge on contaminants entering NZ's receiving environments?

(2) What does the evidence say about the effectiveness of regulatory system to manage the risks?

1.3 Scope of this Report

This project investigated the following:

- The common/routine CCs monitored from consented effluents and discharge points at the different regions across New Zealand;
- Identify CCs that are monitored in receiving environments through Regional Council (RC) and Unitary Authority (UA) State of the Environment (SoE) monitoring programmes (e.g. coastal water quality programmes);
- Assess which CCs are currently at levels above regional specific (if applicable) water and sediment quality guidelines; and

[1] https://www.mfe.govt.nz/publications/fresh-water/australian-and-new-zealand-guidelines-fresh-and-marine-water-quality

- Identify any other non-regulated compounds (such as emerging contaminants (ECs)) collected as a part of regular council-controlled sampling regime or from research one-off studies.

In terms of information on CCs monitored as part of regular long-term network (SoE) monitoring, the focus for this report was for information held in groundwater, rivers, and coastal monitoring programmes. Information about any chemical monitoring data that can be considered as non-routine has also been gathered. This would, for example, include information that may be included in targeted or one-off investigations, and may include ECs.

The consented activities investigated are discharges of leachate from active landfills, discharges of treated wastewater from municipal wastewater treatment plants and discharges of stormwater focusing primarily on global consents but also considering a representative range of other stormwater consents for residential, commercial and industrial land uses.

1.4 Document Structure

This document is structured as follows:

- Section 1 provides the introduction and background to the project;
- Section 2 describes the context of existing monitoring programmes;
- Section 3 describes the approach to gathering and analysing the data;
- Section 4 sets out the overall results of this study for consent-based monitoring;
- Section 5 sets out overall results of this study for State of the Environment and non-routine monitoring, citing three case studies of consenting approaches;
- Section 6 summarises councils' approach to monitoring;
- Section 7 summarises the key findings.

1.5 Definitions

The following definitions were applied.

Table 1 Definitions used in this report

Word or phrase	Definition used in this report
Chemical contaminants (CCs)	Metal and organic compounds (hydrocarbons, pesticides, other organics), specifically 'any synthetic or naturally occurring chemical that is not commonly monitored in the environment but has the potential to enter the environment and cause known or suspected adverse ecological and (or) human health effects'. For the purpose of this investigation we are focussing on chemical toxicants only. Physical, nutrient and microbiological monitoring parameters have been specifically excluded.
Consent monitoring	Authorised monitoring undertaken for a specific discharge activity, assessed against specific and permitting decisions set out in Regional Plans. Monitoring is specified under consent specific conditions.
Councils	Used here as a collective word to represent the Regional Councils (RC's) and Unitary Authorities (UA's) in NZ
Routine contaminants	Analytical suites of metals and/or organic compounds that are implemented on a regular basis for specific discharges or receiving environment types, that may be common to both consented discharges as well as SoE monitoring programmes

Word or phrase	Definition used in this report
Emerging Contaminants (EC's)	Any synthetic or naturally occurring chemical or any microorganism that is not commonly monitored in the environment but has the potential to enter the environment and cause known or suspected adverse ecological and (or) human health effects. [2] Of note: this project focused on chemical contaminants so microbial data was not gathered or reviewed.
State of the Environment (SoE)	Long-term routine catchment network monitoring mandated under Section 30 of the RMA, designed to describe state and trends of environmental quality.
Targeted investigation	A project focused on gathering data for a specific purpose that is generally of shorter duration and not intended to be routine/ongoing.
Municipal wastewater	Treated wastewater, discharged into the environment from a municipal wastewater treatment plant (usually council owned).
Biosolids	Sewage sludges or sewage sludges mixed with other materials that have been treated and stabilised to the extent that they are able to be safely and beneficially applied to land.
Stormwater	Surface water that runs of land that is collected and discharged into rivers, lakes and the sea
Landfill leachate	The liquid waste stream discharged from a landfill that is usually captured and treated on site or trucked to a municipal wastewater treatment plant for treatment.
Global Consent	An overarching consent over a specific region or district that allows a specific activity to take place. These generally reduce the time and cost associated with compliance, whilst providing a mechanism for monitoring and managing the activity. Global stormwater consents are relatively common for urban areas.
Trigger Value (TV)	A concentration threshold that once exceeded, initiate a predefined set of actions.
Hazardous substance	Any substance identified in the Hazardous Substance and New Organisms (HSNO) Act. The Worksafe website provides a searchable database of hazardous substances (worksafe.govt.nz)
Trade waste	Wastewater from any industrial or trade activity. These may be discharged into a municipal wastewater treatment plant, or treated sand disposed of separately at the industrial site.
Discharge monitoring	Monitoring of discharges into the environment, usually required as part of a resource consent.
Receiving environment monitoring	Monitoring of the receiving environment into which discharges are occurring, such as: water, air, land and sediment.
Legacy contaminants	Known contaminants present due to a historic discharge that has since ceased.
Monitoring/Management plans	Documents providing the framework for discharge monitoring, usually to meet the requirements of a resource consent.

[2] https://toxics.usgs.gov/investigations/cec/index.php

1.6 Assumptions

The following assumptions were made.

Table 2 Assumptions made for this project

Subject area	Assumption made
Water and sediment quality guidelines	For the purposes of this report the guidelines used were those thresholds or limits outlined in each specific resource consent document (where these existed). Given the large number of discharges and receiving environments under consideration across NZ and regional differences in approaches, it was not possible to identify receiving environment guidelines/limits that could be consistently applied across all of the data collected. Hence the existing guidelines/limits that were determined on a site-specific basis for each consent were used to compare data to for analysis of whether data was above or below guidelines.
Water and sediment quality guidelines	It was assumed that guidelines or limits set in resource consents were environmentally sound and tailored for both the activity and receiving environment. No assessment of the suitability of any limits specified in consent documents was undertaken as part of this study.
Trigger value exceedance	An exceedance was recorded for any monitoring data provided that exceeded the corresponding TV listed in the consent condition. There are a wide range of trigger values and reporting mechanisms across activities, regions and monitoring requirements for the same contaminant. Thus, a meaningful and robust method to compare the magnitude of monitoring exceedances was not possible. Where data were provided, and records indicating an exceedance specific to the consent TV, at any time in the record, was recorded as a binary (yes, no) response.
Only active landfill consents included	As agreed with PCE at the beginning of the project, only data on operative landfills that were actively receiving waste were included. These are considered more likely to generate leachate that represents current NZ waste streams and the controls associated with these. Closed landfills were specifically excluded.
Range of stormwater consents chosen were representative	Stormwater consents cover a range of land uses and sizes of operations from individual lots through large subdivisions to regional focused multi-settlement consents. These consents can be held by individual councils, private industry, and public organisations. Due to the volume of potentially available consents, councils were asked for a subset of these, focusing primarily on global consents but also considering a representative range of other stormwater consents for residential, commercial and industrial land uses and consents that were less than 10 years old. The analyses therefore assumed that data provided for each region is representative of that region, but limitations of data are also addressed.
Representative municipal wastewater treatment plants	Wastewater discharge consents were for municipal treatment plants only so exclude private industrial facilities, with councils asked to focus on settlements with a population equivalent of over 1000 people. This was to minimise the number of consents for very small plants and it was assumed that smaller treatment plans would be less likely to have extensive chemical monitoring being undertaken.
Biosolids	Based on the case study of biosolids management in NZ, the majority of biosolids disposal is undertaken under consents for other activities. Therefore, review of biosolids disposal to land consents was undertaken through a case study approach (see Appendix B)
Single exceedances	Single reports produced as part of general consent reporting do not generally require an assessment of trends/patterns over time. Exceedances/ one-off exceedances were indicated in data records provided, the longer-term consequence/historical records of similar exceedances are difficult to assess in the context of this project.
Out of scope	The following were considered out of scope for this project: - Suitability of information contained in the consent conditions, including the assessment of the appropriateness of TV (where indicated) was not assessed. - Assessment of annual compliance

1.7 Acknowledgements

Jacobs wish to acknowledge the Local Government sector's Resource Managers Group (RMG) for facilitating council contacts and dissemination of information regarding this survey.

Acknowledgement and appreciation is extended to the many council staff members for their time to collate and supply requested data, and for the extra time to discuss the survey.

Drs Louis Tremblay from Cawthron Institute and Mike Stewart from Streamlined Environmental Ltd whose roles as leading NZ researchers into ECs provided guidance on the overall direction and approach of this project and review of the main findings.

2. Review of Existing Monitoring Programmes

This section provides an overview of the key drivers for why councils undertake different monitoring programmes. This informs the understanding of how approaches to monitoring can differ depending on the regulatory driver, and between regions across New Zealand.

2.1 National Guidance

National guidance is available in some instances to assist in decision making around resource consent monitoring, and to some degree can assist in providing consistency across NZ in CC monitoring. Examples of key guidance documents include:

- Landfill guidelines[3] that document suggested monitoring suites for active landfills;
- The ecologically focused Australian and New Zealand Guidelines for Fresh and Marine Water Quality Guidelines[4] (ANZG 2018);
- New Zealand Municipal Wastewater Monitoring Guidelines[5].

It is noted here that these guidelines are non-statutory, meaning that there is no legal obligation for these to be implemented on their own.

There are also a range of statutory guidelines, standards and policies that include provision for activity-specific monitoring to be undertaken, for the purpose of ensuring that there are no adverse effects of that activity on the receiving environment. Examples of these, relevant for the discharge of landfill leachate, stormwater and municipal wastewater discharges, include:

- The National Policy Statement for Freshwater Management [6] sets out mandated objectives and policies that apply across all freshwater in NZ, specifying a hierarchy of rights of protection under Te Mana o te Wai;
- National Environment Standards for Freshwater[7], specifying requirements for carrying out certain activities that pose risks to freshwater and freshwater ecosystems;
- New Zealand Coastal Policy Statement[8], specifying policies that address the requirements for councils to regulate stormwater, wastewater and toxicant discharges to the coastal receiving environment;
- The Guidelines for Drinking Water Quality Management for New Zealand (2019)[9] , specifying maximum allowable values (MAV) of toxicants in potable water.

In the absence of New Zealand based guidelines, a variety of international guidelines can also be referred to where available, and where council experts have considered all practicable options. Examples of commonly cited international guidelines include those derived from the United States EPA, European Union, and various Australian based guidelines.

2.2 Resource Consents

The Resource Management Act1991 (RMA) and Council RMA planning framework generally govern monitoring of discharges to the environment, including any monitoring of CCs as part of any resource consent. The data gathered as a result of monitoring is therefore focused on the requirements of the resource consent conditions specific to that activity and location.

[3] Technical Guidelines for Disposal to Land (updated August 2018) https://www.wasteminz.org.nz/pubs/technical-guidelines-for-disposal-to-land-april-2016/
[4] https://www.waterquality.gov.au/anz-guidelines
[5] https://www.waternz.org.nz/Article?Action=View&Article_id=33. The authors note that these NZMWWMG are nearly 20 years old, whilst providing some guidance, best practices are out of date
[6] https://www.mfe.govt.nz/publications/fresh-water/national-policy-statement-freshwater-management-2014-amended-2017
[7] https://www.mfe.govt.nz/fresh-water/freshwater-acts-and-regulations/national-environmental-standards-freshwater
[8] https://www.doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/coastal-management/nz-coastal-policy-statement-2010.pdf
[9] https://www.health.govt.nz/publication/guidelines-drinking-water-quality-management-new-zealand

Regional specific issues are identified through the RMA planning framework (regional plans developed under the RMA focus on the management of issues specific to that region) and therefore the requirement for resource consents follow on from these regional specific issues. –. One regulatory management method is to have rules that specify a requirement for resource consent for specific activities or locations. For example, discharges of wastewater from municipal wastewater treatment plants, leachate from landfills and stormwater from urban areas generally require resource consents. However, each councils' Plan rules and requirements are different depending on how the Plan is written, in particular, the provision for certain discharges to be allowed as permitted activities (thus needing no consent). This results in differences between regions regarding the approach to rules for each activity. This means that the requirement to monitor CCs for a specific discharge activity may also differ between regions.

Each resource consent application assesses the matters of relevance to that activity and location – the resource consent application will include an Assessment of Effects on the Environment (AEE) that is in accordance with the scale and nature of the potential effects to the specific receiving environment. Hence, consideration is made of the nature of the discharge, the treatment being provided and the type and quality of receiving environments, among other matters. This means that the CCs of interest are inherently linked to the original resource consent application[10].

Given that monitoring is required for specific reasons, each resource consent application is decided on its own merits in relation to the location, environment and opinions of submitters (among other matters). Thus, the monitoring requirements are usually specific and tailored to the consented activity and the reasons for that monitoring. This can result in differences between consents in terms of what monitoring is undertaken and what outcomes occur as a result of that monitoring, for example:

- Monitoring can be required for discharges only, or one or more receiving environments (e.g. groundwater or surface water);
- Numerical limits can be set to one or both receiving environments, and in the case of surface water, would usually be set with consideration of a zone of reasonable mixing. These further tailor any numerical limit to the activity and location;
- Limits can be set as an absolute limit to protect a particular environmental value, or can be focused on triggering further management actions through trigger values specified within consent conditions.

2.3 Monitoring under State of the Environment Programmes

RCs and UAs are mandated under Section 35 of the RMA (Section 35(1) and 35(2)) to gather information, monitor, and keep records about the state of the environment. This is commonly referred to as State of Environment (SoE) monitoring. Furthermore, the RMA specifies that information must be compiled and reviewed at least every 5 years (s35(2A)) – this is commonly referred to as 'Trend' analysis. This monitoring can include CCs.

Differences in the SoE monitoring occurs across the different regions of NZ due to:

- Monitoring is generally in accordance with the requirement of specific regional plans – given each regional plan differs, and catchment specific requirements differ, then in turn SoE monitoring programmes are different between councils in terms of network design;
- Network and monitoring design is generally undertaken on a representative area for major land-use and catchment types – and undertaken on a representative catchment basis, rather than specifically directed at point source or activity based discharge effects monitoring.

[10] The assessment of consent applications was not addressed in this report and is noted here for context only.

However some effort is currently being made to create consistency under the SoE programme, via the data reporting systems implemented by Land Air Water, Aotearoa (LAWA), and mandated by the sectors Resource Managers' Group (and then by the Regional Councils' Special Interest Groups), as outlined further in Section 2.4.

2.4 Other drivers for CC Monitoring

A number of other key drivers exist that directly or indirectly support councils to further develop knowledge about CCs, across a range of methods. These include council focussed initiatives facilitated through the RMG, central government funded programmes, central government policy reforms, and parallel investigations and avenues for improving the standard of consistency in monitoring, as outlined below.

- Council focussed initiatives:
  - Council Special Interest Groups (SIGs) have provided funding for championing MBIE Envirolink[11] advice programmes and monitoring 'tool' development'. Some examples of what has been produced out of these tools include the Estuarine Trophic Index (ETI) Tool, Urban Water Quality Tool, Eco-Sediment Guideline Value Tool, Review of EOCs in New Zealand (full technical reports are available from the Envirolink publications page);
  - LAWA[12] module development – a coordinated data reporting system, funded by MBIE and MfE, supported by councils, for the purpose of reporting SoE data across domains. The domains for groundwater and river water quality are publicly available, but data currently reported does not currently include the full suite (including the target CC) of parameters analysed by each council. The domain for coastal/estuarine quality is currently under development;
  - National Environment Monitoring Standards[13] (NEMS) - a series of standardised sampling methodologies detailed across a series of environmental monitoring disciplines, designed by technical expert working parties in collaboration with regional council experts, for the purpose of setting out protocols for best practice for field sampling and data management.
- Central Government Funding and role of CRI / Research collaborations including:
  - Cawthron-led MBIE funded 5-year Emerging Contaminants programme – a comprehensive research programme to investigate the risks of EOCs to New Zealand biota;
  - ESR-led Aotearoa Impacts & Mitigation of Microplastics (AIM^2)[14] MBIE programme – a comprehensive programme to investigate the risks of microplastics to New Zealand's ecosystems, biota and people.
- National monitoring programmes:
  - National Groundwater Pesticides Programme[15] - undertaken on a four-yearly basis in collaboration with regional councils, including a comprehensive analysis of EOCs in the 2018 round.
- Central government policy reforms:
  - Three Waters Review by the Department of Internal Affairs[16] , setting out a series of detailed reports regarding the status of Three Waters (drinking water, wastewater, stormwater) service provision and asset management by councils across New Zealand;
  - Establishment of a new Water Services Regulator, Taumata Arowai[17] (announced in September 2019 following the DIA Three Waters Review), the creation of the Taumata Arowai Establishment Unit within the DIA in November 2019, and the Water Services Regulator Act[18] passed in July 2020. Once fully functional, the Unit will oversee, from a national perspective, the environmental performance of waste water and storm water networks across New Zealand (as well as drinking water).

[11] https://www.envirolink.govt.nz/
[12] https://www.lawa.org.nz/
[13] http://www.nems.org.nz/
[14] https://www.esr.cri.nz/our-research/research-projects/aotearoa-impacts-and-mitigation-of-microplastics-aim/
[15] https://www.esr.cri.nz/our-services/consultancy/groundwater-in-new-zealand/
[16] https://www.dia.govt.nz/Three-waters-review
[17] https://www.dia.govt.nz/Taumata-Arowai-Establishment-Unit
[18] https://www.legislation.govt.nz/act/public/2020/0052/latest/LMS294345.html

- National Reporting and reviews:
  - Ministry for the Environment's Urban Water Quality State and Trends[19] report – providing a detailed assessment of the state and trend of water quality in urban streams for several sites across New Zealand for which long term records for key metal CC are available;
  - Environmental Reporting Act review by the PCE[20] - whilst the report is focussed on the Act itself, key themes relevant for councils have emerged regarding the differences in how monitoring data is collated and reported across New Zealand.

[19] https://www.mfe.govt.nz/sites/default/files/media/Fresh%20water/urban-streams-water-quality-state-and-trends-report.pdf
[20] https://www.pce.parliament.nz/publications/focusing-aotearoa-new-zealand-s-environmental-reporting-system

3. Approach to Data Collection

A set of questions was developed and agreed with the PCE with the aim of gathering information from RC's and UA's in New Zealand (referred to collectively as councils in this report). This was issued to all councils as an online form. The questions focused on the following areas:

- Details of consented discharges: Data on the requirements of existing discharge consents was sought. This included details of what CC monitoring is required of both the discharges and the receiving environments for each consent;
- Provision of available CC consent monitoring data: Councils were asked to upload available monitoring data (preferred) and/or monitoring reports to the form for each consent. More recent (last 10 years) data was requested;
- Identification of SoE monitoring: Councils were asked to provide information on relevant SoE CC monitoring undertaken, the monitoring parameters included and links to data and reports.
- Identification of non-routine/ EC data gathering: Councils were asked to provide details of any work they were aware of within their region that may have included the gathering of data on non-routine CCs, such as EC's that was not directed by consent conditions or SoE monitoring requirements. This could include one off or targeted investigations by councils or other bodies;
- Council approach to monitoring and managing CCs: Councils were asked about their current regulatory/non-regulatory approaches to monitoring and managing CCs and opinions about potential future approaches.

A flow chart describing the on-line questionnaire and a copy of written survey questionnaire can be found in Appendix A.

Data provided by councils was collated and summarised into a series of spreadsheets, with additional categories identified to supplement the CC information itself. From these a national level summary was developed identifying the key themes and gaps across NZ.

The following information was collated under separate data categories for each consent entry:

- Average duration of the consent activity (recorded as the start year and expiry year);
- For stormwater consents, if the consent was a 'global' consent;
- If point-source discharge and/or receiving environment monitoring required (and the location of where any receiving environment monitoring was required if listed;
- If a TV was specified for a CC in the wording of a condition itself;
- If data indicated TV was exceeded (as yes/no);
- Where monitoring records were provided by council, whether the data records indicated that any exceedance of a TV, at any time, was recorded (where no monitoring records were provided for consents that listed a TV, this was also recorded as 'not provided');
- If consents listed any direct reference to SoE monitoring in the consent condition wording;
- Any requirement for monitoring plans/management plans to be set out in relation to the management of CCs;
- If there were any references to other tests/assessments related to CCs, such as whole effluent toxicity (WET) testing (occasionally undertaken for effluent toxicity assessments);
- Any reference to hazardous waste, trade waste (for WWTP only), other similar clauses.

Further information on how the information was collated into the spreadsheet is outlined in Section 3.1.1 and 3.1.2 below. Discharge of biosolids arising from wastewater treatment plants is not usually authorised by the wastewater effluent discharge consents. The case study in Appendix B highlights that the majority of NZ

biosolids is actually disposed of or used under other consented activities (e.g. landfills and quarry rehabilitation). Therefore, a case study of CC monitoring under specific biosolids use/disposal activities approach was undertaken rather than a wide review of biosolids discharge to land consents.

3.1.1 Data screening and sorting

Individual files were received by a variety of methods from council – either as files uploaded to the online data portal provided, as files emailed directly to the project team, as links to shared folders for larger numbers of files held by council. Several councils provided lists of files compiled into summary spreadsheets, with corresponding document identification numbers, or URL links to online files.

For councils that provided lists in spreadsheet form, these lists were sorted into activity type, and further sorted to ensure the requirements of the scope were being met – i.e. active landfills only (all closed landfills were excluded), any WWTP that services a population of more than 1,000 (sceptic tank, small dwelling discharge consents were excluded), and for stormwater a subset of consents was selected on the basis of main population centres in regions as well as targeting any global discharge consents (i.e. all subdivision and earthworks consents were excluded).

Any consent certificates (and reports/data files) provided were examined to assess whether the target CC for this report were listed in the consent/SoE document. Where there as no indication of any CC being listed, the files were excluded from further analyses.

3.1.2 Trigger Values (TVs)

Where there was a trigger value (TV) specified for a CC, in any of the relevant conditions for a targeted consented activity, this was recorded in the data analysed for that consent.. This specific wording could be located within the:

- Main text of the specific consent condition as a specified numerical value;
- Main text of the specific consent condition as a specified comparison to default guideline values (from a specified guideline);
- A table/list of numerical values for the CC;
- A separate schedule, attached to the consent, and cross references in the specific wording of the consent condition itself.

If the wording of a condition indicated that a TV for a CC were to be developed and included in any additional monitoring plans required under a consent condition, then this was not recorded as a TV being specified in the consent condition itself. Where this occurred, but with no TV being explicitly listed, was generally due to a combination of the following:

- The setting of a TV in a management plan (MP) was not indicated as mandatory for purpose of the consent, and was instead up to the discretion of the content of the MP itself (and thus up to the discretion of the approvals process of the MP);
- The separate management plans were generally not provided by councils, and for more recent consents were still under development;
- The CC for which a TV may be indicated was not specified in the wording of the consent condition, for example several instances were noted where the wording of the consent indicated that the default guideline levels for the ANZG (2018, formerly ANZECC) shall be met, but specific CC themselves were not itemised.

Where a TV was recorded for a specific CC in a consent, the monitoring data records (where available for that CC) were examined. If an exceedance of the CC compared with the TV was recorded in the monitoring data, this was recorded in the data analyses as an exceedance. It is emphasised here that the overall implications of this exceedance was not assessed (i.e. consent compliance, potential for adverse effects, further action triggered by exceedance).

4. Overall Results

4.1 Overview of Responses

Over 500 individual consent certificate documents were received, as well as a further set of comprehensive spreadsheets from individual councils, listing all targeted resource consents issued by that council. Of these, 250 were identified as meeting the target criteria (i.e. direct listing of target chemical contaminants) for selection to be analysed in detail. Table 3 lists a summary of the total number of consents per activity, and corresponding average duration of each activity type.

Table 3 Summary of consent duration (years) and total number of consents analysed per key activity

Item	Overall	Leachate	Wastewater	Stormwater	SW Global[2]
Total number of consents analysed[1]	250	44	49	157	58
Consent duration (average)	24	28	24	20	27
Consent start year (range)	1992-2020	1992-2020	1997-2020	1997-2020	2002-2019
Consent end year (range)	2020-2054	2020-2054	2020-2053	2020-2054	2022-2054

[1] Consents analysed for target contaminants only included in the results.
[2] The total number of global stormwater consents is a subset of the total stormwater consents

At the national level, average consent durations issued were broadly similar for wastewater and stormwater and slightly longer for leachate consents. Typically consents for these activities can be regarded as long-term consent durations, whereby shorter durations are generally around five years, and medium-term duration are generally around 10 years.

The survey initially requested all records of global consents, where these existed, to be submitted. However, it became apparent that for most councils, hundreds of consents, and for two councils (Auckland, Canterbury), up to thousands of consents, had been authorised for the discharge of stormwater. As such, the stormwater data analysed in this report are regarded as a 'snap-shot' of examples across this activity. A list of the known numbers of these consents is provided in Table 4.

Table 4 Stormwater (SW) consents held by councils and those analysed for this report

Region	Total SW consents issued by council	Total SW consents analysed for this report[1]	Total global SW consents analysed for this report[2]
Auckland	3731[3]	7	2
Northland	559[4]	37	14
Wellington	136[5]	3	2
Hawkes Bay	342	30	7
Waikato	107	7	2
Nelson	70	2	1
Horizons	182	5	1
Gisborne	97	2	0
West Coast	90	2	1
Canterbury	1143[6]	16	16
Otago	36	3	0
Bay of Plenty	670	21	5
Taranaki	289[7]	12	2
Tasman	574	4	0
Marlborough	147	0	0

Southland	50	6	5

[1]The total number of SW consents analysed were those that specifically included the target CC of interest.

[2]The total number of global consents (authorising discharge from the reticulated network) analysed for this report is a subset of the total number of stormwater consents analysed, per council. Only global consents listing CCs were included in analyses.

[3]For AC, there are 2986 operational SW consents, 621 construction SW consents, 124 'bundled' consents. Most (estimated at >80%) are for sediment control

[4]For NRC, there are 196 consents authorising discharge to water, 262 authorising discharge to land, 101 authorising discharge to the coast

[5]For GWRC, 76 are operational SW consents, 60 are construction SW consents

[6]ECAN – 659 industrial consents, 484 individual/residential consents

[7]Most industrial consents in TRC are very similar in terms of the gas/oil industry present in the region, a subset was provided for this report

The majority (estimated to be >70%[21]) of stormwater consents screened for this project (including global consents) indicated that most are for the management of discharge of sediment laden stormwater,(for example as part of earthworks consents for land subdivision or for new residential properties), and use sediment as a proxy for overall contaminant management.

Similarly, faecal contaminants are also frequently monitored for a large number of stormwater consents servicing urban networks, using faecal contaminants as indicators of potential wastewater entering the stormwater reticulated network. The premise of using both sediment and faecal contaminants as proxies for management, as communicated by councils, is that if these contaminants are being properly managed, then other contaminants, by default, are also being managed[22]. Thus, for most stormwater consents issued by councils, CCs are not required to be included in monitoring suites.

4.2 Resource consent monitoring summary

Table 5 provides a summary of information about the CCs listed in consent conditions that was identified as directly relevant for describing further characteristics associated with the targeted CCs. This included if there were monitoring requirements listed for the CCs (in point-source discharges or in the receiving environment), as well as information about the TVs associated with the CCs (i.e. if TVs were listed, and if so, did monitoring data provided by councils indicate if TVs were exceeded, at any time). If the wording of the consent condition implied that monitoring for CCs was referred to in additional monitoring plans (i.e. stormwater monitoring plans) this was recorded, and is referred to as 'assumed' in the table below. Finally, if any consents included a direct reference to council SoE monitoring, this was also recorded. Where conditions indicated a requirement for broader receiving environment monitoring on a periodic (e.g. 5-yearly) basis, this was recorded as an 'indirect' link to SoE monitoring programmes. Further details are also listed in Appendix C. Further discussion concerning aspects of monitoring requirements, if TVs are specified, and if consent wording specified any direct linkages to SoE monitoring is set out below.

Table 5 Summary of monitoring data captured from target consented activities. Data are expressed as percentages of the response parameter that was recorded in each consent activity type.

Item	Parameter assessed	Overall %	Leachate % response	Wastewater % response	Stormwater % response
Point-source discharge monitoring	Monitoring included in consent condition	77	73	87	75
	Monitoring is assumed to be undertaken in SMP[1]	1	-	-	1.3
Receiving environment monitoring	Monitoring included in consent condition (total %	56	79	65	52

[21] As screened from the Wellington, Auckland, Marlborough, Canterbury, Waikato Regional council consent records submitted. Only an estimate is provided, as all councils submitted only a sub-set of stormwater consents that included the target contaminants. Councils also indicated that due to data base formats, it was not possible to readily provide breakdowns of stormwater consents specific for subdivisions/earthworks/construction only.

[22] Pesticide and pharmaceutical products may not partition equally to the water and sediment/solid phases so and are unlikely to be effectively managed in this way.

	across all receiving environment types)				
	Groundwater monitoring	38	85	35	15
	Surface water monitoring (fresh/marine)	62	57.5	41	74
	Benthic sediment monitoring (aquatic)	38	2.5	44	54
	Biota monitoring (shellfish)	5	-	18	1.3
	Soils/retention device monitoring	12	5	15	15
	Monitoring assumed in SMP	1	-	-	1.3
TV specified[2]	TV directly specified	66	48	59	74
	TV not specified	34			
TV exceeded[3]	TV exceeded	11	5	14	11
	TV not (within TV)	19	18	26	17
	No data available/supplied	36	25	17	45
Link to SoE in conditions[4]	SoE monitoring referred to in consent conditions	6	0	0	10[5]
	SoE monitoring indirectly linked to consent conditions, via monitoring plans	6	5	7	6

[1]SMP – Stormwater Monitoring Plan.

[2]TV specified in the consent document itself (Yes or not applicable as TV not specified in consent wording).

[3]TV in consent was exceeded (Y), not exceeded (N), *no data was provided with the consent certificate (no data provided).

[4]Where the terms 'State of the Environment' or similar were used in the consent wording.

[5]Includes cross reference to SoE specified in s128 review clause.

4.3 Resource Consent – chemical contaminants summary

4.3.1 Metal/metalloid CCs

Table 6 provides a summary of the metal/metalloid CCs listed in the consents assessed in this review, listing any metals/metalloids that were counted on more than five occasions. The full table is listed in Appendix C. For the 250 consents (across all discharge activities), copper, zinc and lead were the most commonly listed in consent conditions. A number of CCs were only listed on occasion in several consent conditions (antimony, molybdenum, selenium, thallium, vanadium, silver – see Appendix C for details). Although cyanide is not defined as a metal/metalloid, it is included in the list below as was commonly listed alongside these CC in consent condition suites.

Table 6 Occurrence of metal/metalloid CCs listed in consent condition wording for leachate, wastewater and stormwater discharges (for clarity of reading, results are for those recorded >5 occurrences only. Full results are listed in Table 16, Appendix C)

Contaminant	All consents[1]	Leachate	Wastewater	Stormwater	
				All stormwater consents	Global stormwater consents
No. of consents	250	44	49	157	58
Essential metals					
Aluminium	25	18	6	1	0
Boron	11	8	1	2	1

Contaminant	All consents[1]	Leachate	Wastewater	Stormwater	
				All stormwater consents	Global stormwater consents
No. of consents	250	44	49	157	58
Cobalt	11	8	1	2	0
Manganese	28	21	3	4	2
Copper	183	32	45	106	50
Zinc	180	37	44	99	49
Iron	40	34	4	2	0
Nickel	97	25	38	34	20
Chromium	115	29	37	49	25
Heavy metals					
Arsenic	96	35	31	30	16
Cadmium	108	33	39	36	23
Lead	158	37	45	76	42
Mercury	50	9	34	7	5
Other					
Cyanide	14	4	10	0	0

Notes: 1 Colour coding is to group parameters into ranges of how frequent as a percentage the contaminants were tested for in consents. Contaminants analysed in 0-25% of consents (no shading), 25-50% of consents (pale yellow), 50-75% (pale purple) and 75 to 100% (pale blue).

Differences were evident across activity types, for example, copper, zinc and (and to a lesser extent) lead are commonly monitored in all stormwater consents, and account for greater than 50% of the occurrences in global stormwater consents (Table 6). Mercury recorded a higher frequency in municipal wastewater discharges compared with landfill leachate or stormwater.

Aluminium, iron and manganese all recorded higher frequencies in landfill leachate than wastewater or stormwater – these metals are also noted as common parameters/indicators for groundwater monitoring, which is the main receiving environment for leachate assessment. Arsenic, cadmium, chromium and nickel were all recorded at similar frequencies across the three discharge activities.

4.3.2 Organic CCs

Table 7 lists the occurrence of organic CCs (including several groups of CC) recorded across discharge activities. For clarity, Table 7 lists the CC terminology that was used in consent condition wording, and the analyses has grouped these according to the class these CC fall into. For example, TPH, PAH etc, are types of hydrocarbon CCs.

It is emphasised here, that CCs of TPH, PAH, organochlorine compounds, and multi-screen tests (SVOC/VOC) are not single chemicals, but represent groups of many chemicals within the same CC class. It is also emphasised here, that a single CC compound within a group poses potentially different risks compared with other compounds within the same group.

For organic CCs there were very few contaminants that were regularly required to be monitored across all discharge activities. Total Petroleum Hydrocarbons (TPH) were required to be monitored in between 50 and 75% of stormwater consents (total and global consents) (Figure 1B). This likely reflects the known contaminant source for TPHs from road runoff of fuels and oils. TPH analysis is also regarded as a form of screening of organic hydrocarbon contamination whereby further detailed analysis of individual or smaller groups of petroleum hydrocarbons can be undertaken if required (and which was observed in several lists of data supplied).

For wastewater consents, no organic CCs were required to be monitored in >25% of all the consents, suggesting little consistency in the suite of organic contaminants required to be monitored under this discharge activity. For landfill leachate, the only parameter that was required to be monitored regularly was SVOC/VOC (semi-volatile organic contaminants/volatile organic contaminants) (Figure 1) which was specified in between 25 and 50% of consents. Phenols, PCBs and OCPs were also more commonly recorded in landfill leachate consents than PAHs or BTEX, and at a higher proportion compared with stormwater or wastewater, but at a lower occurrence than SVOC/VOC (Figure 1).

The analysis of SVOC/VOC is widely applicable across consent activities, and at a screening level can be cost effective. Semi-volatile/volatile organic compound (SVOC/VOC) analytical suites typically include a wide range of groups of organic compounds (e.g up to 74 SVOC compounds and up to 64 VOC compounds) that were also recorded in consent monitoring lists as separate groups (e.g. PAHs, BTEX, organochlorines) or as individual compounds (e.g. individual PAHs, DDT, phenols etc).

Table 7 Occurrence of organic contaminants listed in consent condition wording for three discharge activities (for clarity of reading, results are for those recorded >5 occurrences only. Full results are listed in Table 17, Appendix C)

Contaminant Group	All consents	Leachate	Wastewater	Stormwater	
				All stormwater consents	Global consents
No. of consents	250	44	49	157	58
Hydrocarbons					
TPH	104	4	4	96	32
Total PAH[1]	34	3	6	25	13
BaP[2]	13	0	0	13	13
BTEX	9	2	0	7	4
Naphthalene[2]	7	1	0	6	6
Organochlorines					
PCB	9	6	3	0	0
OCP	9	5	3	1	1
OPP	6	4	2	0	0
ONP	6	3	3	0	0
PCP	6	4	2	0	0
Other organic chemicals					
Phenol	29	9	12	8	1
Propiconazole	5	0	0	5	0
Methanol	3	0	0	3	0
Multiple group screening tests					
SVOC/VOC	40	22	11	7	5

Notes: Colour coding is to group parameters into ranges of how frequent as a percentage the contaminants were tested for in consents. Contaminants analysed in 0-10% of consents (no shading), 10 -50% (pale yellow), 50-75% (pale purple).

[1] Total PAH are assumed to be the suite of the 16 individual high priority PAH as defined by the USEPA. This analyses counted the occurrence of the use of the terminology 'PAH', rather than listing individual compounds themselves.

[2]BaP and naphthalene are types of PAH, individual PAH compounds were counted in the CC where these were listed as individual CC, rather than as part of the PAH class.

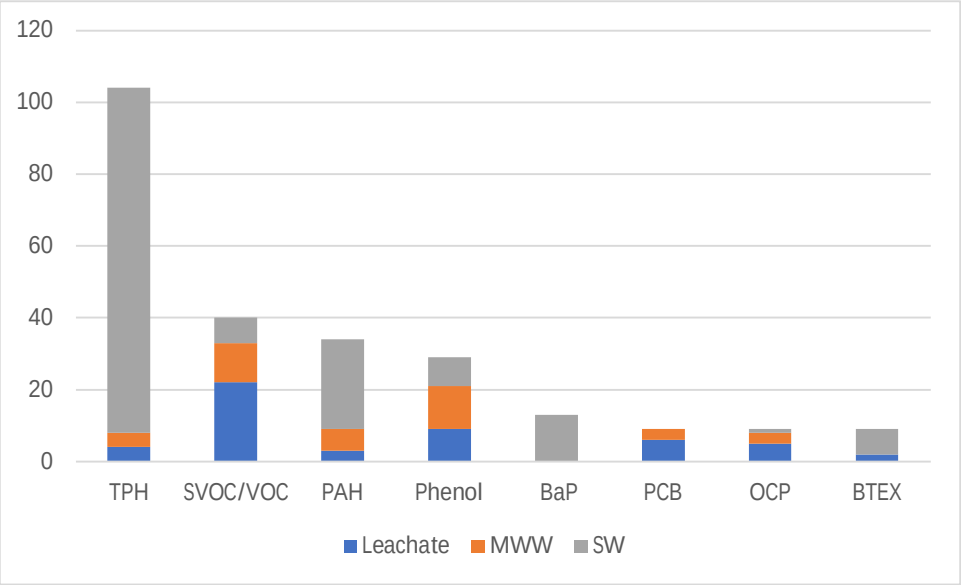


Figure 1A Total count of top eight recorded organic contaminant (as individual compounds or classes) across discharge activities

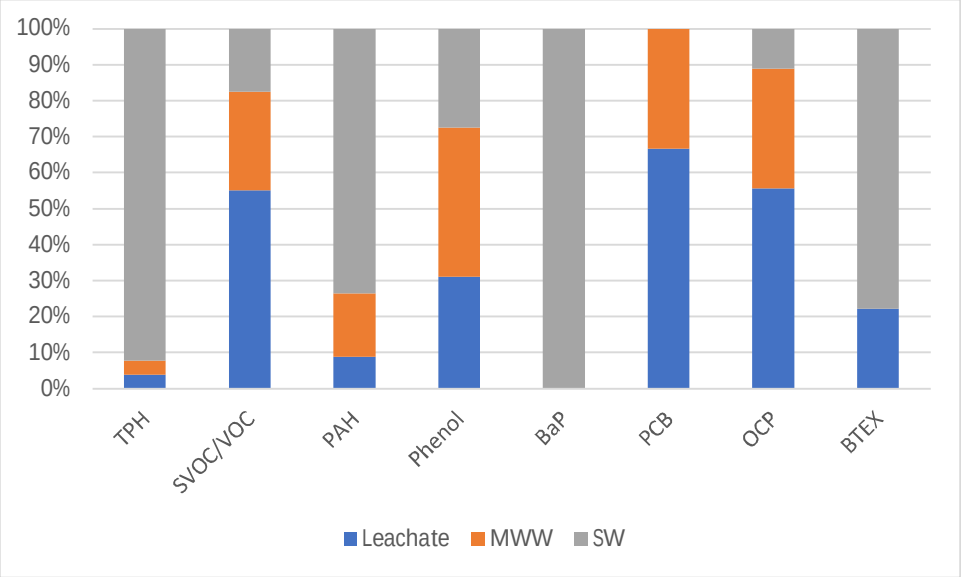


Figure 1B Percentage counts of top eight organic contaminants (as individual compounds or classes) across discharge activities

4.3.3 Emerging organic CCs

Of the 250 consents listing target CCs, six made specific reference to include the term 'emerging contaminants' (ECs) or 'emerging organic contaminants' (EOCs) (Table 8). Five of these were for discharges from municipal wastewater treatment plants, and one was for the discharge of stormwater from the Auckland Council Global Stormwater Consent. It is noted for the analyses of EOCs, the majority of data specific for consenting requirements has been undertaken as part of the consenting application or re-consenting application processes – thus is located in the technical documents supporting specific applications, not in the consent conditions themselves. The technical documents supporting applications were not assessed for this report, but potentially offer a more comprehensive analyses of the state of knowledge about EOCs particularly for discharges from WWTP across New Zealand[23].

Table 8 Summary of consent activities specifying a reference to analysis or risk assessment for emerging contaminants

Council	Activity	Comment
Auckland	Stormwater	All EOCs to be assessed, but is referred to in high level terms only
Bay of Plenty	Municipal wastewater	Required to be analysed as a once-off in consent, 12 months after consent granted
Bay of Plenty	Municipal wastewater	EOCs are referred to in a review clause, if potential risks indicate this is needed under s128 review
Bay of Plenty	Municipal wastewater	Endocrine disruptors in effluent, on request from Council
Hawkes Bay	Municipal wastewater	Review clause to include EOC analysis if warranted, including pharmaceuticals and personal care products, steroid estrogens, flame retardants and other industrial products and endocrine disrupting chemicals.
Waikato	Municipal wastewater	5-yearly investigation into risks and likelihood of occurrence for endocrine disruptors and steroid hormones in effluent. Does not specify that lab analysis is mandatory.

Requirements for analyses of EOCs for the WWTP discharges were generally included in the consent review clause, or to the discretion of the consenting authority. These WWTP references included one-off references to:

- steroid hormones,
- endocrine disruptors,
- pharmaceuticals and personal care products,
- flame retardants,
- industrial products.

The Auckland Council global stormwater consent included a generic clause for analysis and/or review of ECs, without specific reference to particular CC classes.

[23] Expert opinion of report authors and technical review team.

4.3.4 Point source and receiving environment monitoring

Figure shows the regional breakdown of where consents specified a requirement for point-source discharge monitoring and Figure 3 shows the regional breakdown of where consents specified a requirement for monitoring in the receiving environment monitoring for CCs.

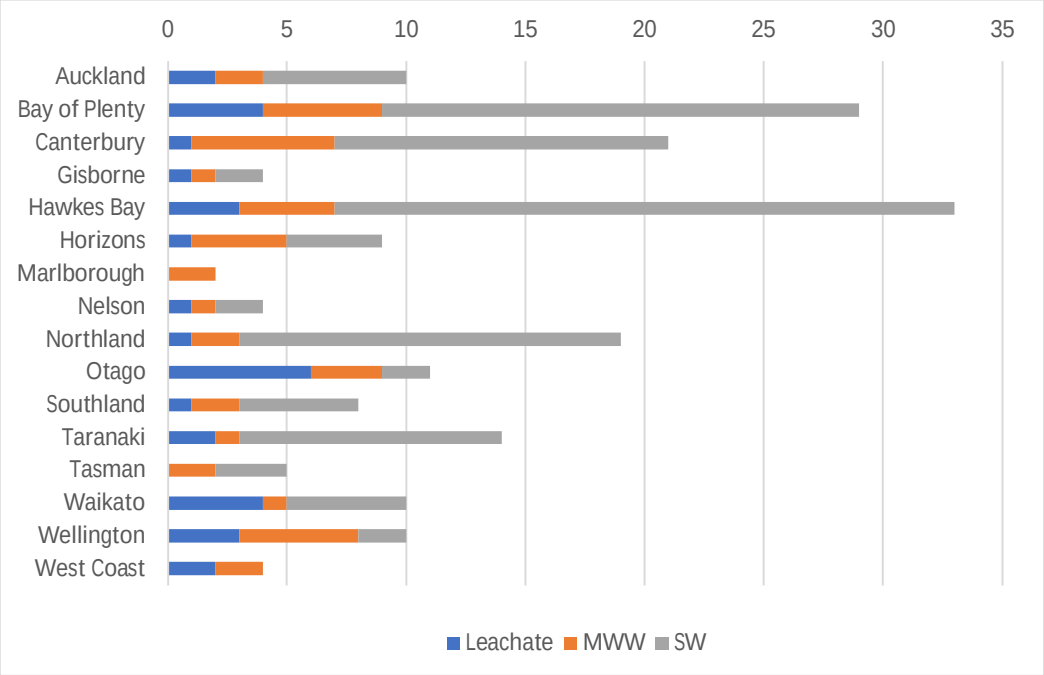


Figure 2A Count of point-source discharge monitoring required across activities for each region. MWW = Municipal wastewater, SW=stormwater

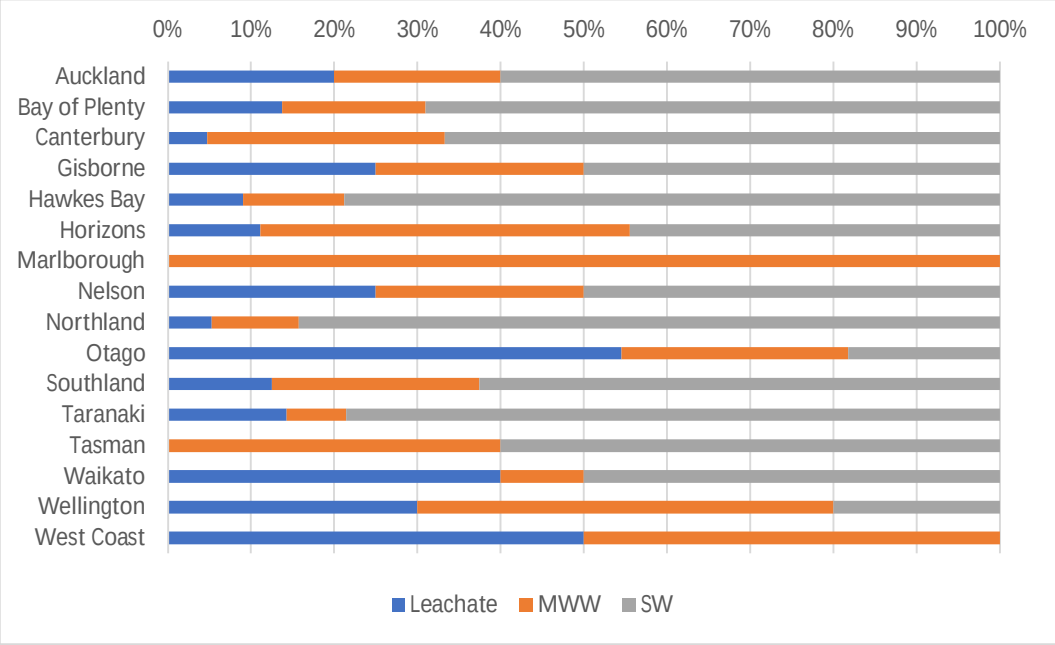


Figure 2B Percentage of point-source discharge monitoring required across activities for each region. MWW = Municipal wastewater, SW=stormwater

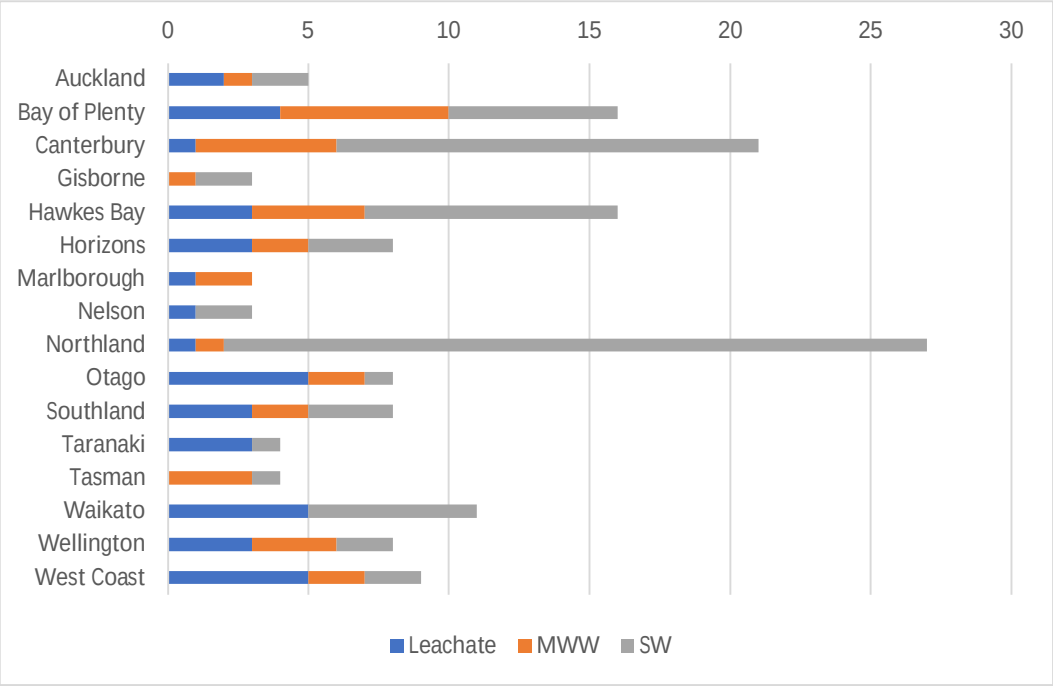


Figure 3A Occurrence of receiving environment monitoring specified in consent conditions across activities for each region. MWW = Municipal wastewater, SW=stormwater

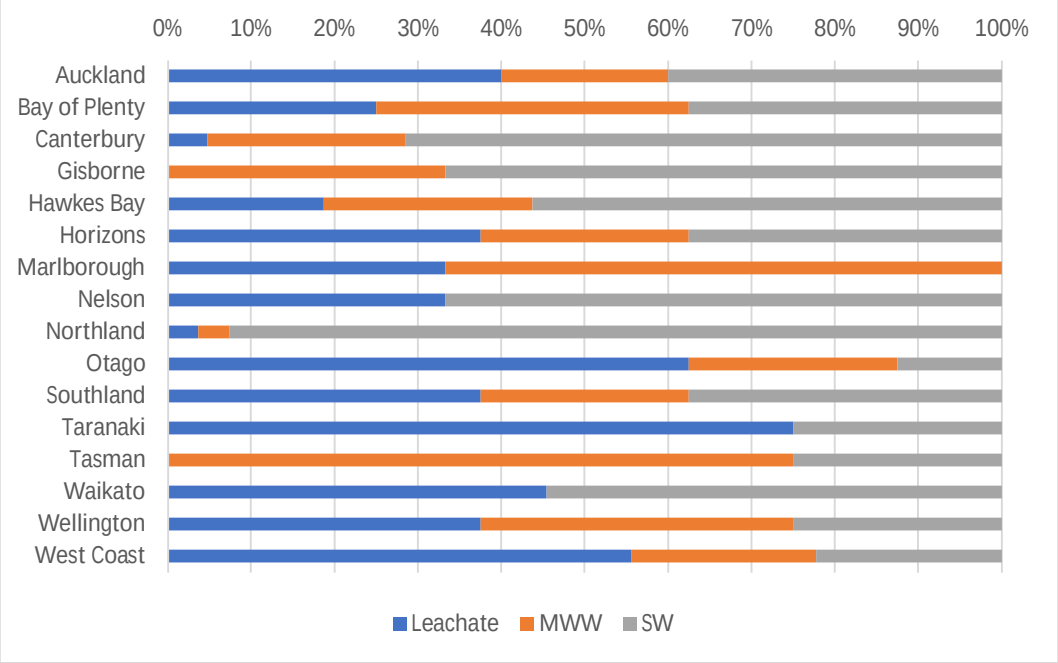


Figure 3B Percentage of receiving environment monitoring specified in consent conditions across activities for each region (B). MWW = Municipal wastewater, SW=stormwater

All regions required some form of monitoring for target CCs at either the point of discharge in the receiving environment (or both), but the specific requirement to do one or the other (or both) was not consistent across all the councils (Figures 1B, 2B). It is again emphasised here, that these data represent the monitoring requirements specified for CCs only and do not include monitoring requirements for non-target contaminants (e.g. sediment, nutrients, pathogens) which are a strong feature of most discharge consent activities. For example as indicated earlier (see section 4.1, Table 4) the total number of stormwater consents is in the hundreds to thousands across regions, but the requirement for analysing CCs in both the point-source discharge (Figure 2) and in the receiving environment (Figure 3) is low by comparison. This is most likely an artefact of the

monitoring suite defined for most stormwater discharge consents, that specify monitoring for sediment and pathogens, rather than the CCs of interest for this report.

4.3.5 Regional application of trigger values (TVs)

Monitoring against TVs for specific CCs was a general feature across most consents, in the discharge, or the receiving environment, or both (Figure). Many consents for which monitoring plans were required did not specifically list TVs, rather the wording for consents required these to be included in supplementary monitoring plan schedules, which were not included with the documents submitted for the data request.

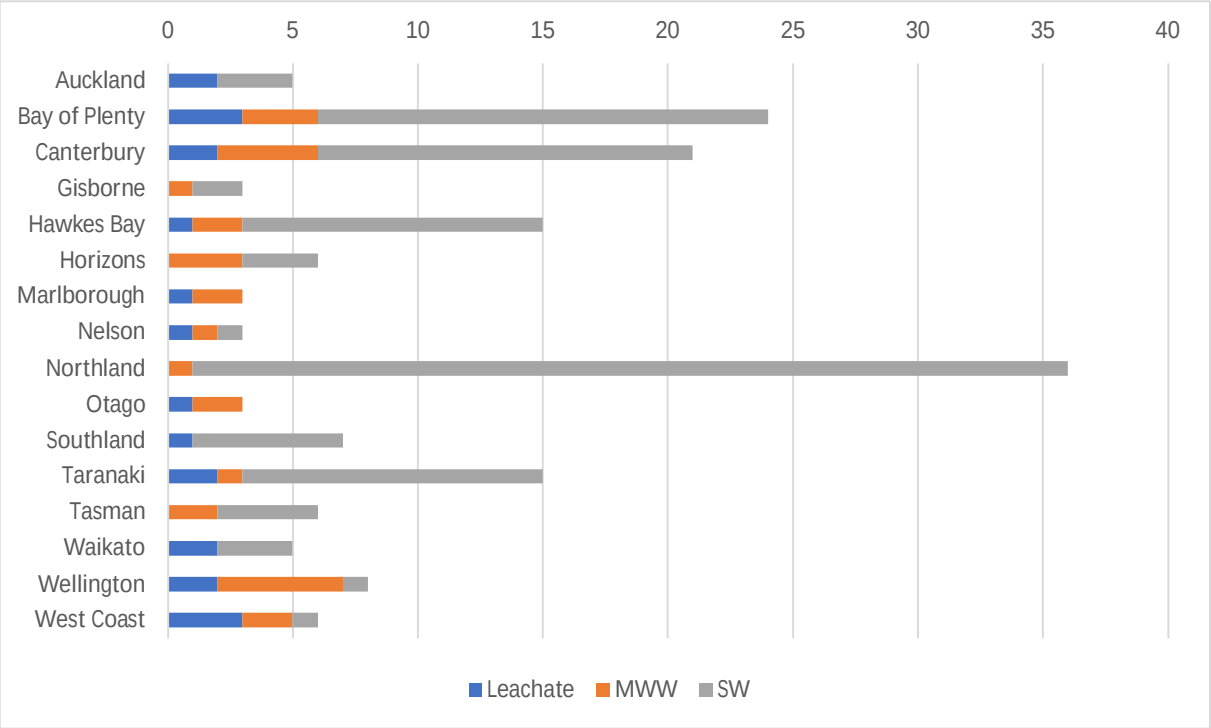


Figure 4A Count of TVs specified in consent conditions across activities for each region

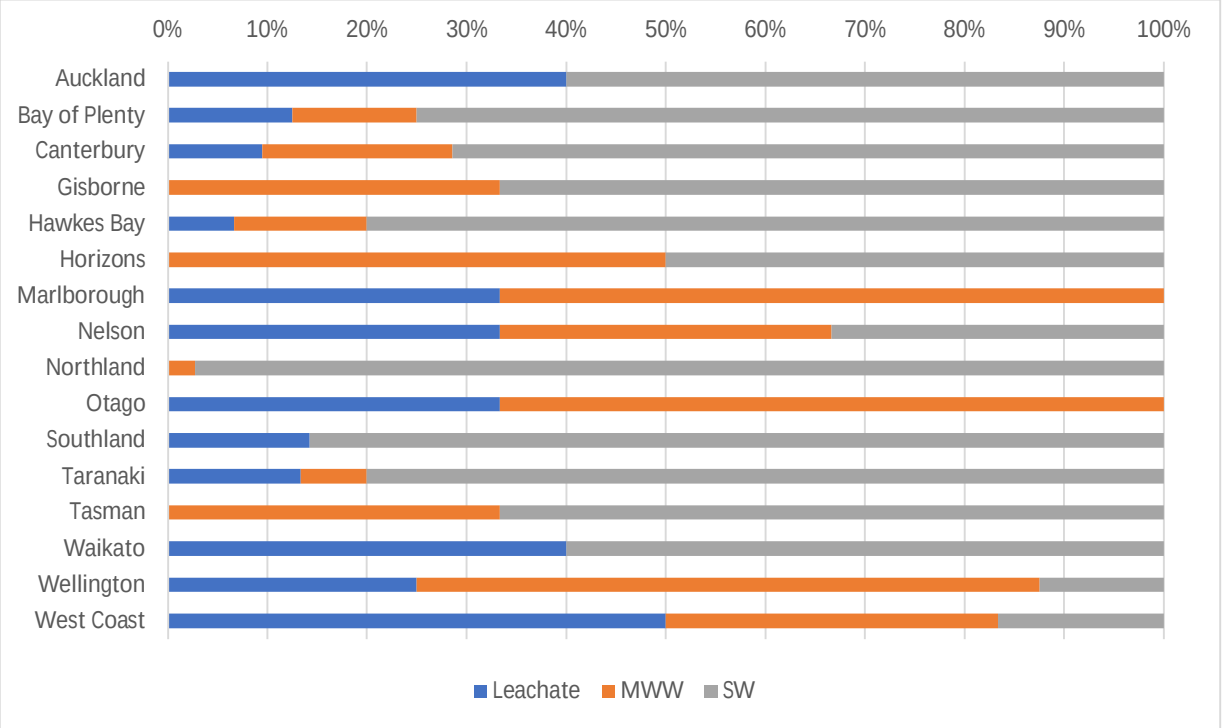


Figure 4B Percentage of TVs specified in consent conditions across activities for each region

TVs for CCs were specified directly in consent conditions in approximately half of the leachate (48%) and wastewater (59%) consents and in a greater proportion (~74%) of the stormwater consents (see Table 5 for details).

It is apparent that for a range of consents where monitoring is required for CC at point-source/receiving environment, that there are not always TV associated with these. For example, although Auckland, Southland and Waikato regional councils all listed consents for the monitoring of CC in municipal wastewater effluent discharges (Figures 2,3), there were no TVs associated with these CC in the consent conditions (Figure 4).

Similarly, several councils listed that CCs are monitored for landfill leachate discharge consents (Auckland, Gisborne, Horizons, Northland), but no TV are associated with those CC.

4.3.6 TV exceedance

Table 9 lists the overall breakdown of consents (per activity) regarding the information about TVs associated with each consent that listed CCs. Where monitoring data was supplied, the percentage of exceedances of TVs were recorded as a percentage of the total of consents for which data were supplied.

Table 9 Overall percentage of exceedance of trigger values listed in monitoring records supplied by councils

	Landfill leachate	Wastewater	Stormwater
Not applicable[1]	52	39	27
Not assessed[2] (data not supplied)	25	22	45
No TV exceedance recorded	18	24	17
TV exceedance recorded	5	14	11

[1]Not applicable: percentage of consents that did not specify a TV for a CC, therefore TV exceedance were not examined further

[2]Not assessed: percentage of consents that listed a TV for a CC, but where no further data records were supplied

Where TVs were listed in activity-specific consent conditions (see Figure 4), and monitoring data relevant to the consents was provided by councils, the TVs were being complied with in ~62% of analysed results[24]. Therefore, this indicates that in ~38% of cases where data was analysed for the range of contaminants across various consent activities, a TV exceedance was recorded in at least one instance on the basis of the monitoring records supplied.

As previously noted, the ability for this report to analyses the frequency and magnitude of exceedances across activities and regions was very restricted due to the variability in the wording and intent of the consented TVs themselves. These regional differences in approaches to consenting requirements was introduced in section 2.1 and is discussed further in Section 5. At a rudimentary level, Table 10 below lists several examples of where an exceedance of a TV was recorded and a brief description, the full data of the TV exceedances of the supplied data are listed in Appendix E.

[24] The total of 62% was calculated as a proportion of the consents with TV, data supplied, and no exceedance recorded. Similarly, the percentage of consents exceeding the TV was calculated as a proportion of the consents with TV, data supplied, and where an exceedance was recorded at any time in the monitoring record.

Table 10 Summary of exceedances of trigger values by target chemical contaminants where data records were provided by councils

Issuing Council	Discharge Activity	Chemical contaminant	Comment
Auckland	Stormwater	Al, B, Fe, Cu, Fe, Pb, Zn	Occasional over the quarterly monitoring 2017 - 2019
Auckland	Stormwater	Cu, Pb, Zn	Cu: 122 x ANZECC Water Quality Guideline Level (95% TV), Pb: 3 x AWQG, Zn:8x AWQG
Auckland	Stormwater	Cu	TV based on multiplier of ANZECC 95% TV - 5x 95%ile, one exceedance of Cu in 2012, Zn one exceedance in 2017
Bay of Plenty	Municipal wastewater	Cu, Zn, Pb	Exceedance of ANZG 80%ile (used as Default Tv for groundwater), Cu most regularly. No exceedance of sediment TV.
Bay of Plenty	Municipal wastewater	Cu, Zn	Zn 2.5 x Marine 90%TV, Cu 3 x Marine 90%TV
Bay of Plenty	Stormwater	Cu, Zn	Regular for Cu, occasional for Zn (TV is ANZECC 80% TV for FW with 5 times dilution factor)
Bay of Plenty	Stormwater	Zn	Minor exceedance for Zn 'maximum', but overall compliance for total Zn load
Bay of Plenty	Stormwater	Cu	Two samples for copper exceeded the TV of 0.007 g/m3.
Bay of Plenty	Stormwater	Cu, Propicanazole, Carbendazim	Copper recorded an order of magnitude higher than the TV of 0.0025 g/m3. Some analyses for propicanazole was below DL, but DL: was > than the TV of 0.0001. Carbendazim, TV = 0.01 g/m3, mostly below DL. One sample in 2015 recorded 0.7 g/m3
Bay of Plenty	Stormwater	Cu, Pb, Zn	Cu, Pb, Zn, all > TV
Bay of Plenty	Stormwater	Cu	Single exceedance recorded in 2016 and 2019
Hawkes Bay	Municipal wastewater	WET[1]	Yes - WET non-compliant for 1 test species, 2018. All sediment, water test compliant
Hawkes Bay	Municipal wastewater	Zn	Yes - minor non-compliance for Zn maximum, but overall compliance for total Zn load
Hawkes Bay	Stormwater	TPH	Single exceedance in 2016 >20 mg/L TPH, sporadic data noted
Hawkes Bay	Stormwater	As	Marginal sediment leachate potential of As > 10x MAV, noting this is a regular occurrence
Hawkes Bay	Stormwater	TPH	Historic exceedances noted, 2017 reported 4 x TV, 2017 t the TV of 15 mg/L TPH. Large gap in data was noted
Horizons	Municipal wastewater	Zn	Zn elevated in both upstream and downstream locations, all other metals compliant
Horizons	Stormwater	Zn	Historical records of metals, Zn, exceeding ANZECC 95%
Marlborough	Leachate	Cu	Isolated instance of Cu exceeding ANZECC 95% in a surface water sample
Southland	Leachate	Cu, Ni	Very minor exceedance at one site for Cu, Ni above the baseline
Southland	Stormwater	Zn, Cu	Zn 3.8 x ISQG-L, Cu marginal above ISQG-L
Southland	Stormwater	As, Cu	As, Cu exceeded ANZECC ISQG-L in monitoring
Taranaki	Stormwater	Zn	Single exceedance for Zn
Taranaki	Stormwater	Cu, TPH	Single exceedance for Cu. TPH >15 mg/L

Tasman	Municipal wastewater	Ni, As	Ni, As in SCS, overall annual loads is compliant (based on 2013 data)
West Coast	Municipal wastewater	As, Hg, Pb, Zn	Downstream sediments exceeded for As (>ISQG-H) , Hg, Pb (>ISQG-L) , minor historic exceedance for Zn (2013 - 2015 data). All effluent metals compliant

[1]WET=whole effluent toxicity test, an accredited test USEPA test, commonly using three aquatic test species such as an alga, diatom and crustacean

On the basis of the monitoring records provided, the metal CCs were the most common contaminants to record an instance of the TV being exceeded – the most common for these were copper, lead and zinc. Exceedances varied from minor exceedance whereby concentrations were reported to exceed the TV (these TV were generally the baseline/background ambient concentrations for the CC in the receiving environment, or the default TV for the ANZG (2018) 95% level of protection for biota). Other exceedances were recorded as orders of magnitude higher than the TV. In some cases, the analytical detection limit indicated in data reports was noted as being higher than the prescribed TV, making it impossible to determine if a TV has been exceeded[25].

A general comment, however, is that for activities that data were shown to record an exceedance of a TV, this does not directly infer that adverse environmental effects were occurring, or that the consented discharge activity was non-compliant. Given that TVs are all specific to the consent and management response conditions within that consent, the management responses will also differ. Also, a single exceedance of a TV may also form part of the overall compliance assessment tools that are used for assessments, such as assessments of monthly loads, calculation of rolling medians or annual 95th percentiles, or if a consecutive monitoring rounds demonstrate a continued exceedance of a TV – different levels of decisions are then required, along with different management responses.

4.4 Interdependency between resource consent and SoE monitoring

For consents that listed a target CC, any relevant monitoring and reporting conditions associated with those CC were analysed to determine if there were specific requirements to link resource consent monitoring to SoE monitoring (see Appendix C, Figure 9).

Where there was no reference in any form to receiving environment monitoring, this was defined as being no link to SoE monitoring. Where consent wording included wording referring to the wider receiving environment, such as 'harbour' or 'estuary', this was defined as an indirect reference to SoE monitoring. Where consents specifically referred to existing SoE programmes, this was defined as a direct link to SoE programmes. For a series of stormwater consents in Northland, there was specific reference to SoE monitoring under the s128 clause[26], however this was defined as an indirect reference only given it was a standard inclusion across most of the s128 clauses included for stormwater consents from NRC.

Across the regions, there was a small number (~3%) of stormwater consents that specified with direct reference the regional SoE monitoring. These included the global stormwater consents for Auckland, Canterbury and Wellington regions.

Overall, most consents did not directly specify any form of requirement to take into account or acknowledge SoE monitoring. Indirect reference was implied where there was receiving environment monitoring undertaken in wider coastal environments such as harbours or estuaries, which are also generally the locations of coastal SoE monitoring. For example, for discharge of municipal wastewater into off-shore receiving environments, nine regions impose a monitoring requirement for full scale receiving environment on a periodic (e.g. 5 yearly) basis, with sediment quality, biota, and full data review, to be undertaken.

[25] This commonly occurs where the consent condition has not specified the analytical method, and the laboratory uses the default screening method for analyses of CCs. The requirement for analysis to be undertaking at a lower detection limit, such as trace or ultra-trace analysis, needs to be specifically requested by the field officer as part of the routine paper work, known as the sample Chain of Custody, submitted to the laboratory with samples.

[26] Standard consent condition review clause

An example of this approach is set out in the Nelson Regional Sewage Business Unit Bell Island Wastewater Treatment Plant Resource Consent (issued by Tasman District Council). Consent Condition number 24 of RM171256 requires '*monitoring of the receiving environment in accordance with the monitoring programme(s) contained in Appendix 2 attached to these consents*'. Part One of the Appendix 2 Receiving Environment Monitoring Programme sets out the requirements for a five-yearly benthic and sediment monitoring programme (and indicates this can be coordinated with the councils five-yearly SoE monitoring), to include the following:

- Field survey – across prescribed long-term monitoring sites
- Analytical requirements for sediment physico-chemical characteristics, chlorophyll-a content, and infauna species identification and enumeration
- Chemical analyses – eight trace metals in sediment and shellfish across all sites.

5. State of the Environment and non-routine monitoring programmes for chemical contaminants

5.1 Routine monitoring

For routine State of the Environment monitoring programmes for coasts, rivers and groundwaters, the occurrence of metal analyses across routine monitoring programmes was compiled (Table 11).

Coastal SoE programmes generally undertook a higher frequency of estuarine and subtidal benthic sediment quality assessments as core components of routine assessments – the sediment analyses account for most of the observations of the 11 different metals currently incorporated into council coastal/estuarine SoE programmes, with several smaller contributions of regular biota (shellfish) analyses.

Metal analyses were less common for rivers water quality SoE programmes – only six councils indicated that at least some form of metal/metalloid analysis was undertaken on a regular occurrence. In addition, no river metal data is currently included in the LAWA state of the environment online reporting – the long-term data sets are currently held by Auckland, Canterbury and Wellington councils, where these analyses are currently incorporated into rivers' SoE programmes, but at selected urban sites only (not across the entire SoE monitoring networks).

For the West Coast Regional Council, only the groundwater SoE programme indicated that metal/metalloid analyses was routinely undertaken. There was no indication that metals/metalloids were included in routine coastal or rivers' SoE programmes.

Table 11 Summary of routine metal/metalloid analyses across coastal, river and groundwater SoE programmes for each council.

Metal/metalloid per monitoring domain	Council																
	AC	BoP RC	Cant	Gisbn	HBRC	Horizons	MDC	NCC	NRC	Otago	Southl	Taranaki	Tasman	Waikato	Wgn	West C	Count
Coast (9)[1]																	
Arsenic	As	As	As	As	As	As	As	As	As		As	As	As	As	As		14
Cadmium		Cd	Cd		Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd	Cd		13
Chromium		Cr	Cr		Cr	Cr	Cr	Cr	Cr	Cr	Cr	Cr	Cr	Cr	Cr		13
Copper	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu		15
Lead	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb		15
Mercury	Hg	Hg	Hg		Hg	Hg	Hg	Hg	Hg	Hg	Hg	Hg	Hg	Hg	Hg		14
Nickel		Ni	Ni		Ni	Ni	Ni	Ni	Ni	Ni	Ni	Ni	Ni	Ni	Ni		13
Silver							Ag								Ag		2
Zinc	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn		15
Rivers (8)[1]																	
Arsenic							As		As					As			3
Boron														B			1
Cadmium			Cd						Cd								2
Chromium																	1
Copper			Cu				Cu		Cu	Cu					Cu		5
Lead			Pb						Pb								2
Nickel			Ni														1
Zinc			Zn				Zn		Zn	Zn					Zn		5
Groundwater (11)[1]																	
Iron	Fe	Fe	Fe	Fe	Fe	Fe	Fe		Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	15
Manganese		Mn	Mn		Mn	Mn	Mn		Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	13
Aluminium		Al		Al													2
Boron		B	B			B	B		B					B	B		7
Arsenic	As	As			As	As	As		As	As				As			8
Cadmium	Cd				Cd				Cd								3

Chromium	Cr				Cr					Cr							3
Nickel					Ni												1
Copper	Cu		Cu		Cu									Cu			4
Zinc	Zn	Zn	Zn		Zn									Zn	Zn		6
Lead	Pb				Pb				Pb						Pb		4

[1]Number in brackets denotes the total number of metal/metalloid types recorded for that monitoring domain

In terms of organic contaminant monitoring, only groundwater and coastal/estuarine sediments are indicated to be routinely analysed by Councils. For groundwater, councils routinely participate in the National Pesticide Monitoring Programme, coordinated by ESR Laboratories. This is a long-term comprehensive analysis of pesticides in groundwater across New Zealand, and data from most regions is published every four years. The most recent survey (2018/19) also included a comprehensive analysis for a suite of emerging organic contaminants[27]. The results of this survey have been widely disseminated on council websites, as well as ESR.

For coastal/estuarine sediments, a summary of routinely analysed organic contaminants is listed in Table 12. Hydrocarbons (PAHs, TPH) are analysed across seven councils, while VOC/SVOC are analysed routinely across five councils. As with the rationale cited by councils for analyses, the proximity to urban and city centre runoff from stormwater and wastewater network overflows is the key driver for these analyses.

Table 12 Summary of routine organic contaminant analyses undertaken by councils under coastal (sediment) quality long-term monitoring programmes

Council	Analysis
Auckland	PAH, DDT
Bay of Plenty	PAH
Canterbury	PAH
Marlborough	SVOC
Nelson	PAH, DDT, TPH, VOC/SVOC, Phenols, BTEX
Tasman	PAH, DDT, TPH, VOC/SVOC, Phenols
Wellington	PAH, DDT, TPH

5.2 Targeted monitoring

As part of the data request from councils, information regarding non-routine monitoring was also provided – this included one-off investigations, such as response to incidents/discharge events, as well as targeted investigations undertaken by Council (Table 13). A number of technical reviews of nationally significant topics, such as stormwater management and contaminant load model development, pesticide risk assessments, as well as risk assessments of emerging contaminants was also provided. This list is not exhaustive, but provides examples of the stand-alone technical investigations and information held by councils.

Table 13 Examples of stand-alone technical reviews of contaminant specific investigations that are not routinely monitored as part of the SoE programmes.

Council	Domain	Type	Contaminants
Auckland	Coastal	Review	Review of data quality and sample design metals, PAHs in coastal areas
Auckland	All	Review	EOC suite in sediments
Auckland	Rivers	Review	Endocrine disruptors
Horizons	Rivers	Review	Urban Stormwater contaminant
Wellington	Rivers	Review	Catchment impact review (Owhiro Stream)

[27] https://research.esr.cri.nz/articles/book/National_survey_of_pesticides_and_emerging_organic_contaminants_EOCs_in_groundwater_2018/9937304

Canterbury	Rivers	CLM Development[1]	Load model development
Horizons	Rivers	Review	Stormwater network
Southland	All	Risk assessment	EOC - Risk assessment
Southland	Coastal	Review	Microplastics review and risks for Southland
Southland	All	Risk assessment	Comprehensive Risk assessment for pesticides (inclusive of an extended range of OCP, acid herbicides)[2]

[1]Contaminant Load Model (CLM) have been set out by several councils including Auckland, Wellington and Canterbury. Similar process of desktop assessments and modelling is followed, using proxy contaminants such as copper and zinc as proxy contaminant loads. Specific CLM examples were not provided by all councils.

[2] This risk assessment includes terbuthylazine, but not the neonicotinoids

A selection of 37 targeted investigations (7 coastal, 22 rivers, 8 groundwater investigations across 13 councils) were reviewed to assess the contaminants analysed, as well as possible links to consent based monitoring. Targeted investigations were generally inclusive of a broader range of organic contaminants, and were also cited as being initiated as an investigation to a pollution incident, or a one-off inclusion alongside routine monitoring.

Overall, the suite of metals analysed as part of targeted investigations was the same as those analysed during routine monitoring programmes. The range of organic contaminants was wider for targeted investigations compared with SoE monitoring (Table 14), and included both total suites for analyses (e.g. acid herbicide and general pesticide suites, VOC/SVOC suites) as well as specifying single contaminants (e.g. brodifacoum, dieldrin, endrin, lindane).

Table 14 Summary of organic contaminants analysed by councils as part of one-off/targeted investigations

Council	Domain	Analysis
Auckland	Coastal	PAH, TPH, VOC/SVOC, Phenols, BTEX
Canterbury	Rivers	PAH, TPH
Hawkes Bay	Rivers	DDT, pesticide suite
Marlborough	Rivers	PAH, TPH
Nelson	Rivers	PAH, TPH, DDT, VOC/SVOC, Phenols, BTEX, Terbuthylazine, acid herbicide extended suite
Tasman	Coastal	PAH
	Rivers	DDT, Phenols, BTEX, SVOC
	Groundwater	PAH, DDT, VOC/SVOC, Phenols, BTEX
Horizons	Groundwater	Phenols, VOCs, BTEX, coal tar derivatives, acid herbicides, OCP
Southland	Rivers	PAH, OCP, DDT, dieldrin, endrin, anticoagulants, brodifacoum, Bromadiolone, Coumatetralyl, Flocoumafen, Warfarin
Waikato	Coastal	OCP, PCP, TBT, PAHs
	Rivers	PAH, OCP
Wellington	Rivers	PAH, OCP, DDT lindane, dieldrin
West Coast	Rivers	Phenols

5.2.1 Linkages to consent monitoring

In general, the annual and comprehensive State of the Environment (SoE) reports that included monitoring for metals, included high-level narratives attributing sources of contaminants to wastewater overflows and stormwater/urban catchment derived sources. A high-level assessment of the annual monitoring reports, as well as State and Trend assessments generally indicated that for coastal programmes undertaking regular metal analyses in sediments (and in some cases, shellfish), proximity to urban centres, impacts of stormwater assessment and management were key drivers for including extended metal and organic contaminant suites. Several examples relating to this are set out in the two case studies below for Auckland Council and Bay of Plenty Regional Council. A third case study is also presented, summarising the collective concerns related to urban catchment issues in the Owhiro Bay catchment, in the Wellington region.

The annual State and Trends reports did not, however, explicitly identify discharges from municipal wastewater treatment plants as drivers for monitoring. It is understood, however, that for contaminants that are not the focus of this report, such as faecal and nutrients, that councils undertake a comprehensive level of monitoring and reporting for these contaminants in relation to other issues such as network overflow issues, and degraded infrastructure. As recognised through programmes such as those reported on LAWA ('Can I swim here'), as well as the targeted studies set out by the Department of Internal Affairs, issues regarding infrastructure and pathogen contamination are widespread across New Zealand urban centres, and water quality assessments are targeted to pathogenic assessment, rather than metal or organic contaminant assessments.

Case Study 1: Auckland Council Regional Sediment Contaminant Monitoring Programme (RSCMP)

The Auckland Council, through its Healthy Waters Department, manages the public stormwater network across the Auckland region. This network is extensive, comprising more than 6,000 kilometres of pipelines, several thousand outfalls and more than 900 stormwater treatment facilities. The network discharges to streams; coastal environments, including harbours, estuaries and open coastal water; and shallow groundwater systems in some parts of the region. A Network Discharge Consent (NDC) global Stormwater Consent was issued in 2018 to authorise the discharge of stormwater across the public stormwater network to the receiving environment. Condition 37 of the consent requires an 'Auckland Stormwater NDC Monitoring Strategy' to be set out, that incorporates relevant aspects of the long term SoE monitoring programmes: stream water quality; stream ecology; groundwater quality; marine benthic contaminants; and marine ecology.

In terms of marine sediment quality monitoring, Auckland Council's "Regional Sediment Contaminant Monitoring Programme" (RSCMP) conducts regular marine sediment contaminant monitoring across the region's harbours and estuaries. Data from over 130 sites has been collected to date. A sub-set of RSCMP monitoring sites, usually about 20–30 sites, are sampled each year.

The RSCMP is undertaken across three programmes:

1. The State of the Environment (SoE) marine sediment monitoring programme, covering 27 sites, monitored approximately every two years since 1998. This programme aims to provide long-term information on contaminant status and trends across the region;

2. The Regional Discharges Project (RDP), which monitored an additional 51 sites, at 2–5 yearly intervals. Monitoring in the RDP began in 2002, and was administered by the ARC on behalf of the region's Territorial Local Authorities (TLAs). This programme was aimed primarily at monitoring the effects of stormwater discharges, as part of the TLA stormwater network discharge consenting programme; and

3. The Upper Waitemata Harbour (UWH) benthic ecology programme, which has monitored 13 Upper Waitemata Harbour sites since 2005. This programme provides information on the effects of urban development on the Upper Waitemata Harbour.

The contaminants routinely analysed in the RSCMP are currently limited to total recoverable metals – copper (Cu), lead (Pb), zinc (Zn), arsenic (As; a metalloid species), and mercury (Hg).

Persistent organic pollutants (POPs) such as polycyclic aromatic hydrocarbons (PAH), organochlorine pesticides (OCP), and polychlorinated biphenyls (PCB) have also been analysed at times in the past. These contaminants are now scheduled to be analysed much less frequently than for metals and at only selected "at risk" sites, for example estuaries at the bottom of established industrial catchments with a history of contamination, or coastal sites at the bottom of catchments undergoing land-use change associated with urbanisation and industrial growth.

EOCs are not yet routinely analysed in the RSCMP. A scoping study commissioned by AC of sediments from 13 estuarine locations around Auckland was undertaken in 2008, with samples analysed for 34 emerging contaminants that could be analysed by commercial laboratories at the time. Subsequently, a range of common pharmaceuticals was also analysed on these samples. The findings of these initial scoping studies were reported by Stewart et al. (2014).

Analysis of EOCs at six RSCMP sites was undertaken in conjunction with the 2017 RSCMP sampling round. Additional sites are to be assessed by AC under the RSCMP in future to build up a more comprehensive picture of EOC distribution.

A comprehensive quality assurance (QA) system is conducted to check that the RSCMP data are "fit for purpose" – i.e. suitable for reliably assessing status and temporal trends. The QA system has evolved over time since the SoE programme first began in 1998. Single Site Reports (SSRs), which summarise sediment contaminant status and trends at each site, are updated annually and reported on the Knowledge Auckland website https://www.knowledgeauckland.org.nz/.

The long term data records of key stormwater contaminants copper, lead and zinc, and PAHs enable annual trend detection analyses to be updated with data relevant to the subset of catchment sites sampled: this serves as a key use of the data for a multiple range of uses, including State of the Environment (SoE) reporting; stormwater quality management; resource consenting; policy development, and public education.

A feature of the comprehensive/global consents set out by councils in centres with larger populations are characterised by comprehensive approaches to catchment management, iwi partnership and community consultation. Whilst the specific wording of consent conditions themselves often have not set out explicit lists of contaminants and TVs, the requirements set out in the details to be included in comprehensive management plans is indicative that councils recognise there is not a 'one-size-fits-all' approach to catchment management, and that the flexibility of adaptive monitoring and management allows for targeted and catchment specific issues to be investigated as needed.

Case Study 2: Tauranga City Council, Bay of Plenty Regional Council

Tauranga City Council (TCC) holds three global stormwater consents: Tauranga City Comprehensive Stormwater Consent (CSC) Number 66823•Papamoa Comprehensive Stormwater Consent (CSC) Number 63636•Maranui/Mangatawa Stormwater Consent (CSC) Number 65714. The consents set out the requirements for monitoring and reporting on discharge quality and the State of the Receiving Environment. The consents also set TVs for discharges and set out what actions are required if results repeatedly exceed TVs.

TCC is required to prepare a five-yearly monitoring report (2013-2017) in accordance with condition 9.9 of the TCC Tauranga City Comprehensive Stormwater Consent (CSC) Number 66823. Stormwater monitoring in the

Papamoa and Maranui/Mangatawa catchments is also required by Resource Consents 63636 and 65714, respectively.

Funding for comprehensive/global consents and SoE monitoring typically requires budgeting to be forecast and submitted to the local Long-Term Plan (3-yearly) process. TCC undertook this to determine the cost of anticipated future works to mitigate stormwater effects and undertake waterway enhancements. A substantial revision of the monitoring plan was also undertaken in response to the data analysis and need to increase spatial coverage of discharge point monitoring.

TCC also commissioned the full 5-year report for the stormwater and State of the Receiving Environment (SoE) monitoring. The report analysed monitoring data for stormwater quality and receiving environments for the full 5 years from 2013 to 2017 for each sub-catchment against the relevant consent requirements. The report also summarises identified stormwater issues, and discusses these against the findings and long term trends of the SoE monitoring. The report also includes recommendations for future programme changes, as well investigative, remedial/mitigation and enhancement actions.

In terms of other linkages between the monitoring programmes and consents, across a wider suite of chemicals and drivers, the targeted investigations, as undertaken by science departments, has provided an avenue for councils to respond to issues of ongoing concern on an as-needed basis. Each council provides for their own methods to instigate these targeted investigations, such as under additional Schedules or specified Methods in the regional planning framework, or as prompted by collaboration across agencies (e.g. Council Controlled Organisations), response to community concerns, or as instigated by the Regional Council Special Interest Group. An example of this is set out below for the Owhiro Stream Catchment.

Case Study 3: Wellington City Council, Owhiro Bay catchment water quality issues

A comprehensive review of the issues in the Owhiro Stream Catchment was undertaken in 2017, following a record of historic consent discharges from the operational landfills in the catchment, strong community concerns regarding poor water quality, and the poor water quality issues apparent following the Kaikoura earthquake which caused localised land slumps and influenced leachate bahavior.

The Owhiro stream runs through the southern urban centre in Wellington, discharging to Owhiro Bay on the south coast, and into the Taputeranga Marine Reserve. It has two main tributaries, draining Kowhai Park Gully (where the T&T landfill is located) and Carey's Gully (where the Southern Landfill and the C&D landfill are located).

Current landfill related monitoring requires a combination of monthly to quarterly monitoring for nutrients, faecal contaminants and suspended sediment. Macroinvertebrate sampling is also required as part of consent monitoring. An artificial wetland is also being constructed to treat the surface stormwater and leachate prior to discharge to the stream. Recent notifications regarding orange/rust coloured precipitate in section of the stream have prompted further analyses of water quality with regard to discharges from the landfill.

In addition to landfill consent monitoring, Wellington Water's global stormwater consent (GSC) includes a series of sites primarily focussed on monitoring for indicators of faecal contamination.

A key recommendation from the 2017 review included the reinstatement of the downstream Owhiro Stream SoE site and include a metal suite for analysis (previous monitoring under the regional SoE programme was discontinued as the impact of urbanisation on local streams has already represented in the SoE network). Current monitoring schedules have also included the lower reaches of the Owhiro Stream as a site in the current

global stormwater consent (GSC, held by Wellington Water), and includes analyses for metal CC at the bottom of the catchment.

A key action initiated in response to the ongoing water quality issues and under the framework of the GSC have focussed on mitigation of human health impacts, rather than the management of CCs, as human health effects are considered to require the more immediate attention with respect to overall risk management.

Condition 13 of the GSC requires the implementation of a 'Human Health Mitigation Project' to address concerns of poor water quality and impacts on human health (i.e. with a focus on identification and reduction of wastewater network overflows that are entering into the stormwater network), and to establish this as 'template' / framework for other investigations that have been escalated in other sub-catchments being monitored under the GSC. The projects are implemented across the Wellington region, under the GSC, where the risk to human health has been assessed as unacceptable (under the internal framework developed by WWL), and requiring priority funding to repair infrastructure (as set out in the Long Term Plan funding cycles, administered by WWL on behalf of Wellington City Council) and communicate risks to the public.

Results of monitoring under the GSC are pending, and a full review is likely to be undertaken in 2024 to inform the requirements for long term monitoring options, as well as to contribute knowledge to the development of the second stage global stormwater consent which sets out the long term catchment priorities and strategy.

Other linkages of these catchment investigation outcomes to the Wellington Whaitua (NPSFM implementation) process of setting water quality limits and objectives for the catchment (in both freshwater and in the near shore coastal receiving environment), that are then recommended for inclusion into the Wellington Region's Natural Resources Plan. These outcomes will likely include objectives for key stormwater contaminants copper and zinc, as well as acknowledgement and measures for the enhancement of water quality of the Taupeteranga Marine Reserve as a key receiving environment at the bottom of the Owhiro Stream Catchment.

6. Council approach to monitoring contaminants

Councils were requested to respond to a series of additional questions that were intended to capture informal considerations and opinions to monitoring of CC – it is noted here that the level of detail of individual council responses were up to the discretion of each council, and for some reflected individual responses, and in others were combined officer responses. A summary of key themes is set out below, with more details listed in Appendix D.

Key issues regarding regional plans and consenting processes include:

- Councils generally consider the full range of potential contaminants that may be present in discharges and identified during the application and processing of consents,
- Consideration to ECs is only featured in new generation plans – older style plans (e.g. prior to 2015) do not identify ECs. A couple of councils gave specific information regarding where emerging contaminants have been considered in consents and monitoring,
- Differences apparent in the approach for the inclusion of CC in the three focus activities – largely depended on the size/scale of the council and/or activity. Overall, the approach to consenting has not changed with activities being assessed on the scale and nature of potential effects but the knowledge of what contaminants may be involved has changed,
- Council approach to monitoring CC has changed over time - newer consents have a requirement for monitoring a wider range of contaminants,
- A range of potential barriers for further consideration of a wider number/range of CC for consenting were cited by Councils including:
    - Limited knowledge and council expertise of the potential effects of contaminants;
    - Lack of nationally consistent guidelines or frameworks to facilitate comparison of contaminants;
    - Lack of known practical treatment or mitigation;
    - High cost of non-standard testing;
    - Lack of knowledge for council of where (and whether) contaminants are an issue.

Key issues regarding SoE monitoring include:

- Generally, councils were not planning on including additional CCs into routine SoE monitoring, but it is noted they have been involved in regular long-term national monitoring programmes (e.g. ESR's pesticides in groundwater);
- Councils presented a range of views regarding the effectiveness of SoE/other routine programmes to understand CC across the regions; some councils consider that their SoE monitoring was effective at providing data on levels of contaminants and others suggesting it was less so. Generally, councils identified that the SoE monitoring was focused on understanding the broader regional scale presence and distribution of contaminants rather than on specific smaller areas and activities;
- To increase effectiveness of SoE monitoring for understanding the presence/impact of CC, a wide range of points were raised by councils. For non-routine CC, the key question was understanding of the effects of these non-routine CC (including emerging contaminants) on the environment or human health that would then justify the expenditure and effort required to do further monitoring[28];

[28] Noting here that for routine CCs, there are well documented guidelines and monitoring frameworks already established under these, such as the ANZG (2018), which sets out the rational for inclusion of monitoring, such as a weight-of-evidence framework. This knowledge has not yet been fully developed into similar frameworks for EOCs.

- Clear guidelines/limits to comparing any data with that relate to effects and inexpensive analysis methods that allow for routine monitoring was also identified as a requirement for incorporation on non-routine CC/EOCs;

- For linkages between consenting and SoE, council responses were mixed: a number of councils answered that they did not draw such links between the data, whereas a broadly equal number said they did, or did in part (e.g. using SoE data to understand effects of activities during consenting application stage for overall Assessment of Effects);

- A number of councils suggested that they were considering a wider range of targeted/one-off investigations for specific CC (including pesticides, emerging contaminants). This was cited as follow ups from work that has already been done, and were prompted by perceived issues and potential concerns, i.e. all are prompted by external concerns and topical issues;

- Barriers for SoE inclusion of CC include:

    - Evidence of the need for monitoring is also required, so evidence of the risk and therefore purpose of the monitoring was noted as a barrier, especially in councils that did not see that some CC were an issue within their regions;

    - Lack of national guidance of relevant limits for many non-routine CCs, and limited expertise within councils;

    - Staff cost for both monitoring and reporting. Councils also noted that limited lab availability, lack of competition/ long timelines and variability in laboratory results/methods were also barriers.

7. Discussion

7.1 Summary of key investigation questions

Common/routine chemicals monitored from consented effluents and discharge points at the different regions across New Zealand

Overall, copper, lead and zinc dominate the monitoring requirements for the metal CCs across wastewater, leachate and stormwater discharge monitoring. This is followed by chromium, cadmium, nickel and arsenic. For organic CCs, monitoring parameters are dominated by the hydrocarbon group of TPH, followed by the multi-screen test for SVOC/VOCs, PAHs, and individual compound tests for phenols. As mentioned in section 4.3.2, the CCs of TPH, PAH and SVOC/VOCs are all large groups of many individual compounds, whereby individual compounds within a class may potentially represent a greater risk to other in the same class.

Stormwater consents were typically dominated by the metals copper, lead and zinc, and the organic CCs TPH and PAH. These CCs have generally featured in long-term stormwater related monitoring programmes, and are regarded as key indicators of stormwater contaminants. Lead has historically been used in motor vehicle fuels, and has continued to be analysed in stormwater suites and receiving environments associated with stormwater catchment assessments (e.g. Auckland Councils' long term Regional Sediment Contaminant Monitoring Programme), as a means of assessing whether trends are declining over time.

Similarly, copper and zinc are recognised as common metals associated with tyre wear and break pad liners from vehicles, as well as zinc as a source from building materials – the long term monitoring records for these aim to assess whether there are potentially increasing trends in receiving environments, and to feedback to decision makers about efficacy of stormwater controls. PAHs are products of incomplete combustion, so for higher density urban and city environments with higher vehicle use, are commonly analysed in stormwater runoff from urban and city land areas as indicators of stormwater contaminants from vehicle emission sources.

Wastewater consent monitoring suites were dominated by the metal CCs copper, lead, zinc and chromium, and to a lesser degree arsenic, nickel, cadmium and mercury. The non-metal compound cyanide was also notable in a sub-set of WWTP monitoring suites. The organic CCs were dominated by phenols (as individual parameters) and SVOC/VOC multi-screen analyses (noting that phenols are also included in the groups of compounds analysed under the SVOC/VOC analyses). The requirement to analyse hydrocarbons as a suite was not a common feature for WWTP discharge consents – this is not surprising given that TPH (most likely an indicator of a fuel source) is not an expected contaminant in treated wastewater effluent. Screening for a suite of SVOC/VOC represents an analysis that can include a higher number of organic contaminant classes than if selecting for individual classes/compounds on their own. If detected above a certain TV this may then instigate follow up analyses for targeted compounds or groups.

Landfill leachate monitoring suites were dominated by lead, arsenic, zinc, and to a lesser degree by copper, nickel, chromium and cadmium. In addition, aluminium and manganese were also included in routine leachate monitoring – these metals, along with boron and cobalt, are more commonly included for groundwater monitoring suites, which is the main receiving environment monitoring location for assessment of landfill leachate effects. Organic CCs were dominated by SVOC/VOC multi-screen analyses for landfill leachate consents, followed by phenols, PCB and OCP suites. These classes of SVOCS, PCP, and OCPs, and the individual phenol compounds were more commonly monitored in leachate compared with stormwater or wastewater, most likely due to the mixed nature of the accepted waste at landfills, and the potential breakdown products associated with these classes (especially for SVOC/VOC).

Common/routine chemicals monitored in receiving environments via State of the Environment (SoE) monitoring programmes (rivers, groundwater or coastal SoE programmes)

Across the SoE programmes, similar suite of metal CCs were monitored compared with those listed under the consent-based metal suite. Coastal/estuarine sediment SoE and groundwater SoE programmes listed nine and eleven metal CCs, respectively. The River's SoE recorded eight metal CCs.

Near shore coastal and estuarine benthic sediment quality assessment programmes are long-term programmes established across the majority of councils – 12 councils list benthic sediment analyses for a suite of metal CCs as part of routine long-term sediment quality monitoring programmes. Similarly, 15 councils were recorded as including a wide range of metal CCs as part of routine groundwater SoE programmes. A notable difference for the groundwater SoE suite is the inclusion on the metals iron, manganese, and boron – these metals are not commonly included in either the coastal or rivers SoE programmes, and are used as indicators of groundwater quality, source, aquifer characterisation and surface water connectivity. Thus, their inclusion in the groundwater SoE is not directly linked to anthropogenic sources of contaminants in the wider catchment.

Only six councils routinely included metal CCs in rivers SoE programmes – and five of these were inclusive of key stormwater/urban contaminants copper and zinc. Copper and zinc are generally regarded as 'indicator contaminants' for urban runoff/stormwater assessments[29]. Data records for copper and zinc collated under these longer term SoE monitoring have also been the subject of the Ministry for the Environment's Urban Water Quality Assessment to analyse state and trends of key indicator contaminants at key urban centres. Despite this, widespread and routine monitoring of CCs in surface waters in urban (or rural) centres is not a common feature for council river's SoE programme.

Stormwater analytical suites for both metal and organic CC were, in general, common to the coastal/estuarine benthic sediment quality assessment SoE programmes. Drivers cited in the coastal SoE programmes refer to the use of long-term monitoring sites at the bottom of catchments to analyse key CC, and to maintain the long-term monitoring records with comprehensive QA/QC processes to enable long-term trend detection to be assessed. These drivers also commonly included reference to sources of stormwater derived contaminants, amongst others.

The longevity of the SoE coastal programmes (up to ~20 years for some councils) has also meant that the new generation of global stormwater consents (e.g. those established in Wellington, Auckland, Christchurch, Bay of Plenty etc) are able to be structured in the style of an Integrated Catchment Management Programmes (ICMPs). These ICMPs are inclusive of catchment based monitoring programmes, include iwi and community partnerships – features that are generally not included in consented landfill leachate discharges, and are included to a limited extent in larger WWTP consents. The inclusion of robust data quality control processes into these SoE programmes has also ensured that data are fit for purpose to assess long term trends – a feature that is commonly absent from the specific consent requirements themselves, but is recognised in the science community as essential for data management and interpretation.

The breadth of monitoring of CC in surface water SoE networks is restricted to a smaller proportion of councils – it is focussed largely on urban/city centres and include CC that are generally regarded as known stormwater contaminants. For groundwater SoE, the metal CC suite is broader, and includes a suite of key metal CC that are strongly associated with the assessment of groundwater quality that is not necessarily driven by land-use change and anthropogenic influence. For groundwater SoE, assessment of effects of anthropogenic change is focussed on the long-term pesticide monitoring programme, as well as nutrient and faecal indicator bacteria trends.

For organic CCs, long-term national monitoring programmes have been comprehensively developed for NZ groundwater systems to include four-yearly pesticide monitoring, and which also recently included an EOC study across New Zealand[30].. This study confirmed the presence of at least one or more classes of EOCs in up to 70% of wells tested, and confirmed the presence of 25 out of 29 compounds tested

To our knowledge, an equivalent or similar comprehensive national monitoring programme does not exist for surface water or the coastal receiving environments. There were no records of organic CCs being included in routine rivers' SoE programmes. For coastal sediment programmes, seven councils indicated organic CCs are routinely analysed in benthic sediments. These typically included PAHs and SVOC/VOCs – i.e. CC that are also

[29] Authors note – zinc is now being recognised as a contaminant source in rural areas where zinc treatment for livestock facial eczema is commonly used in warmer climates, and copper is a common ingredient in many fungicide products, thus representing mixed sources.
[30] https://www.esr.cri.nz/home/about-esr/media-releases/groundwater-pesticide-survey-finds-organic-contaminantsnew-news-page/

common to stormwater discharge consent analytical suites. For four councils the legacy organochlorine pesticide DDT is also routinely analysed to assess degradation over time.

Monitored chemicals exceeding water and sediment quality guidelines

Where TVs were listed in consent conditions, and monitoring data relevant to the consents was provided by councils, the TVs were being complied with in ~62% of analysed results. As discussed in Section 4.3.6, a quantitative assessment of the magnitude of exceedance of a TV is restricted due to differences in the quality of the data collated, and the fact that sampling programmes are not aligned. At a high level, the following observations were made (see Table 10 for full details):

- For wastewater discharges, CCs recorded as exceeding TVs included copper, zinc and lead,
- For stormwater discharges, CCs recorded as exceeding TVs included aluminium, boron, iron, copper, lead, zinc, TPH, and the timber treatment chemicals propiconazole, carbendazim (one occasion each),
- For landfill leachate discharges, CCs recorded as exceeding TVs were isolated with minor exceedances of copper and nickel only.

TV exceedances by the metal CCs copper and zinc were the most common for the data provided for stormwater monitoring – the recorded exceedances ranged from minor exceedances just above the TV to an order of magnitude higher than the prescribed TV (see Table 10 for full details).

The ANZ Guidelines (2018) (formerly ANZECC 2000) are the commonly referenced guidelines applied for the assessment of concentrations of CC in receiving environments, and for SoE programmes that include CC. As demonstrated below, there are also a wide range of examples of different TV for the same CC, which further restricts the ability to assess the question of the magnitude of a TV exceedance. Examples of TV include:

- Exceedance of the annual rolling 95th percentile,
- Exceeding 2 times the standard deviation from the baseline monitoring (but noting that the requirements from the baseline monitoring have not been defined in the consent condition itself),
- Single grab sample compared against a guideline value such as the ANZG 2018 (formerly ANZECC 2000) default TVs,
- Comparison against NZ Drinking Water Standards (but not indicating if water is a potable source),
- 24 h composite sample not to exceed a specified limit (with the basis of the limit not defined),
- Exceedance of 5 times (or a nominal multiple) of a default percentile level of protection, e.g. 5 times the 80% percentile default freshwater TV,
- A single sample not to exceed a specified limit, and a monthly or annual load calculation not to exceed a specified limit.

Issues encountered by the project team in preparing this report that restricted the ability to comprehensively review aspects of monitoring where TVs may or may not have been exceeded include:

- Monitoring data was not provided by councils,
- Data provided was sporadic and poorly labelled, including missing years/missed samples/only a single sample result provided for a time of sampling several years ago

Another critical aspect influencing the ability to assess magnitude of exceedances and trends across CC in discharges/receiving environments relates to the quality of data control that councils are aiming to achieve for

the SoE programmes, primarily via the National Environment Monitoring Standards and reporting under the NPSFM NOF and LAWA data requirements. These are all focussed on SoE programmes, and are targeted primarily at key indicator or attribute water quality variables that do not currently include the CC of interest in this investigation.

In principle, the same aspects of data integrity apply to the usefulness of consent-based data to inform state and trend detection – that there needs to be consistent, robust, quality control measures built into consent-based monitoring programmes to ensure that data are fit for purpose to be useful for analyses outside the immediate reporting period for the consent compliance assessment. These levels of consistency and robustness are inherent where consents have stipulated that monitoring plans be developed to include SoE networks, but in the absence of these the data presented in consent-based records are not sufficiently quality assured, collated or groomed to ensure that a representative detection of trends can be undertaken.

As mentioned in Section 4.3.6, the magnitude of exceedance of a TV does not imply non-compliance overall – given the variety of approaches to TV, a magnitude of exceedance of a TV for one consent is not equal to a magnitude of exceedance to another. For example, some TVs will be conservatively set to trigger further actions rather than indicate actual environmental effects are highly likely to be occurring.

An example of this is demonstrated by the Opotoki WWTP consent in the Bay of Plenty region, which sets out a tiered approach to monitoring, whereby if one level of monitoring results exceeds the specified TV, then this triggers another tier of monitoring. For this particular consent, the consent authorises a discharge to land for treated effluent, and requires a specific suite of CC to be monitored on a 3-monthly (quarterly) basis in groundwater. The TV for groundwater in this consent is defined as the ANZECC (2000) 80% DGV for freshwater. A condition of consent is that if this is exceeded, then this triggers another series of monitoring in sediments in the adjacent estuary. This sediment analysis also has a defined set of sediment TVs, which if exceeded, then triggers a shellfish monitoring response for the target CC.

Thus not all consent approaches are the same and the absence of TVs in the wording of the main body of the consent certificate itself does not mean that there are no TVs or guidelines followed by the activity. Often, especially under more adaptive management focused consents, TVs may be specified in management plans associated with consents.

Monitoring of non-regulated chemical contaminants

For non-regulated, non-routine CCs (including emerging contaminants), council SoE programmes indicate that these data are not routinely included in SoE programmes, rather these are collected as part of one-off or targeted investigations for specific issues. Councils may also initiate small or medium advice projects via central government Envirolink funding to address specific questions of concern (see Appendix C for a list of examples).

Council initiated Targeted Investigations are in a response to a variety of drivers depending on the source and type of contaminant, sensitivity of receiving environments, as well as community interest. A common feature is that the requirements for monitoring do not sit in the mandate of a consented activity, nor under the routine SoE network monitoring. Section 35 of the RMA, however, directs councils to undertake investigation in response to issues of concern that arise as a result of SoE monitoring.

As discussed in Section 3, several significant barriers to wider monitoring for non-routine CC have been cited to include the cost-prohibitive nature of laboratory costs, the lack of national guidance and protocols for data management and interpretation, and the lack of certainty as to whether there is a real or perceived risk of non-routine CCs.

Data specific for assessment of effects, such as those assessments included in consent pre-application stages, are also potentially a key source for determining the state of knowledge of CC – this question was out of the scope of this current investigation, but it is apparent that a significant amount of risk assessment and data exist in a format that, although publicly accessible, is not readily discoverable. This presents an additional barrier to the dissemination of information about CCs in NZ, and the benefit that existing information can add to similar assessments is not utilised.

Linkages between consent monitoring and SoE monitoring

A key aspect of this investigation was to identify whether there are key linkages between consent-based monitoring and routine SoE programmes. Overall, there was evidence that there is recognition across both the SoE and stormwater consents for the respective monitoring programmes and information sharing requirements. This is demonstrated by the following points:

- Global/comprehensive stormwater consents (GSC) are generally set out as catchment-based framework for TLA managed network, and in some consents specific wording includes direct reference to council SoE programmes
- These linkages are generally apparent between GSC and long-term estuarine/near shore coastal SoE monitoring programmes. These SoE programmes across main urban centres incorporate long term sediment quality monitoring records on a scale designed to ensure long-term trend detection is possible,
- Interpretation of results against long-term catchment land use changes (i.e. via the use of modelling tools such as Contaminant Load Models).
- Integration of long-term monitoring sites into consenting Adaptive Management Plans / monitoring frameworks, as well as inclusive of consultation processes
- Limited monitoring in rivers' SoE network (limited to several councils, focus is on urban catchments only, and key link is to stormwater consent monitoring, predominantly in the lower reaches of catchments)

There is limited evidence for direct linkages between WWTP monitoring programmes and SoE programmes. Where linkages are inferred, this is generally where a condition is to prepare an Environmental Monitoring Plan and to include a comprehensive receiving environment assessments. For example, the monitoring plan may direct the consent holder to undertake a comprehensive assessment on a 5-yearly basis for the duration of the consent, and to include assessments for habitat quality (e.g. as broadscale habitat assessment for estuaries, transects and visual observations for subtidal discharges), comprehensive physico-chemical analysis of benthic sediment samples, sampling and assessment for benthic invertebrate species, and in some cases, toxicity testing of treated effluent. For estuarine based monitoring, this approach is commonly also applied for coastal SoE monitoring programmes, that include comprehensive sediment physico-chemical monitoring, habitat assessments, and benthic invertebrate monitoring on a similar periodic basis. Whilst specific sites may differ, several discharge consents for both stormwater and wastewater indicated that monitoring may coincide with council led SoE monitoring programmes (e.g. Tasman, Wellington, Auckland, Bay of Plenty, Hawkes Bay). Direct linkages were not evident for current landfill leachate discharge consents.

Consent specific clauses

In addition to the information about chemical contaminants, other features noted in consent conditions were identified as other methods to manage risks associated with CC of specific activities, such as specific clauses and references to management plans. Full details of these are set out in Appendix C, with several examples summarised there.

A feature of consents managing leachate is the inclusion of specific clauses directing the consent holder to manage any handling of hazardous substances, reporting trade waste, or to develop site specific/hazard specific management and monitoring plans. Other analyses included the requirement to undertake Whole Effluent Toxicity Tests (e.g. for treated effluent from WWTP) and the inclusion of standard review clauses that provide effects-based characterisation (i.e. as a section 128).

Monitoring plans and management programmes are also a common feature of the most consents, especially for wastewater effluent discharge consents (nine out of the 16 regions for wastewater discharges indicated management/monitoring plans as a requirement that was specifically linked to the CCs for this report).

Further opportunities for investigations

Other avenues related to council held information relevant for assessing the source and fate of CC in New Zealand may include:

- Council held records regarding compliance assessments, investigation of non-compliant reports, incident management and prosecution records;
- Contaminated site registers of known HAIL classified land parcels, and associated discharge consents linked to these;
- Investigation of closed landfills across regions, and management of leachate;
- Information regarding the overall annual consent compliance, reported on an annual basis by councils, may also cover issues of non-compliance that are not associated with CC included in the consent;
- Other regulatory mechanisms – such as enforcements/abatements/prosecutions are also undertaken by council in response to contaminant discharge issues – this was not in the scope of this current project but is possible avenue for follow up with council regulatory departments to determine the key drivers for these.

Appendix A.

Online survey portal structure and questionnaire

A.1 Online survey portal flow diagram

Design of flow chart for PCE Emerging Contaminants Data Capture

Questions numbers in boxes, online portal appearing as 'pop-up' depending on answer

"Activity and overview" questions (all consents)

1. Discharge Activity (select activity from list: stormwater, municipal wastewater or leachate)
2. Issuing Council (pick list all 16 Regional Council or Unitary Authority Names)
3. Consent Holder (free text field)
4. Consent Number (free text field)
5. Global consent (Y/N) – This question should only appear if in Q1 "stormwater" is chosen.
6. Number of discharge locations (free text)
7. Start date (year only) – pick list 2020 BACK 35 years only
8. Expiry date (2020 FORWARDS 35 years only)
9. Discharge Quality Monitoring Required (Y/N)

If Q 9 is Y move to Q10 (orange box). If Q9 is N move to Q14.

Q10 List discharge monitoring parameters for “Regular” contaminants

List all the regular contaminants on the page with a tick box for “Yes” if monitored, then another box appearing next to it for frequency (pick list, monthly, two monthly, three monthly, four monthly, five monthly, six monthly, eight monthly, 9 monthly, 10 monthly, annually, every 2 years, every 3 years, every 5 years or other. If other another field for please state (free text field)

Have a field for discharge quality limit (pick list Y/N) if Y have another three text boxes appear. One for numerical limit (free text) and another for units (pick list mg/L, Ug/L, mg/m^3, g/m^3, ppm, ppb) plus a free text field for notes).

Go through all metals, nutrients and other regular contaminants (See separate list below

See example below.

Then have a field at the end for Q11 If any other parameters routinely monitored that are not emerging contaminants please enter below: (Have free text field for parameter, then same frequency and limits fields as above. Allow more than one parameter to be entered so maybe complete each line and have option to add another.

Example for orange box:

Parameter	Monitored (Y/N)	Frequency	Discharge Limit	Limit Value	Limit Units	Limit notes
Metals						
ZN (T)	Y	2 monthly	Y	0.2	mg/L rolling 90%ile	
Zn (D)	y	12 monthly	N	no other fields appear		

Etc for each contaminant of interest

Q11 Any other “regular”/non-emerging contaminants monitored? Y/N

If Y then a new line appears with following headings

Parameter	Monitored (Y/N)	Frequency	Discharge Limit	Limit Value	Limit Units	Limit notes

And once filled in a prompt for another line if needed. If not ability to move on to next question (Q12).

Q12 List Discharge Monitoring Parameters “Emerging Contaminants”

Do another page as for Q10 but populate with emerging contaminants list

(Drop down list includes all CC)

Q13 If any other parameters routinely monitored that meet the projects definition of emerging contaminants please enter below: (design as Q11)

Then move on to Q14

Q14 – Is any receiving environment monitoring required? Pick list (Y/N)

If Y put up following 4 options as tick boxes

Surface (freshwater), Coastal or estuarine, Groundwater, Sediment (freshwater / coastal)

If one or more are ticked then the information in Q10 and Q11 and Q12 and Q13 have to be repeated for EACH receiving environment type chosen (as may be more than one) but not those left unchecked. With the only change being instead of a field saying “Discharge limit” it will be “Receiving Environment” Limit

If answer is N to Q14 move to Q15

Q15 – Please upload pdf of consent document

Q16 – Please upload monitoring data as excel or other documents (include separate field for excel format (preferred) or other formats (pdfs etc). With separate tick box option of not supplied).

Move to document upload fields (council to upload document)

Allow to save all info and move to next consent data input and run through all the above again.

Tier 1 'Core' list of 'marker' ECs recommended for initial phase of sediment monitoring

From: Stewart, M., Northcott, G., Gaw, S and Tremblay, L A (2016). An update on emerging organic contaminants of concern for New Zealand with guidance on monitoring approaches for councils. Prepared by Streamlined Environmental Ltd, Northcott Research Consultants Ltd, University of Canterbury, Cawthron Institute and the University of Auckland for Auckland Council, Greater Wellington Regional Council and Environment Canterbury Regional Council. Auckland Council technical report, TR2016/006

Class	Representative EOC
Flame retardants	BDE 47
	BDE 99
	BDE 209
	TDCP
	TPP
	TCPP
Plasticisers	DEHP
	BBP
	Bisphenol-A
Surfactants	Nonylphenol
	LAS (Linear alkyl benzene sulfonate)
Perfluorinated compounds	PFOS/PFOA (numerous)
Polycyclic musk fragrances	Galaxolide
	Tonalide
Herbicide	Glyphosate/AMPA
Neonicotinoid insecticide	*Imidacloprid*
Pyrethroid insecticides	Bifenthrin
	cis-permethrin
	trans-permethrin
Pharmaceuticals	Acetaminophen
	Carbamazepine
	Diclofenac
	Ibuprofen
Steroid estrogen	Estrone
Personal care product	Triclosan
	Methyl-Triclosan
Preservative	Methyl-Paraben
Anti-corrosive	Benzotriazole
Tier 1 'Specific ' list of 'marker' ECs recommended for initial phase of sediment monitoring	
Class	Representative EOC
Antifouling agents	Diuron

	Isoproturon
UV-Filter	Benzophenone-3

BDE = brominated diphenyl ether;
BBP = benzyl butyl phthalate;
DEHP = Bis(2-ethylhexyl)phthalate
LAS = linear alkylbenzene sulfonate;
PFOS = perfluorooctanesulfonic acid; PFOA = perfluorooctanoic acid;
TCPP = Tris (1-chloro-2-propyl) phosphate;
TDCP = Tris[2-chloro-1-(chloromethyl)ethyl]phosphate;
TPP = Triphenylphosphate.

Core list of 'regular' chemical contaminants included in consenting data as well as SoE monitoring

Indicate in drop down box:

Water: Total, Total Recoverable, dissolved

Metal suite
Arsenic
Cadmium
Chromium
Copper
Mercury
Nickel
Lead
Zinc
Other
TPH
PAHs - 16 priority PAHs
Acenaphthene
Acenaphthylene
Anthracene
Benzo[a]anthracene
Benzo[a]pyrene (BAP)
Benzo[b]fluoranthene + Benzo[j]fluoranthene
Benzo[g,h,i]perylene
Benzo[k]fluoranthene
Chrysene
Dibenzo[a,h]anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-c,d)pyrene
Naphthalene
Phenanthrene
Pyrene
Other Organics
DDT (& isomers)

DDE
DDD
Other
VOC/SVOC suite

A.2 Written survey for council officers, copy of word document emailed to councils

Context of this investigation

The Parliamentary Commissioner for the Environment (PCE) is investigating the state of knowledge of chemical contaminants in Aotearoa, and the effectiveness of management systems to manage their risks. The PCE's key research questions are:

(1) What is the state of knowledge on contaminants entering NZ's receiving environments?

(2) What does the evidence say about the effectiveness of regulatory system to manage the risks?

To expand on these; we are investigating the following:

- What are the common/routine chemicals monitored from consented effluents and discharge points at the different regions across New Zealand?
- Of these chemicals, which ones are monitored in receiving environments through Regional Council (RC) and Unitary Authority (UA) State of the Environment (SoE) monitoring programmes (e.g. coastal water quality programmes)?
- Of those chemicals monitored, which present values above regional specific (if applicable) water and sediment quality guidelines?
- From each region, are data from non-regulated compounds (such as emerging contaminants) collected from regular council-controlled sampling regime or from research one-off studies?

For the purpose of this investigation, chemical contaminants are defined as metal and organic compounds (hydrocarbons, pesticides, other organics). We are specifically not including physical, nutrient, microbiological monitoring parameters.

The focus for consented activities is discharges of leachate from active landfills, discharges of treated wastewater from municipal wastewater treatment plants and discharges of stormwater focusing primarily on global consents but also considering a representative range of other stormwater consents for residential, commercial and industrial land uses.

The focus for any regular long-term network monitoring, such as SoE monitoring, is on groundwater, surface water (fresh and coastal) and any associated sediment quality monitoring, for the similar suite of chemicals listed for consents as well as any information collected part of targeted or one-off research investigations for council.

In addition to information about routinely monitored chemical contaminants, we are also asking for information about any chemical monitoring data that can be considered as non-routine. For example information that may be included in targeted or one-off investigations, and may include Emerging Contaminants (ECs - defined here as '*any synthetic or naturally occurring chemical or any microorganism that is not commonly monitored in the environment but has the potential to enter the environment and cause known or suspected adverse ecological and (or) human health effects*'). For the purpose of this investigation, however, we are focussing on chemicals only, and microorganism information is out of scope.

The questions in this survey form the basis of the investigation and are being sent to all Regional Councils and Unitary Authorities in New Zealand. There are a range of questions seeking factual information and those seeking for the opinion of council staff.

Final output is a report delivered to PCE. Any publicly released report will not contain names of individual responders. We will also provide Special Interest Groups (SIGs) with regular updates.

PART ONE

[Council name] Consented discharge activities, please use this link here:

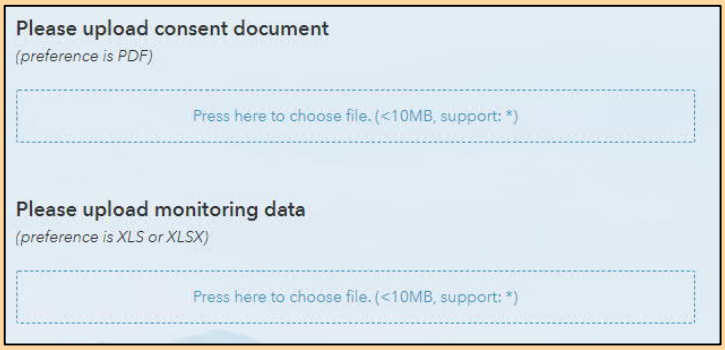
https://survey123xxxxx[copy link]

Staff member(s) details completing PART ONE of this survey

Regional Council or Unitary Authority Name	
Staff member(s) details (name and role), Department, years of relevant experience	
Contact email/phone number (only for clarification purposes)	
Please indicate if you wish to keep your response anonymous	

Please answer the following 2 sections in the online link provided. Documents can be uploaded to the 2 provided portals (see example in box). Please save this document and upload this to the online portal along with the copies of the consents and monitoring reports supplied.

You will see links like this to upload documents:



Section A Online survey – Relevant consented activities:

Please identify all resource consents for the following activities in your region:

- Active landfill leachate discharges (not including closed landfills)
- Municipal wastewater treatment plant discharges (>1000 population equivalent), including discharges to land
- All global stormwater consents
- A representative number of other stormwater consents, covering the range of larger residential, commercial and industrial activities that occur in your region (preferably newer consents <10 years old)

Note for online survey - p*lease respond in the supplied URL link provided with consent numbers, granting dates and other data as noted.*

Please upload copies of consent certificates and s42a reports for corresponding consents.

Please upload copies of monitoring data/annual reports.

The survey will need you to populate & submit the information for each individual consent requested
Section B Online survey – Monitoring parameters Please indicate if discharge and receiving environment monitoring is required. Where monitoring is required, indicate for each consent the following from the drop-down boxes provided: • Contaminant type (Organic, Metal, routine or emerging contaminant) • Specify the parameter • Specify the monitoring frequency • Specify the discharge/environment quality limit, if available
Note for online survey, monitoring parameters - *Please ensure copies of relevant consent documents and monitoring data (e.g. annual data summary reports) have been uploaded for each consent activity category listed. Multiple reports can be submitted, please note the 10MB size limit.* *Please provide data in excel format (including units) covering up to the last 10 years in one excel spreadsheet per consent where possible.* *Please name each spreadsheet / report file using the consent number and Regional Council/Unitary Authority name)* *If data exists in other less accessible formats (e.g. pdf reports) please upload copies of these files also using the online upload link provided in the survey link*
Please answer the following five questions in the space under each question – add more lines if needed. Please save this document and upload this to the online portal along with the copies of the consents and other reports supplied.
Q1 - Does the regional plan (policies, objectives and rules) identify emerging contaminants as an issue for your region? If yes, what activities are these for (e.g. discharge to land, discharge to groundwater, discharge to surface water)?
Answer 1 –
Q2 – How are ECs considered during the resource consent process by your council?
Answer 2 –
Q3 – Is the approach for the inclusion of chemical contaminants different for the three focus activities (landfill leachate, municipal wastewater and stormwater)?
Answer 3 –
Q4 – Has the approach for the inclusion (or not) of monitoring chemical contaminants changed over time- i.e. is chemical contamination an issue for new consents only compared with older consents?
Answer 4 –

Q5 – Are there any barriers to consideration of a wider number/range of chemical contaminants during consent processing? What are these barriers and where do they sit (e.g with applicants or Council)?
Note for Q5 - Some examples of barriers may include • Costs of sample collection, laboratory analyses • Not considered a relevant issue for the region • There is a lack of appropriate information for councils • Council/applicant does not want to set a precedent Answer 5 –

PART TWO

[Council name] Routine 'State of the Environment' network monitoring and targeted investigations, please use this link here:

https://survey123xxxxx[copy link]

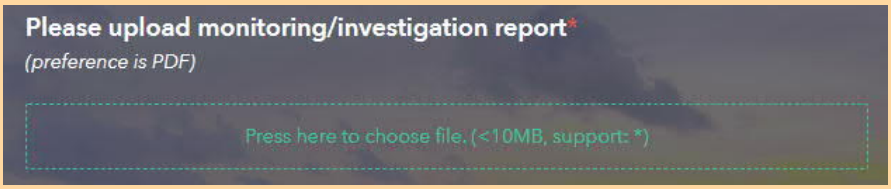
Staff member(s) details completing PART TWO of this survey

Regional Council or Unitary Authority Name	
Staff member(s) details (name and role), Department, years of relevant experience	
Contact email/phone number (only for clarification purposes)	
Please indicate if you wish to keep your response anonymous	

Note: This section will ideally need to be filled out by a staff member(s) from a science team – noting that science staff may sit in groundwater, surface freshwater, or coastal water quality. More than one staff member may populate the survey and upload files.

Please answer the following section in the online link provided for this part. Documents can be uploaded to the portal provided (see example in box). Please save this document and upload this to the online portal along with the copies of the monitoring reports supplied.

You will see links like this to upload documents:



Online survey: SoE monitoring

For council SoE (or other regular/routine) monitoring for groundwater quality, surface water quality (freshwater and coastal) as well as any related sediment quality monitoring undertaken as part of these programmes, please provide:

- A list of routine chemicals (metals, hydrocarbons, other) that are regularly/routinely analysed
- A list any water quality guidelines/limits/threshold that these are compared/benchmarked against
- Indicate if these chemicals are analysed in all samples at all sites (e.g. some may be analysed in samples from urban/developed land areas and not from rural sites).
- Provide copies or links of the relevant monitoring reports from the last 10 years
- Indicate if any monitoring has included analysis of Emerging Contaminants
- Provide a list/link to these monitoring data and report(s)
- identify any SoE or other routine council monitoring that also includes testing for emerging contaminants. Please upload a copy/copies of the report and/or identify where that data is reported and can be accessed.
- If monitoring is 'targeted' – please identify if this is 'one-off', initiating further investigation, or an inclusion to routine monitoring

Note for the online SoE survey – *Please identify the relevant SoE programme and other routine monitoring (for all receiving environment types) and please identify using the tick boxes the monitored parameters for those programmes.* *Please upload copies of monitoring data/annual reports relevant to your SoE programme.* *The survey will need a staff member to populate & submit the information for each individual SoE programme requested*
Please answer the following nine questions in the space under each question – add more lines if needed. Please save this document and upload this to the online portal along with the copies of the SoE and other reports supplied.
Q1 - Is your council intending to incorporate any additional chemical contaminant including emerging contaminant, monitoring as long-term programme parameters (e.g. as an urban water quality programme or other)?
Answer 1 –
Q2 – What is your view on the effectiveness of the SoE and other routine monitoring at providing data to understand the presence and levels of chemical & emerging contaminants across your region?
Answer 2 –
Q3 – What (if anything) is needed to increase the effectiveness of SoE and other routine monitoring for understanding the presence and levels of chemical & emerging contaminants across your region?
Answer 3 –
Q4– Does your RC/UA draw links between the understanding of chemical & emerging contaminants provided from SoE and other routine monitoring and the consented leachate, wastewater and stormwater monitoring occurring in your region? Can you explain how this is done and if reported formerly in technical reports or other documents? Please provide examples.
Answer 4 –
Q5 - Does your Regional Council/Unitary Authority intend to undertake any other monitoring as targeted or one-off investigations for specific chemicals of concern? If yes – what are the drivers for this? What are the chemical classes intended to be analysed (*even if not certain at this stage – an indication of intent is useful*):
Answer 5 –

Q6 – Are you aware of any other monitoring that your council has done that has included non-routine and/or emergency contaminants? E.g. one off or targeted studies, non-consent directed monitoring by Councils of their wastewater discharges. *Please upload that data and relevant report.*
Answer 6–
Q7 - Are you aware of any other monitoring that is undertaken or has been commissioned under any other programmes by other RC/UA departments that is aligned with this project (e.g. contaminated soils, closed landfills – *though these are not in scope of data capture, might be useful to note*)? Please provide contact details of relevant staff for follow up.
Answer 7 –
Q8 – Are you aware of any other monitoring of emerging contaminants that other agencies, bodies or industries may have done in your region? E.g. non- consent directed monitoring by district or city councils in your area, monitoring by industry or research organisations. If publicly available please provide that data and relevant reporting. Or please provide contact details for further follow up by us.
Answer 8–
Q9 - What does the council perceive as barriers to the capture of information regarding chemical contaminant monitoring? For example – o Data base management o Standardized protocols o Laboratory analytical techniques o Costs of monitoring o Other
Answer 9 –

Appendix B. Biosolids case study

Biosolids are sewage sludges or sewage sludges mixed with other materials that have been treated and stabilised to the extent that they are able to be safely and beneficially applied to land. There are two grades in the Biosolids guidelines[32], the first letter denotes the stabilisation grade of the biosolids (Grade A or B) and the second letter denotes the contamination levels of heavy metals and pesticides in the biosolids (Grade a or b). Grade A stabilisation requires a quality assurance program to be in place in addition to a robust pathogen reduction process (e.g. thermal treatment, lime stabilisation and composting). Grade B stabilisation requires the biosolids to be processed via an acceptable vector attraction reduction (VAR) method. Biosolids that satisfy the contaminant Grade "a" are expected to have very low concentrations in metal and pesticides. Refer to the Biosolids guidelines for details on the derivations and the limits of the stabilisation and contamination grades.

Biosolids are known to have significant fertilising and soil-conditioning properties as a result of the nutrients and organic materials they contain – thus the Guidelines set out in 2003 (revised as a draft in 2017) sets out a pathway for the beneficial re-use of this as a resource to enhance soil condition and provide an alternative to disposal to landfill. However, in addition to natural nutrients, biosolids may also contain pathogens, heavy metals and synthetic organic compounds. They therefore require appropriate management to minimise the risk to public health and the contamination of the receiving environment (i.e. land, surface and groundwater and the coastal marine area).

New Zealand produces an estimated 300,000 tonnes of municipal biosolids from the 320 WWTP each year. Of this, approximately 32% is disposed of to landfill/onsite storage (Table 15) and 45% goes to quarry rehabilitation. Therefore, for the majority of NZ biosolids the potential effects of both landfilling and rehabilitation activities will be governed by consents held for those activities rather than under consents specific to the disposal of biosolids to land. For example, the quality and chemical constituents of biosolids going to landfills will be managed through the Waste Acceptance Criteria set in the landfill (disposal of waste to land) consent or management plan. Then the effects of their disposal would be on resulting leachate quality that would be managed by consents authorising the discharge of leachate.

Table 15 End product percentage (dry solids) of surveyed utilities by end date. Table from Tinholt et al (2019).

End Fate	End product percentage by wet tonnes for surveyed WWTPs	Classification
Land Application	3%	68% Resource Recovery
Forestry	2%	
Agricultural Land	14%	
Landfill Cover	4%	
Quarry Rehabilitation	45%	
Landfill	27%	32% Waste
Onsite Storage	5%	

Vermicomposting in the Waikato Region has been operating under several resource consents (since approximately 2012) to include the use of biosolid in the consented waste stream accepted on site for the purpose of mixing with other organic waste streams, via a vermicomposting (worm-based composting) process.

[32] https://www.waternz.org.nz/Attachment?Action=Download&Attachment_id=3293

Up to 28,000 tonnes of municipal biosolids is consented to be processed at the vermicomposting facility each year. Results of leachate characterization (as required in the consent) indicate that the Class B leachability limits are generally complied with. Soil testing conducted in 2019 indicated that soil quality underneath the vermicomposting windrows (piles) were not impacted by elevated soil concentrations of arsenic, boron, cadmium, copper, mercury, nickel or zinc.

In the Auckland Region, the Mangere WWTP, servicing a population of 1.1 million people, produces around 43 % of the total biosolid volume in New Zealand. This volume of biosolids is currently managed under the Puketutu Island Rehabilitation Management Plan (PIRMP, as part of the managed fill consent). Biosolids from the Mangere WWTP undergo dewatering and drying, and are disposed of to the Puketutu Island site, for the dual purpose of rehabilitation of the area previously use as a quarry, and to provide for a means of disposal of the biosolids volume.

Receiving environment consent monitoring imposed on the site requires routine groundwater monitoring (zinc, cobalt, copper, nickel, arsenic, chromium, iron, lead, manganese, mercury, tin and TPH). A baseline assessment conducted in 2014 was required to establish and trigger of target contaminant values to be incorporated into the PIRMP. TV specified an 'alert level' of three standard deviations above the mean, and a response level at four standard deviations above the mean of baseline sampling results.

Results from the 2020 Annual Monitoring report indicate occasional exceedances of boron and copper above the 'alert level' TV. The report indicates monitoring will continue at 2-weekly intervals, and that exceedances were not considered to be indicative of a liner breach (i.e. indicating discharge of leachate to groundwater).

Appendix C. Summary data figures and tables

C.1 Regional summary breakdowns

Figure 5 sets out the average duration of discharge consents across activity types per region. Overall landfill leachate discharge consents were on average longer than wastewater or stormwater discharge consents across regions. Short durations for Wellington consents is reflected in part by the short term nature of the new generation plan consent rules compared with other regions.

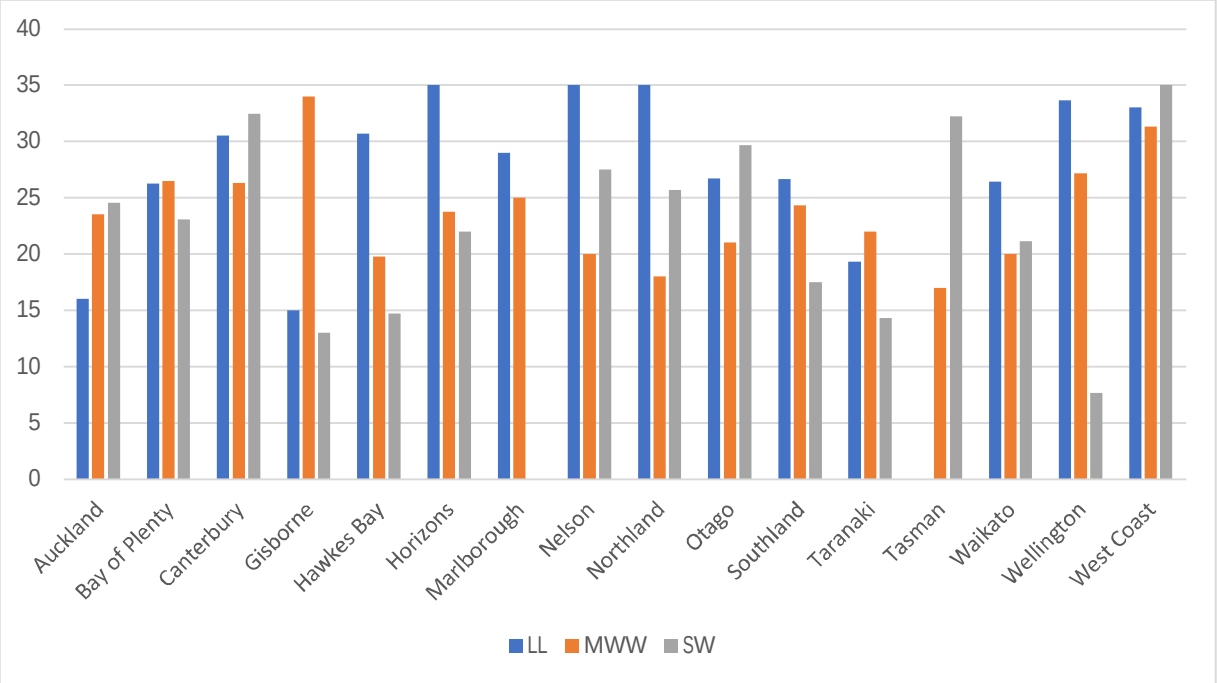


Figure 5 Average consent duration across regions

C.1.1 Management plan requirements for CCs by region

Across most regions stormwater discharge consents generally set out requirements for monitoring plans/programmes to be included and which are also inclusive of the target CCs (Figure 6). Similarly, this was also a general requirement for landfill leachate consent discharges. Monitoring/management plans for target contaminants was listed in nine out of the 16 regions for wastewater discharges.

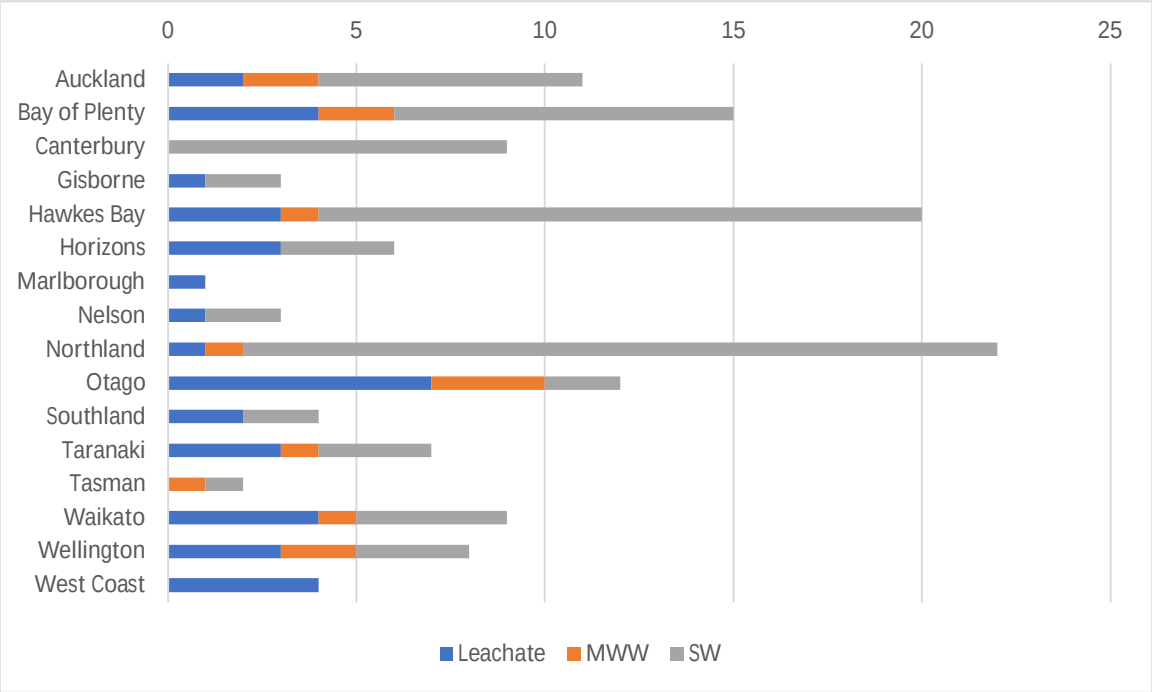


Figure 6A Consent conditions specifying the requirement for monitoring/management plans to be developed, where these are inclusive of the requirement to monitor the target contaminants, expressed as total occurrence for that region. MWW = municipal wastewater, SW=stormwater

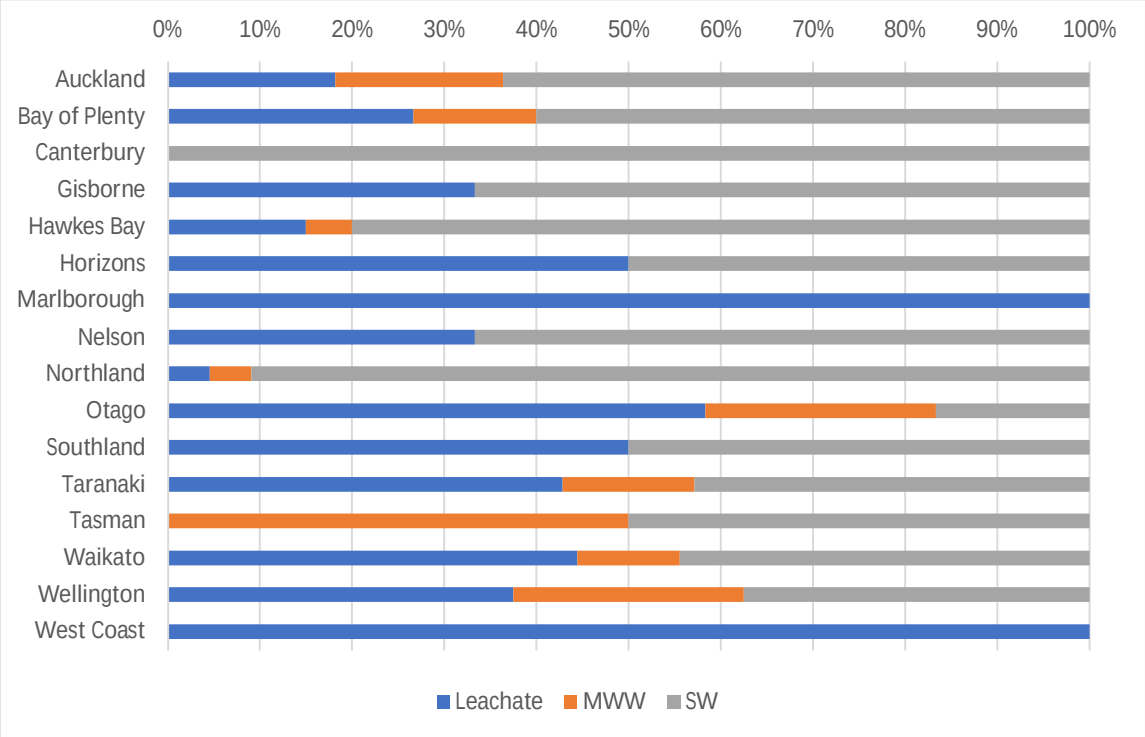


Figure 6B Consent conditions specifying the requirement for monitoring/management plans to be developed, where these are inclusive of the requirement to monitor the target contaminants as a percentage of the total for that region . MWW = municipal wastewater, SW=stormwater

Not all councils included CC specific standards or guidelines in consent conditions for the three discharge activities (Figure 7). Standards were a common feature for stormwater consents where target CCs were listed. It

is noted that target CCs were not recorded for stormwater discharges in Marlborough, but these listed non-target CCs.

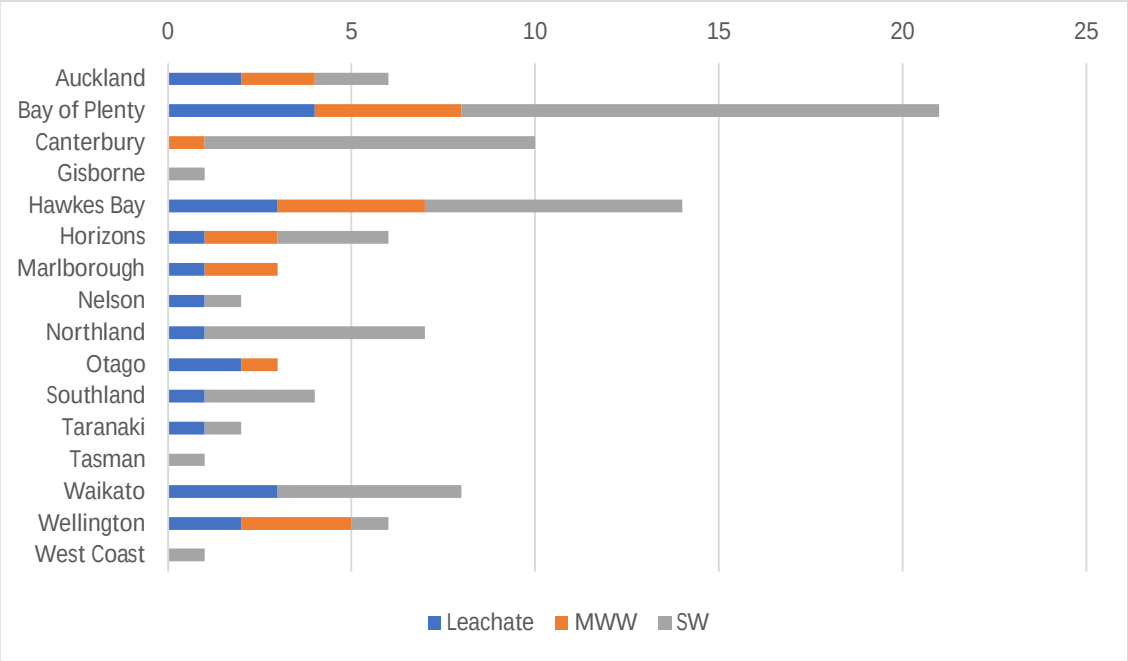


Figure 7A Consent conditions specifying monitoring/reporting of target contaminants against a specified standard or guideline to be followed, shown as the total occurrence. MWW = municipal wastewater, SW=stormwater

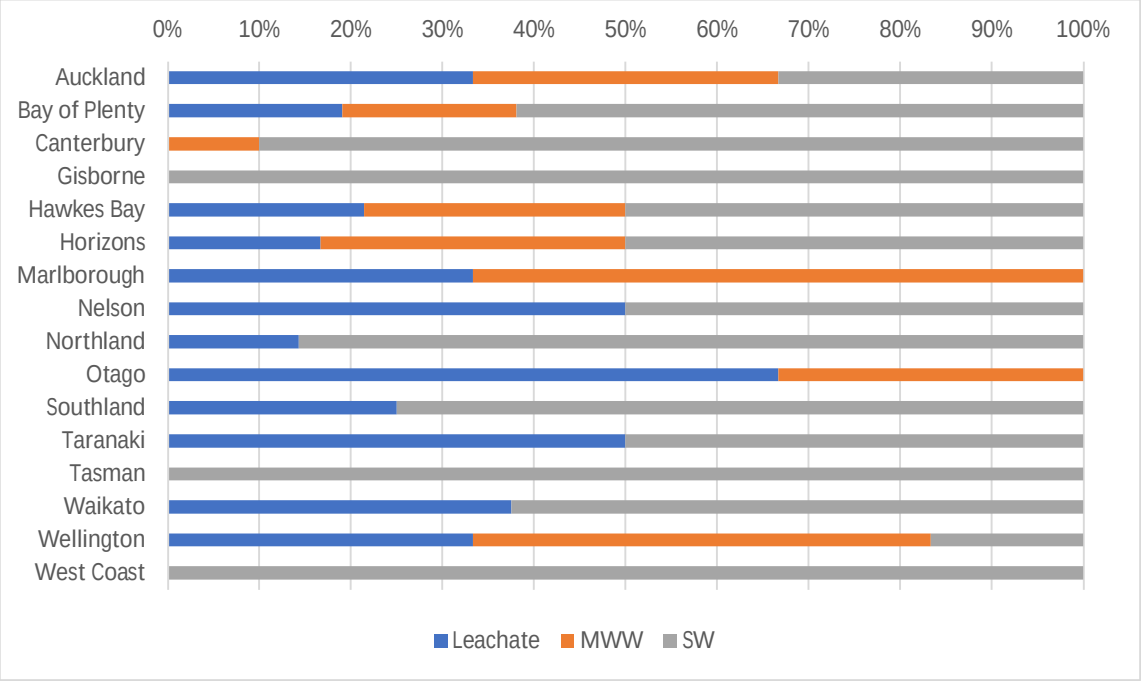


Figure 7B Consent conditions specifying monitoring/reporting of target contaminants against a specified standard or guideline to be followed, shown as the percentage of the total for that region. MWW = municipal wastewater, SW=stormwater

Table 16 Full count of metal/metalloid CCs listed in consent condition wording for three discharge activities

Contaminant	All consents[1]	Leachate	Wastewater	Stormwater	
				All stormwater consents	Global stormwater consents
No of consents	250	44	49	157	58
Aluminium	25	18	6	1	0
Antimony	2	0	1	1	0
Arsenic	96	35	31	30	16
Boron	11	8	1	2	1
Cadmium	108	33	39	36	23
Chromium	115	29	37	49	25
Cobalt	11	8	1	2	0
Copper	183	32	45	106	50
Cyanide	14	4	10	0	0
Iron	40	34	4	2	0
Lead	158	37	45	76	42
Manganese	28	21	3	4	2
Mercury	50	9	34	7	5
Molybdenum	1	0	1		
Nickel	97	25	38	34	20
Selenium	5	4	0	1	0
Silver	5	0	3	2	2
Thalium	2	0	1	1	0
Vanadium	4	3	1	0	0
Zinc	180	37	44	99	49

[1] Colour coding is to group parameters into ranges of analysed in 0-25% of consents (no shading), 25-50% (pale yellow), 50-75% (pale purple) and 75 to 100% (pale blue).

Table 17 Full count of organic CC listed in consent condition wording for three discharge activities

Contaminant Group	Contaminant	All consents[1]	Leachate	Wastewater	Stormwater	
					All stormwater consents	Global consents
	Number of consents	250	44	49	157	58
	Contaminant					
Hydrocarbons	TPH	104	4	4	96	32
	PAH	34	3	6	25	13
	BaP	13	0	0	13	13
	BTEX	9	2	0	7	4
	Naphthalene	7	1	0	6	6
	Pyrene	3	0	0	3	3
	Anthracene	1	1	0	0	0
	Fluoranthene	1	1	0	0	0
	Phenanthrene	1	1	0	0	0
Organochlorines	PCB	9	6	3	0	0
	OCP	9	5	3	1	1
	OPP	6	4	2	0	0
	ONP	6	3	3	0	0
	PCP	6	4	2	0	0
	DDT	3	2	0	1	1
	Dioxin	2	1	1	0	0
	Endosulfan	1	1	0	0	0
Organic Chemicals	Phenol	29	9	12	8	1
	Propiconazole	5	0	0	5	0
	Methanol	3	0	0	3	0
	3-iodo-2-propynyl butyl carbamate	3	0	0	3	0
	formaldehyde	3	0	0	3	0
	Benzalkonium chloride	2	0	0	2	0
	methylene bisthiocyanate	2	0	0	2	0
	n-octyl isothiazolinone	2	0	0	2	0
	Iodocarb	2	0	0	2	0
	Iodofon	2	0	0	2	0
	TBT	2	0	1	1	0
	Carbendazim	1	0	0	1	0
	Furan	1	1	0	0	0
	Permenthrin	1	0	0	1	0
	Tebuconazole	1	0	0	1	0
Multiple group screening tests	SVOC/VOC	40	22	11	7	5
	13 Water treatment chemicals*	3	1	1	1	1

	10 Water treatment chemicals*	3	1	1	1	1
	'Pesticides'	3	0	1	2	2
	'Acid herbicides'	2	2	0	0	0
	Resin Acids	2	0	0	2	1

[1]Colour coding is to group parameters into ranges of analysed in 0-10% of consents (no shading), 10 -50% (pale yellow), 50-75% (pale purple).

*Water treatment chemicals were specified lists for Taranaki Regional Council, related to oil/gas industry discharge to farm consents.

C.1.2 Additional items included in consents to manage CC

A number of additional parameters listed in the wording of consents conditions were noted as common across the three discharge types in relation to specifically managing the CC of interest. These are aspects regarding further toxicity testing, management of hazardous substances, the reference to protocols and standards and monitoring requirements beyond the CC. Table 18 summarises the record of consent conditions/clauses that are included specific for the management and analyses of target chemical contaminants.

Table 18 Percentage of consents targeted for specific chemical assessment and/or management for key contaminants

Item	Overall (%)	Leachate (%)	Wastewater (%)	Stormwater (%)
Whole Effluent Toxicity test specified	6	5	22	1
Hazardous substances clause (leachate/SW only)	46	55	na	45
Trade Waste clause (WWTP only)	17	na	17	na
Management/monitoring plans (relevant for target contaminants)	54	89	24	53
Standards specified (relevant for target contaminants)	38	50	39	34

na – not applicable for the activity

It is noted here that these are examples only, and this list is not exhaustive. There are a range of other approaches and indices which are also included in monitoring/management plans that are not specified in consent wording, for example ecological monitoring programmes that are of high importance to AEE process. Also, infrastructure or asset management plans are integral to these activities, and will influence the long term impact of how well discharges are treated or managed – this is not included int eh scope of this current assessment but some details regarding WWTP assets can be found in the DIA Three Waters review discussion papers.

Nine out of 16 councils had at least one consent (predominantly a wastewater discharge) that specified a requirement for a whole effluent toxicity (WET) test (Figure 8). The requirement for a WET test was not common, but is recognised as a tool for assessment of toxicity, and where specified in a consent this was accompanied by a specified testing standard (see Table 18 for list of common standards and guidelines). No results of WET tests were provided in the data request.

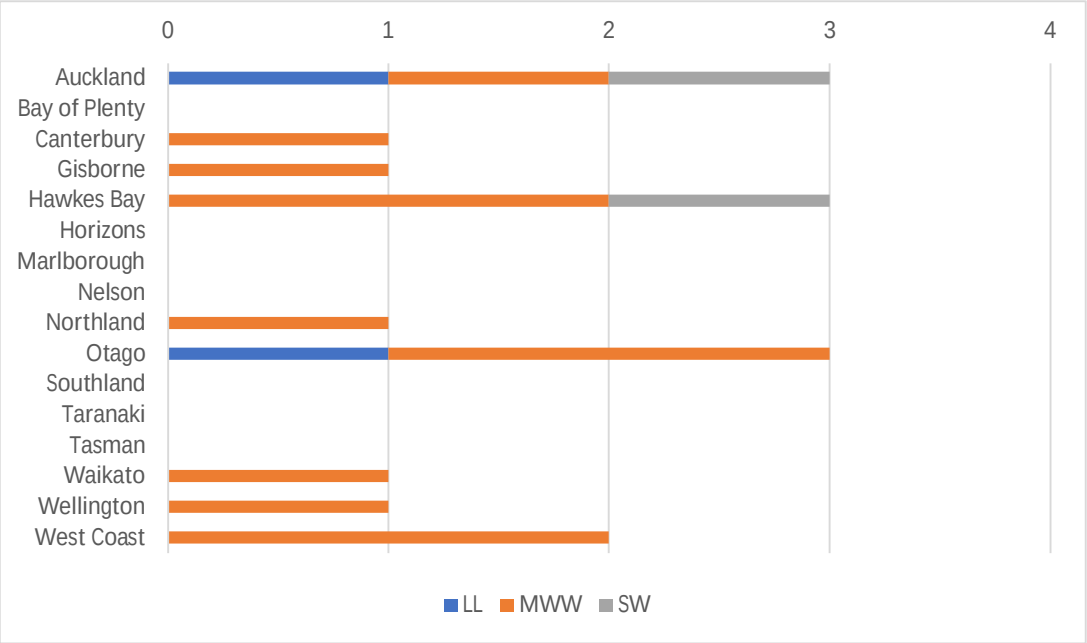


Figure 8 Activity summary specifying Whole Effluent Toxicity testing in consent conditions

A small number of consents contained specific wording with a reference to 'State of the Environment' monitoring (Figure 9). This was not a common feature but was noted in several global stormwater consents that set out wider catchment management approaches for the network discharges.

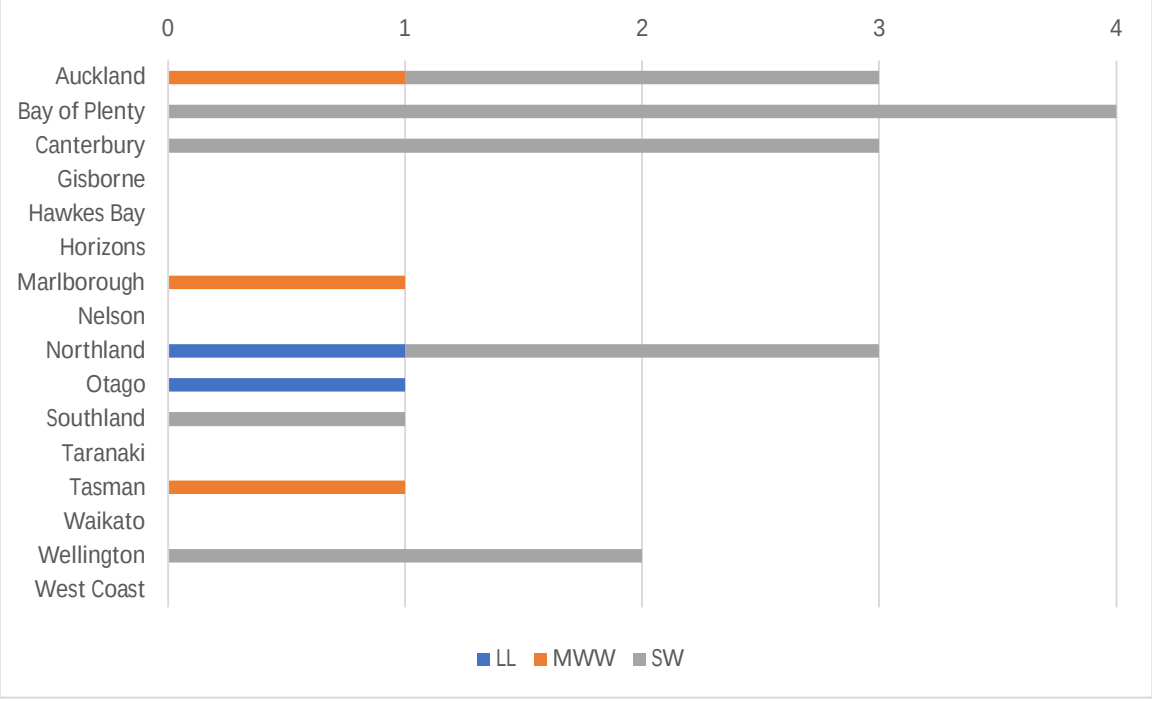


Figure 9 Consent conditions specifying a direct reference to State of the Environment monitoring programmes

Trade waste clauses for wastewater discharge consents, and hazardous waste clauses for stormwater and leachate consents were a feature across most councils (Figure 10). Six councils had trade waste clauses incorporated into discharge consents, but this was noted as an uncommon feature. Thirteen regions included a

hazardous waste clause (or reference to the management of the discharge of hazardous substances) in specific consent wording. Similarly, landfill leachate consents were included in 12 regions, but not in all discharge consents for that activity.

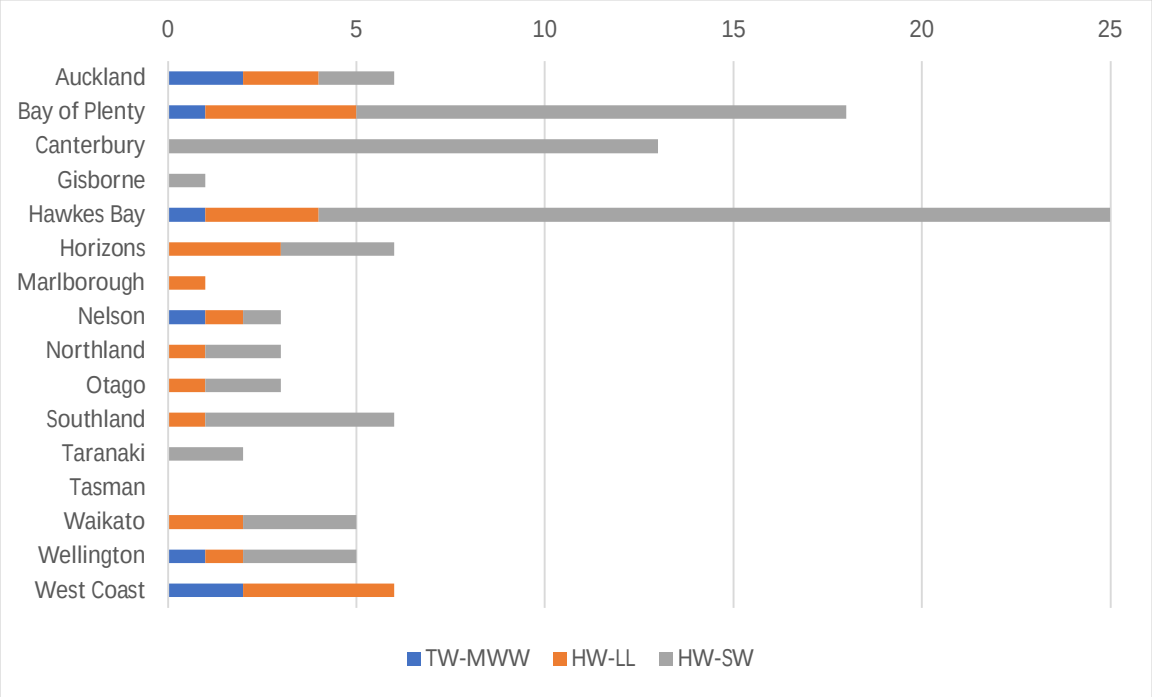


Figure 10 Consent conditions specifying a trade waste (wastewater) or hazardous waste (leachate or stormwater) management clause

Table 19 Commonly cited standards/guidelines included in consent conditions specific for the analyses and/or management of target contaminants

Commonly used standards and guidelines applicable for target contaminants analyses and management	Activity
ANZECC (200)	All
ANZG 2018	All
APHA AWWA, WEF, USEPA	MWW
APHA, ASTM for sampling only, not receiving env GL	All
Best practice guideline for the safe use of timber preservatives and antisapstain chemicals (2005)	SW (timber treatment)
CAE	LL
CLMG limits & MAVs	LL
DWS (various, including the Irish, UK)	LL
DWSNZ	LL
Guidelines for Assessing and Managing Petroleum Hydrocarbon contaminated sites in New Zealand (MfE, 1999)	LL, SW
MfE Environmental Guidelines for Water Discharge from Petroleum Industry Sites in New Zealand	LL, SW
MfE Oil Industry Guidelines 1999	LL, SW
New Zealand Municipal Wastewater Monitoring Guidelines' NZWERF/MfE 2002	MWW
UK Environmental Quality Standards	
USEPA (1991) EPA/505/2/90/001 , USEPA (1992) EPA/600/4/91/003 Effluent Toxicity Assessments;	MWW
USEPA National Recommended WQ Criteria - CMC	SW
USEPA SPLP (Synthetic Precipitation Leaching Rates) for Leachate Triggers	LL
USEPA TCLP	LL
User Guide to HSNO Thresholds and Classifications ER-UG-03-1 08/01 (2001)	
WPCF (Water Pollution Control Federation)	

There were a range of guidelines/standards across activity types, from both NZ/Australian derived guidelines, and including other international documents (Table 19)

Relationship between consent descriptors.

To further assess the relationships between the parameters assessed, a high-level correlation was examined across discharge monitoring characteristics, and contaminant management parameters (Table 20).

Table 20 Correlation matrix for consent parameter assessed for target contaminants across three discharge activities.

	Discharge Monitoring	*RecEnv Mon*	*Monitoring (anywhere)*	*Limit (Y)*	*TV exceeded (Y)*	*SOE (Y)*	*WET (Y)*	*TW/HW*	*MPs (Y)*	*Standards (Y)*	*Duration (AV)*
Discharge Monitoring	1.00										
RecEnv Mon	0.68	1.00									
Monitoring (anywhere)	0.93	0.89	1.00								
Limit (Y)	0.79	0.86	0.90	1.00							
TV exceeded (Y)	0.62	0.12	0.44	0.37	1.00						
SOE (Y)	0.53	0.48	0.55	0.57	0.48	1.00					
WET (Y)	0.07	-0.05	0.02	-0.09	0.10	-0.10	1.00				
TW/HW	0.84	0.45	0.73	0.49	0.56	0.46	0.01	1.00			
MPs (Y)	0.84	0.85	0.92	0.83	0.34	0.52	0.01	0.67	1.00		
Standards (Y)	0.82	0.64	0.81	0.68	0.61	0.66	-0.04	0.76	0.68	1.00	
Duration (AV)	-0.20	0.07	-0.09	-0.07	-0.23	-0.07	-0.11	-0.12	-0.10	-0.04	1

It is recognised here that by the select nature of the data screened that several parameters tend to auto-correlate. For this reason, this correlation matrix is regarded as indicative only, for a fully representative assessment the discharge activities in question would need to be inclusive across all contaminant types, not just the target contaminants in this current study.

Several high-level generalisations can however be made:

- Features regarding monitoring and TVs are auto-correlated – the selective nature of the data being biased for target contaminants has ensured that where TV are indicated, there is monitoring associated with these parameters;
- The paucity of monitoring data submitted by councils has restricted the ability to assess further relationships with other consent features;
- For monitoring plans and standards, these are positively correlated with monitoring and TVs;
- There is no relationship between the average consent duration and other features of consent conditions;
- There is no relationship between the requirement for a Whole Effluent Toxicity test with other consent features.

C.2 State of the Environment monitoring

Routinely monitored metals/metalloid CCs is council SoE programmes is set out in Figure 11.

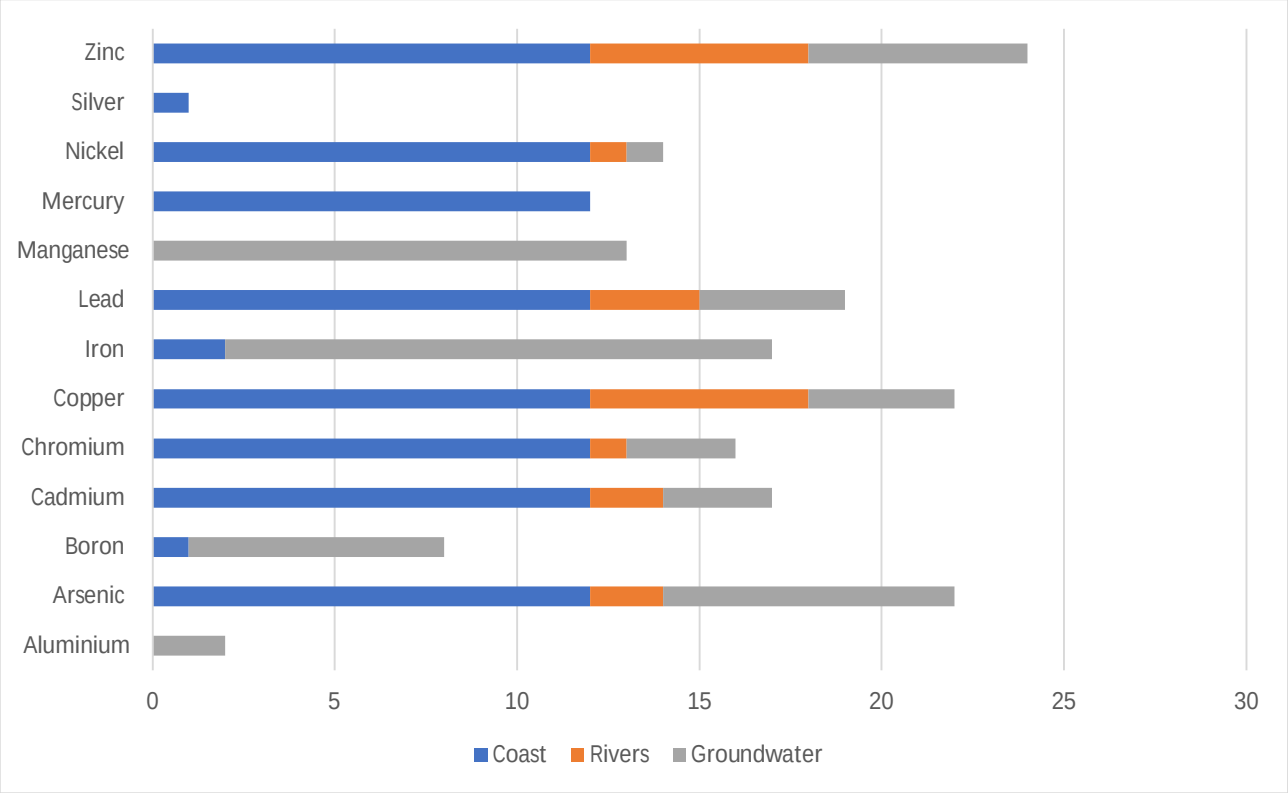


Figure 11 Summary of routinely monitored metals/metalloids in coastal, rivers and groundwater State of the Environment programmes

In addition to Council held investigations, numerous Councils have collaborated with specialists to commission advice and investigation funded via the MBIE funded Envirolink programme. Several examples of advice grants, technical reviews, as well as nationally relevant 'Tools' as listed in Table 21.

Table 21 Summary of Envirolink Advice Grant reports and Tools concerning contaminants assessments, monitoring and risks for Councils in New Zealand

Year	No	Title
Advice grants		
2006	150	Monitoring of Pesticides in New Zealand groundwater systems
2009	691	REPORT PREPARED FOR NZ Regional Council Biosecurity Managers Trends in vertebrate pesticide use and development: alternatives to 1080 - what and when?
2009	820	Sheep Dip Factsheets No. 3 - Arsenic
2009	820	Sheep Dip Factsheet No. 2 - Organochlorine Pesticides
2009	846	Strategy for emerging contaminant issues
2010	884	Environmental fate of brodifacoum in wildlife
2010	877	Ecological relevance of copper and zinc in sediments beneath fish farms in New Zealand
2011	948	Review of the risks of emerging organic contaminants and potential impacts to Hawkes Bay
2012	1029	Environmental impact of Brodifacoum use: monitoring residues in wildlife
2013	1250	Non target risks of using 1080 and pindone for rabbit control
2014	1294	Review of the toxicology and ecotoxicology of PAPP in relation to its use as a new predator control tool in NZ
2014	1446	Experimental protocol to test pasture species susceptibility to the herbicide flupropanate
2015	1602	Trends in Vertebrate Pesticide Use and the Importance of a Research Pipeline for Mammalian Pest Control in NZ
2017	1762	Review of resource consent conditions for stormwater discharge from port log yards
2019	1902	A review of microplastics risk – implications for environment southland
Tools		
2014	R10	Background concentrations and soil guideline values for the protection of ecological receptors
2017	R11	NEMS water quality standard
2019	R13	Cost effective tools for monitoring urban waters

Appendix D. Questionnaire responses

Summary of written responses from councils and key themes

Survey Question	Jacobs summary of all responses and key themes (see note)
Q1 - Does the regional plan (policies, objectives and rules) identify emerging contaminants as an issue for your region? If yes, what activities are these for (e.g. discharge to land, discharge to groundwater, discharge to surface water)?	In general emerging contaminants are not identified as issues in Regional Plans. However a number of Councils did identify that their plans identified a range of potentially contaminating land uses and contaminants in general that then allow effects o all contaminants (including emerging contaminants if required) to be regulated where necessary. A number of Councils identified that their plans were older so did not list or identify EC's. Only one Council (Wellington) identified that its latest proposed plan has a rule for wastewater in which monitoring of EC's is listed as a matter of discretion.
Q2 – How are ECs considered during the resource consent process by your council?	Councils generally identified that the full range of contaminants that may be present in discharges and identified during the application and processing of consents. In general smaller scale activities with well defined contaminants would not involve emerging contaminants whereas larger ones may do depending on the activity. The consent processing would focus on the potential effects and activities required to manage or monitor those. A couple of Councils gave specific information regarding where emerging contaminants have been consider in consents and monitoring. One Council (Hawkes Bay) gave an example of a review condition that has been use do that consent monitoring can be expanded if further emerging contaminants are suspected over the lifespan of the wastewater discharge consent.
Q3 – Is the approach for the inclusion of chemical contaminants different for the three focus activities (landfill leachate, municipal wastewater and stormwater)?	This question was answered differently by differing Councils depending on whether they focused do the consenting process or the outcome of the activities. In summary where Councils discussed the process these were the same for all activities with a requirement to identify the relevant contaminants (routine or emerging) and assess effects of these and then determine treatment, monitoring and management requirements. Some Councils did identify that the consent outcomes were different for differing activities with stormwater more focused on a small suite of parameters and checking performance of treatment devices. A number of Councils (especially those with less urban development) did not consider emerging contaminants to be an issue across any of the activities in their region.
Q4 – Has the approach for the inclusion (or not) of monitoring chemical contaminants changed over time- i.e. is chemical contamination an issue for new consents only compared with older consents?	In general, the Councils answered that yes the monitoring of chemical contaminants has changed over time. Newer consents have a requirement for monitoring a wider range of contaminants. This has increased as knowledge of contaminants and their potential effects has increased with both applicants, the public and Councils. As noted for Q3 the approach to consenting has not changed with activities being assessed on the scale and nature of potential effects but the knowledge of what contaminants may be involved has changed.

Q5 – Are there any barriers to consideration of a wider number/range of chemical contaminants during consent processing? What are these barriers and where do they sit (e.g with applicants or Council)?	A range of potential barriers were cited by Councils including: - Knowledge of the potential effects of contaminants. - Lack of national limits to compare contaminants to. - Lack of known practical treatment or mitigation. - High cost of non-standard testing - Lack of knowledge for Council of where (and whether) contaminants are an issue. A number of Councils identified that emerging contaminants were not considered to be an issue in their region and therefore this is why they were not considered in most consents. As the emerging contaminants were not considered to be a widespread issue in their region it did not justify cost and effort in monitoring.
State of the Environment	
Q1 - Is your council intending to incorporate any additional chemical contaminant including emerging contaminant, monitoring as long-term programme parameters (e.g. as an urban water quality programme or other)?	In general Councils were not planning on including additional chemical contaminants into routine SoE monitoring. However a number noted where they have been involved in regular monitoring programmes (e.g. ESR pesticides in groundwater), screening programmes for contaminants in estuaries and others. Some Councils had also monitored other contaminants over time but changed monitoring due to low concentrations of contaminants. Councils therefore identified that they will continue to keep involved in some of these targeted investigations and also review what is monitored in their SoE work over time and will consider changing parameters if issues are identified.
Q2 – What is your view on the effectiveness of the SOE and other routine monitoring at providing data to understand the presence and levels of chemical & emerging contaminants across your region?	A broad range of views were provided in response to this question. With some Councils considering that their SOE monitoring was effective at providing data on levels of contaminants and others suggesting it was less so. In general it was identified that the SOE monitoring was focused on understanding the broader regional scale presence and distribution of contaminants rather than on specific smaller areas and activities. SOE monitoring focuses on a number of environments (freshwater, estuarine, coastal and groundwater) with variability across Councils of how much monitoring is undertaken where.
Q3 – What (if anything) is needed to increase the effectiveness of SOE and other routine monitoring for understanding the presence and levels of chemical & emerging contaminants across your region?	A large number of points were raised by the respondents, with one of the more common responses to this question being around the understanding of the effects of these emerging contaminants on the environment or human health that would then justify the expenditure and effort required to do further monitoring. A number of Councils also noted that clear guidelines are required (potentially from MfE) regarding which emerging contaminants are a priority. Coupled with this would be clear guidelines/limits for comparing any data too that relate to effects and inexpensive analysis methods that allow for routine monitoring.

Q4– Does your RC/UA draw links between the understanding of chemical & emerging contaminants provided from SoE and other routine monitoring and the consented leachate, wastewater and stormwater monitoring occurring in your region? Can you explain how this is done and if reported formerly in technical reports or other documents? Please provide examples.	A range of responses were received from Council respondents on this question. A number of Councils answered that no they did not draw links between the data like this whereas a broadly equal number said they did, or did in part. Examples given included using SOE data to understand effects of activities during consenting. Identifying issues in SOE data and then linking it to specific discharges. Using the available data from all monitoring to understand the effects of certain activities and landuses.
Q5 - Does your Regional Council/Unitary Authority intend to undertake any other monitoring as targeted or one-off investigations for specific chemicals of concern? If yes – what are the drivers for this? What are the chemical classes intended to be analysed (even if not certain at this stage – an indication of intent is useful):	A number of Councils responded that they are not considering any further monitoring at present. However a greater number suggested that they were, these were generally going to be targeted on specific contaminants (including pesticides and other emerging contaminants), often as follow ups from work that has already been done. These were generally focusing on perceived issues and potential concerns rather than general screening for issues.
Q6 – Are you aware of any other monitoring that your council has done that has included non-routine and/or emergency contaminants? E.g. one off or targeted studies, non-consent directed monitoring by Councils of their wastewater discharges. Please upload that data and relevant report.	Councils generally identified other studies and work of relevance. Due to the question just seeking information sources no further summary has been made.
Q7 - Are you aware of any other monitoring that is undertaken or has been commissioned under any other programmes by other RC/UA departments that is aligned with this project (e.g. contaminated soils, closed landfills – though these are not in scope of data capture, might be useful to note)? Please provide contact details of relevant staff for follow up.	A few Councils identified monitoring of relevance. A high level summary is included here: Key features include: • Contaminated Land remediation projects • Soil investigations for vinyards, pasture (including high intensity), cropping, forestry include trace metals, OCPs • Several contaminated land and groundwater contamination investigated due to compliance investigations • Closed landfill and contaminated land investigations • Collaborations with university research

Q8 – Are you aware of any other monitoring of emerging contaminants that other agencies, bodies or industries may have done in your region? E.g. non- consent directed monitoring by district or city councils in your area, monitoring by industry or research organisations. If publicly available please provide that data and relevant reporting. Or please provide contact details for further follow up by us.	A number of Councils identified monitoring of relevance. A high level summary is included: Key features include • Fire and Emergency NZ – PFAS in soils & urban waterways, associated with fire stations • NZ Defence force assessments for PFAS • NZ Police – drug trials • Passive sampling trials for pesticides (universities) • EC analyses for Wasetewter treatment plant, university based studies
Q9 - What does the council perceive as barriers to the capture of information regarding chemical contaminant monitoring? For example – o Data base management o Standardized protocols o Laboratory analytical techniques o Costs of monitoring o Other	A large number of points were raised by respondents including: - Cost was the most noted point which included both laboratory costs and staff costs in time spent doing monitoring and reporting. - Issues relating to a lack of national guidance of relevant limits for many contaminants was noted (especially emerging contaminants), applicable NZ wide national guidelines or limits are required to make monitoring more relevant and easier to analyse. Combined with this was the fact that there is a large breadth of emerging contaminants that could be analysed for, many don't have guidelines. Guidance on which parameters are priority would also be of value. - A number of Councils noted that evidence of the need for monitoring is also required, so evidence of the risk and therefore purpose of the monitoring was noted as a barrier, especially in Councils that did not see that these contaminates were an issue within their regions. - Councils noted that limited lab availability, lack of competition/ long timelines and variability in lab results/methods were also barriers. - A number of respondents noted that the existing background levels were also a factor, in part not knowing what these are so as to compare results to. Also related was the fact that a lot of results may end up below detection limits. Which is a lot of cost/effort in monitoring for contaminants that are not an issue. This has in the past lead to Councils dropping monitoring programmes once they have demonstrated that parameters are not widely present.

Appendix E. Data

Raw data spreadsheets:

- Consent data (Excel spreadsheet)
- State of the Environment data (Excel spreadsheet)
- Full council written survey (Excel spreadsheet)