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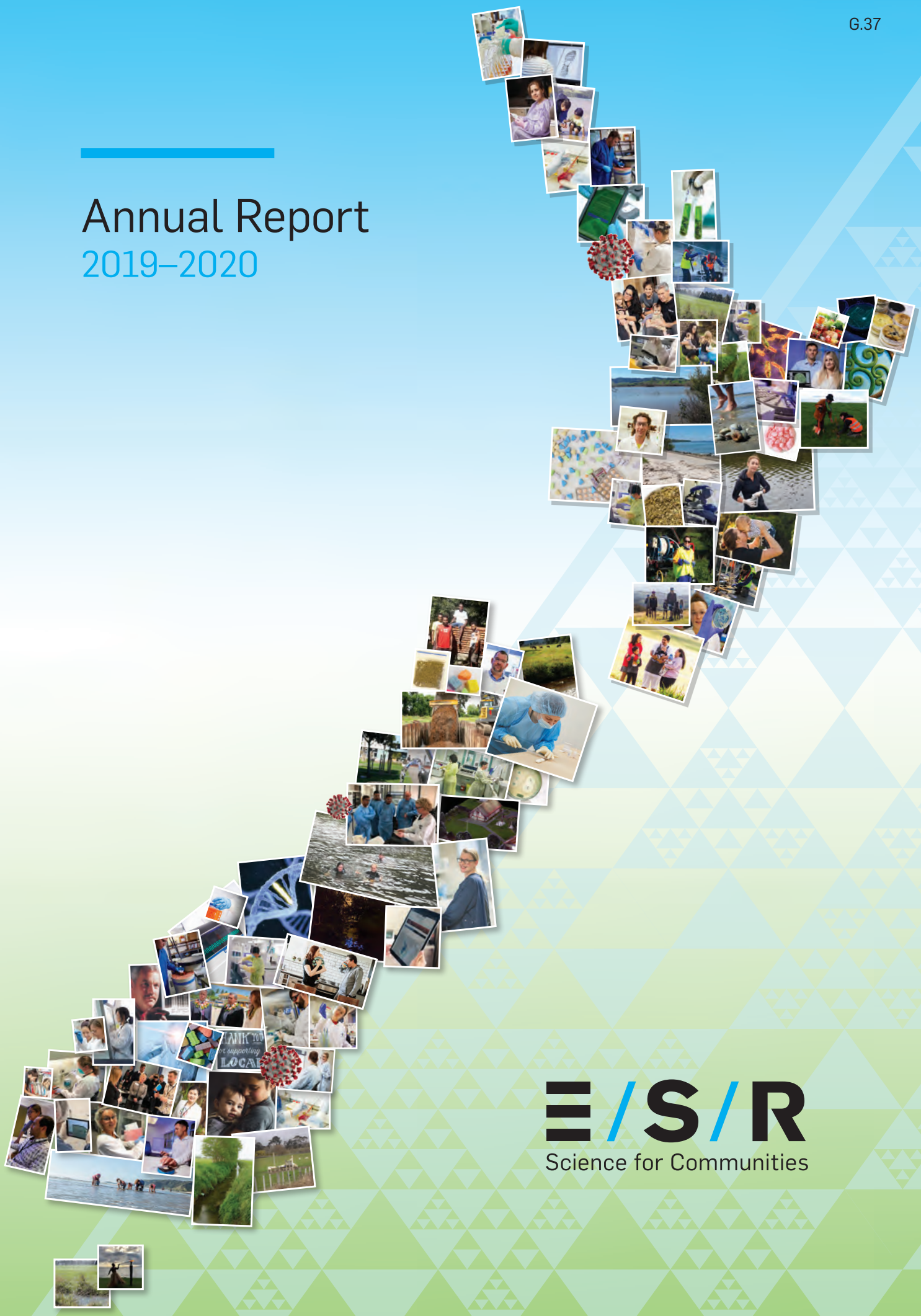
Annual Report
2019–2020



ESR
Science for Communities

Presented to the House of Representatives pursuant to section 17 of the Crown Research Institutes Act 1992.

The Institute of Environmental Science and Research Limited (ESR) is a Crown research institute. It was incorporated in June 1992 and is wholly owned by the New Zealand Government. The two shareholding Ministers appoint a Board of Directors to govern the organisation. ESR has science facilities in Auckland, Wellington (Porirua and Wallaceville) and Christchurch.

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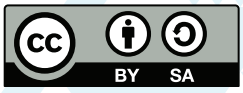


ESR is New Zealand's Crown research institute specialising in science for communities

Contents

Chair and Chief Executive's foreword 02

Summary of our financial performance for the 2019–20 year 04

Key financial performance indicators as at 30 June 2020

Our Statement of Core Purpose 07

What we did over the year to contribute to the wellbeing outcomes 08

Our strategy 12

About us 14

Purposeful collaboration 15

He Pūtaiao, He Tāngata: embedding Vision Mātauranga in our work 19

Core generic performance indicators 20

Strategic Science Investment Fund research 21

Science for impact: Healthier communities 23

Healthier communities performance indicators – results as at 30 June 2020

Science for impact: Safer communities 31

Safer communities performance indicators – results as at 30 June 2020

Science for impact: Safer food 39

Safer food performance indicators – results as at 30 June 2020

Science for impact: Cleaner water and environment 43

Cleaner water and environment performance indicators – results as at 30 June 2020

One ESR – He waka eke noa 51

Celebrating success 58

Governance 61

Our Board of Directors 61

Our Senior Leadership Team 67

Financial statements 70

Independent auditor's report 71

Notes to the financial statements 78

Statement of responsibility 100

Chair and Chief Executive's foreword

It's been a year of tremendous change for ESR, as it has for the nation and the world.

While the 2019–20 financial year was ushered in fairly quietly, though not without some big plans, we have achieved so much and at break-neck speed. Since our scientists first started tracking an unknown virus in Wuhan, China, in late 2019, we have stayed at the cutting edge of scientific and technological developments. As the virus spread throughout the world, shutting down travel routes and borders, ESR stayed ahead of the game. We provided real-time health intelligence, continually innovating to **detect** where the virus was in New Zealand, **connect** with key government agencies and partners and **protect** our communities. Our response was underpinned by our expertise and cross-sector collaboration with other CRIs, universities and government agencies, both here and abroad.

We stood up the nation's first diagnostic test for COVID-19, developed an online dashboard to allow government and the public to stay abreast of the latest data, and were the first in New Zealand to sequence the genome of COVID-19, knowing how useful this emerging technology might prove in the long run. We also applied our expertise in wastewater to pioneer research into how the virus might be spreading in the community. In essence, we have set up an end-to-end system for testing, validating, analysing and reporting on COVID-19 in New Zealand. This work has become vital to informing public health decisions about managing the pandemic.

We've certainly demonstrated our resilience, adaptability and innovation – and all ESR's people played their part in these significant achievements.

Of course, this year hasn't been all about COVID-19. Year-end saw farewells for our previous Chief Executive Keith McLea, who ably prepared the organisation to weather the storm that followed a global pandemic. We owe much of our readiness to his clear direction and resolve. The Board was delighted, in June, to then announce the appointment of the incoming Chief Executive.

We also ushered in a swathe of new projects, innovations and partnerships. For starters, we collaborated with the New Zealand Police to trial the Lumi Drug Scan service, which enables officers to test for the most common drugs on the streets using a handheld device and receive almost instant results through their work-issued mobile phones. We're already receiving positive feedback from the frontline about the difference Lumi is making.

Our genome sequencing was applied to a review of the 2016 *Campylobacter* outbreak in Havelock North. The research demonstrated the true scale of the outbreak – significantly higher than previously calculated.

ESR will receive a government capital injection of $25 million to redevelop the science centre and offices at our campus in Porirua. The redevelopment, which is now in the design phase, will include a mix of modern laboratories, research support spaces, a forensic service centre and offices. It will be a place to call home, to innovate and collaborate. We're proud to be part of Porirua's vibrant community and hope the local community can take pride in our redeveloped campus – and the cutting-edge science that will take place there.

ESR's reputation as a leader in forensics and public health science, research, and innovation has long been known to New Zealanders. In addition to ground-breaking work in these areas, ESR leads high-quality science that impacts a vast range of complementary fields. Our staff continue to play a key role in making sure the food New Zealanders eat and export is safe, by detecting contaminated food and the source of contamination. Our scientists are looking beneath their feet and shining light on the invisible world of microorganisms to understand the health of our groundwater. We're proud to be the CRI that focuses on the social sciences, reflecting the huge potential of this scientific discipline to address some of New Zealand's biggest issues. And we're providing answers about how microplastics are affecting the marine environment,

including through an innovative study into how plastics change over time at coastal sites around New Zealand. In these and other areas, we harnessed our ability to detect, connect and protect New Zealand communities.

In the year ahead, we'll be looking to implement the organisation's new strategy – which brings together all the work that has been done collectively over the last few years. It builds on the intent of our 'Great Plan for Science' and the recently completed 'Science Review'. We know clearly where we stand and how we need to change to build on our strengths and succeed in future.

For us, that means achieving greater impact with Māori – following their lead and growing our understanding and expertise in mātauranga Māori. We'll also be working to anticipate the future of science and harness all our expertise to solve the big problems facing our customers. This won't happen without building our team and putting in place stronger foundations. These are big aspirations, and we're committed to leading and supporting every employee at ESR to make this happen – for the benefit of all New Zealanders.

Denise Church
QSO, CFInstD
Chair

Peter Lennox
Chief Executive Officer

Dr Keith McLea,
Chief Executive of ESR 2014–2020

When Dr Keith McLea joined ESR in 2014, he brought his skills and determination to an organisation that he found both fascinating and full of potential – perhaps not surprising since Keith has a PhD in human genetics and trained as a toxicologist. Keith brought his career experience as an advisor to government ministries and in the personal injury insurance and injury prevention sectors, together with a strong commitment to translating science into impact.

Over his six-year tenure, Keith led the organisation's transformation and cemented ESR's pre-eminence as a provider of robust science advice. Keith served in the prestigious role of special advisor to the China Council for International Cooperation on Environment and Development.

Keith's passion didn't end at the innovative science and research carried out in ESR laboratories every day. His focus was on people: ESR's talented team and the communities that benefit from ESR's science. His community focus is now embedded in ESR's 'science for communities' vision: harnessing science to make our communities healthier and safer and our environment cleaner.

ESR's contribution to New Zealand's COVID-19 response meant extreme demands on the organisation over the past months. Despite the challenges, ESR not only delivered scientific advice to decision-makers, but ensured that business-as-usual work in forensics and other key areas was sustained. ESR's agility owes much to the transformation Keith set in motion.

The Board is grateful to Keith for his service and deep commitment to ESR. Our warmest wishes go to Keith as he transitions to a portfolio of work and well-deserved time for family, friends and interests.

Summary of our financial performance for the 2019–2020 year

ESR recorded a net profit after tax (NPAT) of $2.6m for the 2019–2020 financial year, a 42% increase on 2019 and well ahead of the Statement of Corporate Intent (SCI) target.

Financial performance

	Actual 2020 ($000)	SCI target ($000)	Actual 2019 ($000)
Revenue	83,750	82,869	78,584
Operating margin	8,445	6,443	7,579
NPAT	2,644	202	1,858
Return on equity	4.6%	0.4%	3.4%

Revenue

Our revenue grew by $5.2 million year on year, driven by growth in research revenue and additional funding received from the Ministry of Health for services supporting the Ministry's response to COVID-19.

COVID-19 was a key driver in reduced revenue from commercial and other government contracts, however, the impact of the pandemic was offset by support funding from the COVID-19 Response and Recovery Fund (CRRF).

The increase in our research revenue was driven by: increased influenza research funding from the United States National Institute of Allergy and Infectious Diseases, funding for the development of the Lumi Drug Scan technology and a full year's revenue from the multi-year Endeavour Fund project to investigate the impact of microplastics on the environment. We also benefited from our partnership with the New Zealand Food Safety Science and Research Centre (NZFSSRC).

Investing in the future

Operating expenses increased 7% to $82.3m, and we increased our capital expenditure to $5.4m.

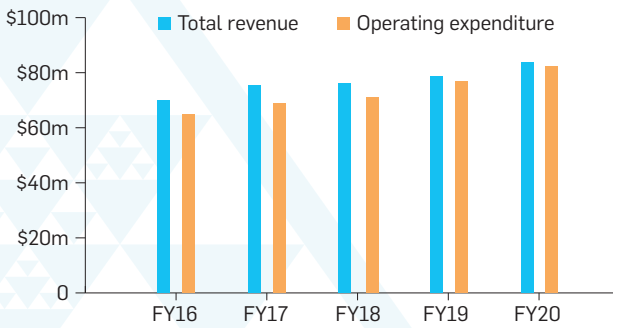
Scientific material and personnel costs increased in line with the increase in research activity and COVID-19 response work. Depreciation was up significantly year on year, with progress made on planning for the Kenepuru Science Centre (KSC) redevelopment, including confirmation of government funding in Budget 2020, necessitating a review of the estimated remaining useful lives of KSC building, fitout and plant assets.

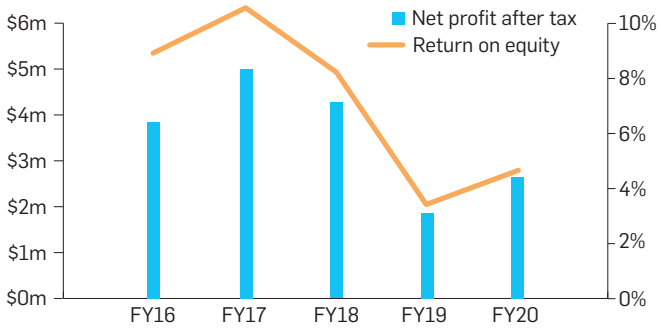
We also increased our investment in strategic initiatives by 65% compared with 2018. This included establishing a transformation programme team and appointing a General Manager of Strategy and Transformation.

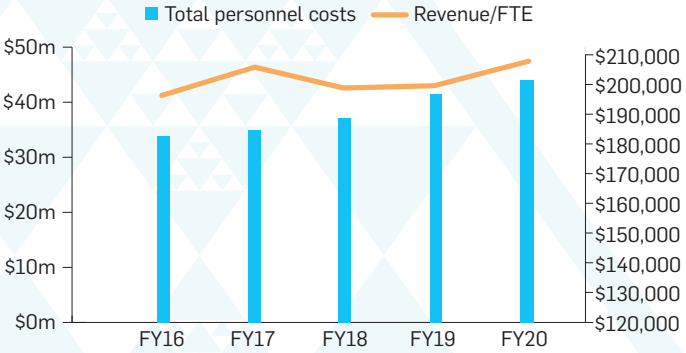
Cash flow

Our operating cash flows remained healthy, supporting a small increase in capital expenditure and the continued accumulation of cash reserves to fund longer-term investment plans, including the KSC redevelopment.

Five-year trends







	2020	2019	2018	2017	2016
Revenue	$83.8m	$78.6m	$76.2m	$75.5m	$70.1m
Operating margin[1]	$8.4m	$7.6m	$10.8m	$12.3m	$10.9m
Net profit after tax	$2.6m	$1.9m	$4.3m	$5.0m	$3.8m
Return on equity[2]	4.6%	3.4%	8.2%	10.5%	8.9%
Return on assets[3]	1.7%	2.4%	7.2%	10.1%	8.6%
Acid test ratio	2.6	2.6	2.8	2.7	1.7
Equity ratio	71.2%	70.6%	71.4%	70.7%	71.3%
Operating margin per FTE	$21,100	$19,300	$28,300	$33,700	$30,500

[1] Earnings before interest, tax, depreciation and amortisation
[2] Net profit after tax to average equity
[3] Earnings before interest and tax to average total assets

Cash flow	2020	2019	2018	2017	2016
Net cash inflow from operating activities	$7.8m	$10.7m	$7.4m	$13.9m	$10.1m
Net cash outflow from investing activities[4]	($5.4m)	($5.1m)	($5.0m)	($3.2m)	($5.2m)
Closing cash, cash equivalents and investment cash	$32.3m	$30.5m	$25.0m	$22.8m	$12.4m

[4] Excluding investment in bank term deposits

Capital investment	2020	2019	2018	2017	2016
Property, plant and equipment	$4.5m	$3.7m	$4.1m	$2.6m	$4.5m
Intangible assets	$0.9m	$1.0m	$1.5m	$0.5m	$1.3m
Other investments	–	$0.2m	$0.3m	–	–
Total capital expenditure	$5.4m	$5.0m	$5.9m	$3.1m	$5.8m

Capital structure	2020	2019	2018	2017	2016
Equity	$59.0m	$56.3m	$54.3m	$50.0m	$45.0m
Total assets	$82.8m	$79.7m	$76.0m	$70.7m	$63.1m
Shareholders funds to total assets	71.2%	70.6%	71.4%	70.7%	71.3%

Key financial performance indicators as at 30 June 2020

	Actual 2020	Budget 2020	Actual 2019
Revenue	$84m	$83m	$79m
Operating margin *Earnings before interest, tax, depreciation and amortisation (EBITDA) as a percentage of revenue*	10.1%	7.8%	9.6%
Return on equity *Net profit after taxation as a percentage of equity*	4.6%	0.4%	3.4%
Return on assets *Earnings before interest and tax as a percentage of total assets*	1.7%	(0.6%)	2.4%
Profit volatility *The standard deviation of EBITDA as a percentage of average EBITDA over the preceding 7 years*	26%	33%	26%
Acid test ratio *Current assets excluding prepayments and inventory to current liabilities, excluding deferred revenue*	2.6	2.0	2.6
Equity ratio *Equity as a percentage of total assets*	71.2%	72.0%	70.6%
Gearing *Debt (including finance lease liabilities) as a percentage of debt and equity*	2.2%	–	–
Revenue per full-time equivalent employee	$208,800	$192,600	$200,200
Operating margin per full-time equivalent employee *Earnings before interest, tax, depreciation and amortisation, per average full-time equivalent employee for the year*	$21,100	$15,000	$19,300

Our Statement of Core Purpose

ESR's Statement of Core Purpose (SCP) is agreed by the Crown and shareholding Ministers. Our SCP is our mandate to operate. It outlines the roles and responsibilities we have and how what we do will benefit New Zealand's people and New Zealand.

Our SCP states that we will:

- 'Safeguard the health of New Zealanders through improvements in the management of biosecurity and threats to public health
- Increase the effectiveness of forensic science services applied to safety, security and justice investigations and processes
- Enhance protection of New Zealand's food-based economy through the management of food safety risks associated with traded goods
- Improve the safety of freshwater and groundwater resources for human use and the safer use of biowaste.'

Our research and services contribute to four impact areas: healthier communities, safer communities, safer food and cleaner water and environment. These impact areas are connected and together improve and influence the long-term wellbeing outcomes for New Zealand's people, communities and environment.

What we did over the year to contribute to the wellbeing outcomes

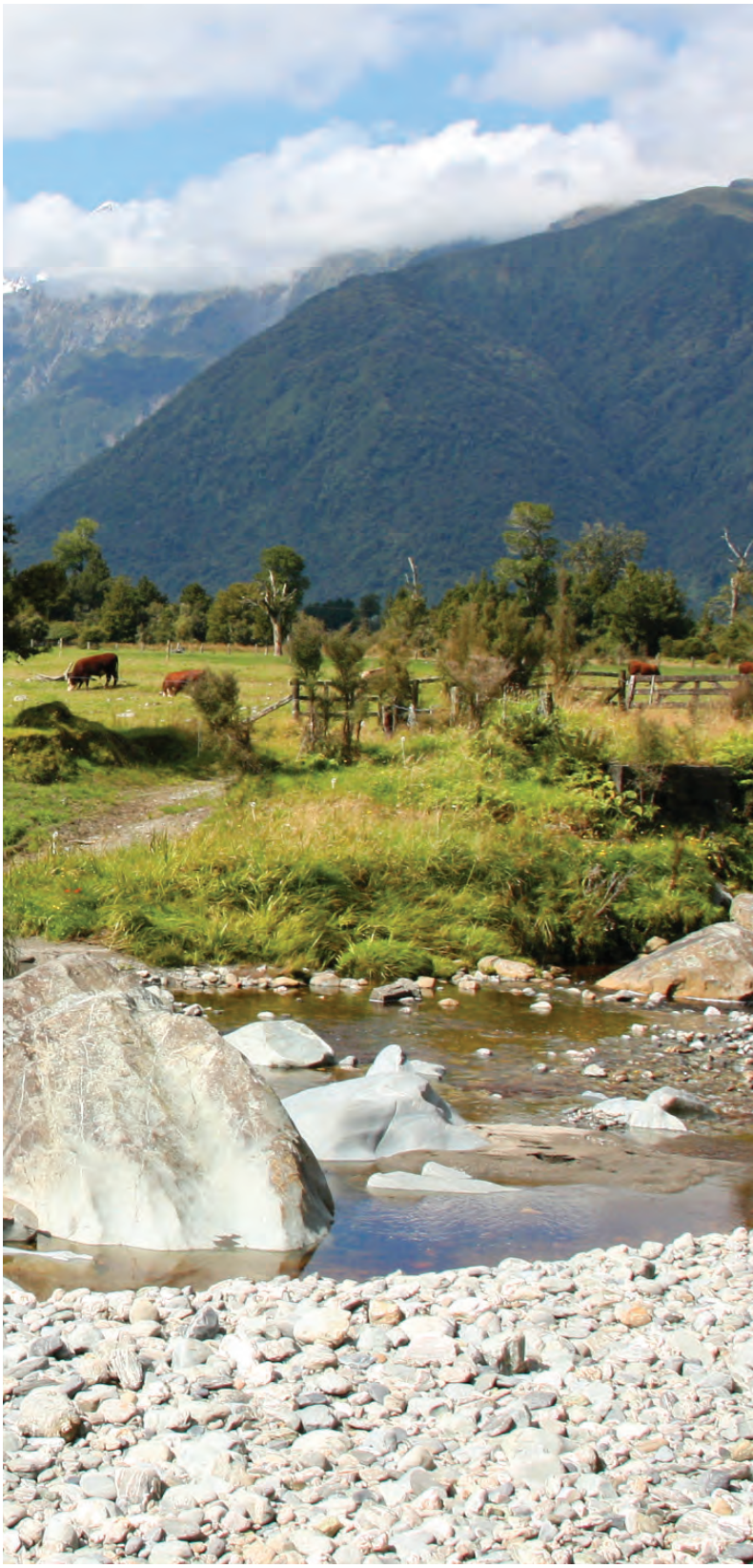
ESR's strategy is clearly focused on delivering value for our customers and New Zealand. To demonstrate our commitment to delivering value and how we are making a difference to wellbeing outcomes, we have assessed our contribution during 2019–20 over our four impact areas against the four capitals (financial and physical, natural, human, and social) as defined in The Treasury's Living Standards Framework (LSF).[1]

Natural capital: This includes land, soil, water, plants and animals, as well as minerals and energy resources. These aspects of the natural environment are needed to support life and human activity.

Human capital: This includes people's skills, knowledge and physical and mental health. These things let people fully take part in work, study, recreation and society.

Social capital: This describes the norms and values that underpin society. It includes things like trust, the rule of law, cultural identity and the connections between people and communities.

Financial and physical capital: This includes things like houses, roads, buildings, hospitals, factories, equipment and vehicles. These are the things that make up the country's physical and financial assets, which have a direct role in supporting incomes and material living conditions.



[1] *See The Treasury, Higher living standards at: https://treasury.govt.nz/information-and-services/nz-economy/higher-living-standards*

Impact area	What we do	Our contribution in 2019–20
Healthier communities	Safeguard New Zealanders' health by improving the management of biosecurity and threats to public health	The long-term wellbeing of New Zealand's people depends on national and international collaborations to improve the way public health and biosecurity threats are managed. We contribute to and collaborate on various national and international research programmes. This year we: • continued human genomics research to increase our ability to offer new insights into clinical health to improve the health of New Zealand's people • embedded our staff in the Ministry of Health, providing technical advice and support on the COVID-19 pandemic to the Ministry of Health's COVID-19 Technical Advisory Group • sequenced the whole genome of New Zealand's first COVID-19 case in March 2020 to contribute to New Zealand's pandemic response and national and international COVID-19 research efforts • created a new real-time COVID-19 dashboard to improve public health surveillance • continued to develop our genome sequencing techniques to build a profile of pathogens that are antibiotic resistant • ran a pilot to test wastewater for COVID-19 to track for cases of community transmission • obtained permission to expand the SHIVERS-II and WellKiwis research programmes to include testing for COVID-19, helping researchers to better understand how the virus spreads in a household setting.

Impact area	What we do	Our contribution in 2019–20
Safer communities  	Increase the effectiveness of forensic science services that are applied to safety, security and justice investigations and processes	Our forensic research and service supports the justice system to meet its goal of keeping New Zealanders safe by preventing, detecting and resolving crime. Ensuring the right information is available at the right quality and time is critical to building trust and confidence in justice outcomes. This year we: • developed a point-of-care technology solution called 'Lumi Drug Scan' that will allow police officers to screen and test for drugs in real time • worked on developing the Integrated Drug Surveillance System (iDSS) to increase drug surveillance capability and intelligence • provided a week-long drug training course to the Tonga Police in November 2019 to upskill police officers in identifying cannabis, using two forensic chemistry techniques • published 'Project Sinnie' survey results on synthetic cannabinoid trends • worked as part of the Disaster Victim Identification (DVI) process to identify individuals who had died in the Whakaari / White Island volcanic eruption on 12 December 2019 • continued genomics research projects, including biogeographic ancestry research (eye and hair colour) from DNA left at a crime scene.

Impact area	What we do	Our contribution in 2019–20
Safer food  	Help protect New Zealand's food-based economy through the management of food safety risks associated with traded goods	New Zealand's reputation as a provider of safe food products for export is essential for international trade and the economy. Improving international trade and the economy increases New Zealanders' standard of living. Our work around New Zealand's food safety system spans the full spectrum of food science research and services for traded goods and mahinga kai. We support and partner with the New Zealand Food Safety Science and Research Centre (NZFSSRC) and other government, research and industry organisations to improve food safety, protect the quality of New Zealand's food and prevent harm caused by foodborne illnesses. This year, we: • completed a study in collaboration with Massey University into source-assigned campylobacteriosis in New Zealand • worked with the Ministry for Primary Industries (MPI) and the Meat Industry Association (MIA) to review, evaluate and provide recommendations on pathogen control in food processing, including ways of improving the New Zealand Process Hygiene Index (PHI) tool • worked as part of an NZFSSRC team to create a PHI toolbox.

Impact area	What we do	Our contribution in 2019–20
Cleaner water and environment	Improve the safety of fresh- and groundwater resources for human use and the safer use of biowastes	Water is essential for life. To protect the health of New Zealand's people, it is essential to improve the quality, management and regulatory oversight of drinking-water, rivers and streams and protect the long-term sustainability of New Zealand's groundwater systems. Developing sustainable options and solutions for managing organic waste, effluent, wastewater, greywater and sewage sludge is vital to improving the health of the environment. This year, we: • undertook a Ministry for the Environment-funded pilot study, looking at the best way to assess the pathogen and indicator relationship in New Zealand recreational freshwater systems • worked with the universities of Canterbury and Calgary and Waikato Regional Council on ways to track water contamination, building a suite of 20 DNA tracer sequences • coordinated the completion of the four-yearly nationwide survey of pesticides in groundwater for regional and unitary councils to assess the quality of groundwater and levels of contamination • completed a collaborative study, using genome sequencing to trace the extent of the Havelock North 2016 campylobacteriosis outbreak • led a Health Research Council (HRC) study into new ways of assessing the risk of waterborne infections from drinking-water • developed our shallow gravel aquifer woodchip denitrification site into a field laboratory for the University of Canterbury's earth science courses • continued exploring alternative cost-effective ways of constructing woodchip denitrification walls in shallow gravel aquifers • researched the movements of contaminants within heterogenous aquifers and the risk of virus transportation from on-site disposal fields into shallow groundwater • worked on establishing a groundwater health index, focusing on macroinvertebrate presence and microbial diversity.

Our strategy

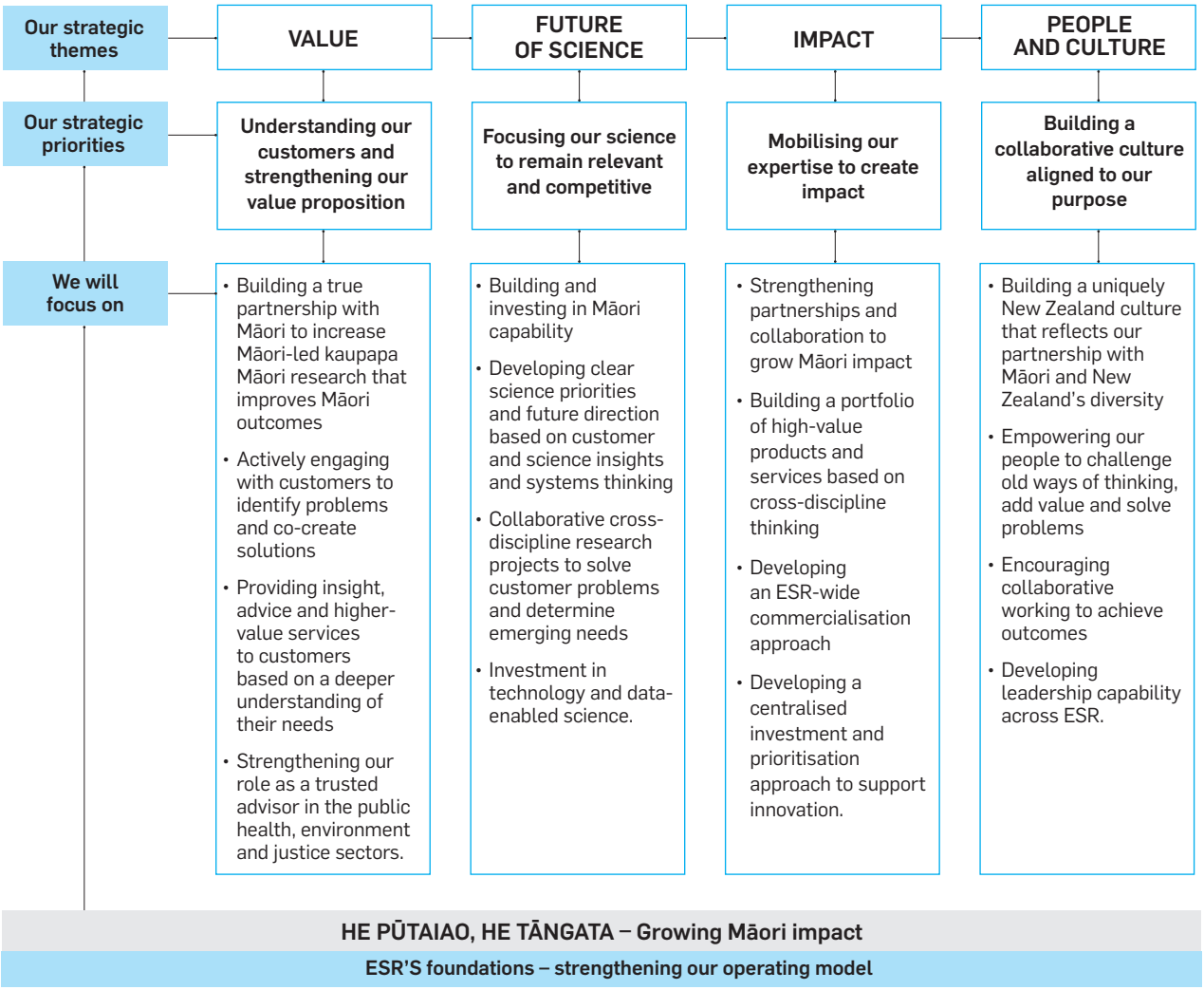
ESR's evolving strategy is focused on positioning us to create a more flexible, adaptive and externally focused organisation with a clear view of our purpose and future direction, based on a deep understanding of our value to customers. With an unwavering focus on adding value and delivering the best outcomes for our customers and New Zealand, we aim to co-create and deliver value-added, novel science solutions to address emerging problems.

To achieve this, we recognise we must keep pace with changes in science and technology, expand our understanding of our value to customers and work collaboratively to develop innovative solutions. We will strengthen our organisation's operating model to support our focus on value, impact and delivering quality outcomes. To drive the strategic transformation we want to see, we have started work on a transformation work programme.

Our strategic themes and priorities are outlined below. Underpinning these is He Pūtaiao, He Tangata: growing our impact with Māori; and work to strengthen our foundations. To successfully execute our strategy, we will need effective and modern approaches, systems, processes and tools.

Our strategy is described in our *Statement of Corporate Intent 2020–2025*. By developing and strengthening our key strategic themes of value, future of science, impact and people and culture, we can make the changes we want to see, deliver high-value innovative science solutions that increase our impact, improve wellbeing outcomes and contribute to a healthy, sustainable and prosperous New Zealand.

ESR's strategic priorities



Transforming for the future

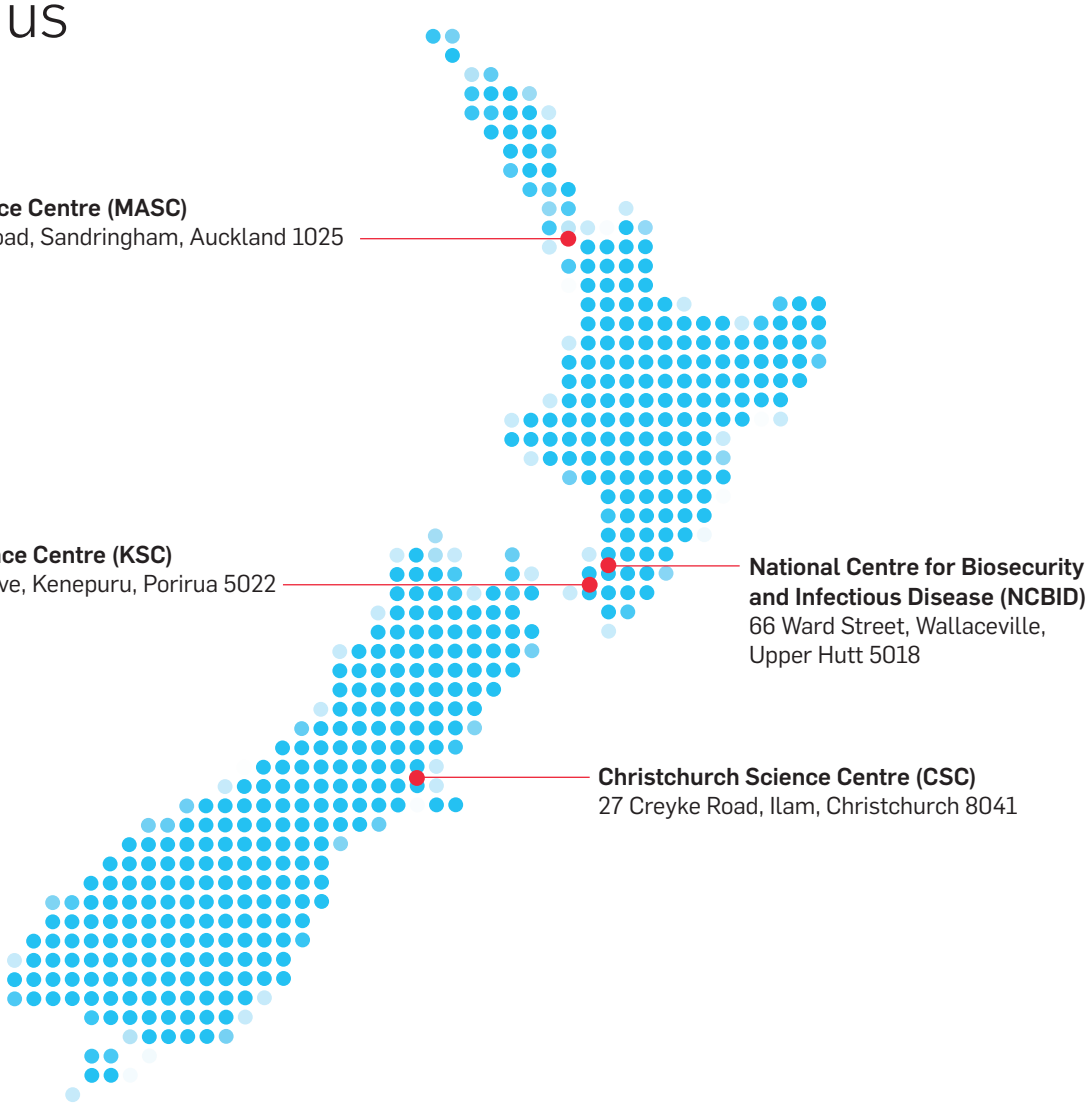
We started work on our transformation work programme over the last quarter of the financial year. This vital programme encompasses all levels of our organisation and considers how we can invest strategically in our science, services and operating model to build our key capabilities and innovate our services to keep pace with rapid changes in science and technology.

Developing a fit-for-the-future Kenepuru Science Centre

In June 2020, the government announced funding of $25 million to support our own investment in the redevelopment of our Kenepuru Science Centre (KSC) in Porirua. A modern, fit-for-purpose infrastructure and technology facility will aid innovation, provide opportunities for increased collaboration and transform the way we do our science for the future.

KSC
NEW BUILD

About us



Our commitment to sustainability

We are committed to being an environmentally conscious workplace and encourage all our staff to follow sustainable practices as much as possible. We define 'sustainability' as:

'a dynamic process, minimising the impact of our operations on the environment by means of continual improvement that enables all people, now and in the future, to have a quality life in a way that protects and enhances the Earth's life-supporting systems'.

This definition aligns with one of our key values, Mahi Pono – We do the right thing.

Our sustainability policy aims to address our operations across the seven areas of:

- purchasing and procurement
- energy and water
- travel
- buildings and local environments
- inclusion and participation
- partnership and promotion
- waste.

Over the year, our multi-site sustainability committee has volunteered their time to progress sustainability initiatives that will reduce: the amount of energy we consume; our waste and our carbon (greenhouse gas) emissions. We are developing plans and targets to reduce our organisational carbon footprint and work towards a low carbon future. We are developing an internal climate change research strategy that aligns with our sustainability goals and is funded by our COVID-19 Innovation Fund. Where possible, this strategy will build on and inform COVID-19 recovery initiatives that have the potential to reduce or mitigate climate change risks.

All Crown research institutes (CRIs) have agreed to collaborate closely on sustainability matters, including reducing air travel, to help drive down greenhouse gas emissions.

Purposeful collaboration

ESR is focused on embedding mātauranga Māori across our organisation and investing in collaborations that deliver innovative and pioneering science solutions for New Zealand's people, communities and environment to improve wellbeing outcomes. We adopt inter- and trans-disciplinary approaches to our science and actively look for meaningful opportunities to collaborate with other CRIs, national and international counterparts, universities and other science organisations to share our expertise and build knowledge and best practices.

Our work in the Pacific, and the WellKiwis influenza and COVID-19 vaccine and Aotearoa Impacts and Mitigation of Microplastics (AIM^2) research projects are examples of collaborative, impactful partnerships and research.

AIM^2 and our own research into microplastics has leveraged heavily from our partnerships with iwi, policy, community and international science networks built within the Centre for Integrated Biowaste Research (CIBR). CIBR, a long-standing collaboration that we fund, is now transitioning to a new project-funded model. CIBR's ongoing work includes the Emerging Organic Contaminants programme led by Cawthron Institute, an independent science organisation (which links closely with AIM^2) and our own Native Plantings project. Projects such as AIM^2 also align with our commitment to expand our work around wai (water) and mahinga kai.

The collaborative research approaches developed in CIBR are being extended in AIM^2 to support science research to connect with communities, strengthening collective and systemic capacities for sustainable change. Community and industry engagement are important for growing science research that supports the implementation of new technologies and research and expands our role in policy development beyond reactive risk response and assessment. These collaborative and networked capacities are also increasingly valuable in helping us respond with agility to current opportunities, which include heightened policy and public/community interest in environmental protection, wai and the green economy COVID-19 recovery initiatives.

Our collaborative work in the Pacific

To improve equitable health outcomes in Pacific countries, it is crucial to build and maintain resilient systems to protect people from health risks related to day-to-day living, natural hazards and disaster events and escalating issues related to climate change.

Pacific countries such as Vanuatu, Tonga, Solomon Islands and Papua New Guinea are ranked among 15 countries with the highest risk of exposure to climate and disaster events.[2]

Our focus in the Pacific aligns with the New Zealand Aid Programme, which seeks to support Pacific countries to lead their own development, helping them to become resilient, prosperous and stable. We provide scientific support as well as help national level planning and delivery in the areas of environmental protection (including climate change) and health, water supply and sanitation to support sustainable economic, environmental and social development and wellbeing.

We work in partnership with Pacific governments and regional organisations such as the Pacific Community (SPC), the World Health Organization (WHO), United Nations International Children's Emergency Fund (UNICEF), not-for-profit organisations, and other New Zealand CRIs and universities. We also provide technical and scientific support to the UNICEF-led 'WASH in schools' programme (water, sanitation and hygiene practices).

[2] *St John Day, Forster T, Himmelsbach J, et al. 2019.* WorldRiskReport 2019: Focus: Water supply. Berlin: Bűndnis Entwicklung Hilft and Ruhr University Bochum – Institute for International Law of Peace and Armed Conflict. *URL: https://reliefweb.int/sites/reliefweb.int/files/resources/WorldRiskReport-2019_Online_english.pdf (accessed 6 September 2020).*

We have been supporting Vanuatu with its national safe drinking-water programme (National Implementation Plan for Safe and Secure Community Drinking Water, and Capital Assistance Programme) for several years and were contracted by Vanuatu's Department of Water Resources (DoWR), MFAT and UNICEF over two years to help with national planning for safe, secure drinking-water. UNICEF's field office support to the DoWR recently reported that our advice and support has contributed significantly to the positive transformation of Vanuatu's water sector.

From our work in the Pacific, we have seen and learnt first hand about a range of risks to health that are found in everyday living for Pacific country communities as a result of natural and climate-change impacts. And although our work originally focused on water supply issues, it has expanded to cover a significant range of environmental and public health topics.

A call to action on water and sanitation in the Pacific

ESR's Dr Jan Gregor worked with Pacific Community to help in strategic discussions with Pacific island governments and partner agencies in November 2019. This involved talks about the call for urgent action to prioritise investments in safe and resilient water and sanitation for all Pacific nations by 2030.

While progress is being made to improve water and sanitation in each Pacific country, current trajectories show that efforts are not keeping pace with population growth, disaster setbacks and climate change. Unless something different is done to meet the region's commitment to safe and resilient water and sanitation by 2030, unsafe water and sanitation will continue to impact the generational wellbeing of Pacific Islanders.

The 'Call to Action' document was published in March 2020[3] to coincide with World Water Day, and calls for action to:

- strengthen water and sanitation leadership
- increase support to strengthen local resilience
- invest in and develop evidence-based decision-making
- harness advocacy for a change across all levels
- coordinate efficient and effective efforts across sectors
- establish effective frameworks for action that support local and regional plans.

It is hoped that this call will encourage further community, national, regional and international dialogue, greater commitment to action and more importantly, delivery of these actions.

A new mobile environmental health laboratory in Tonga

Healthy Tonga Environments is a five-year New Zealand Aid Programme funded project that we co-deliver alongside Tonga's Ministry of Health and that will be completed in 2021. The purpose of this project is strengthening the Tonga Ministry of Health's delivery of its environmental health responsibilities. It aims to upskill and build capability across environmental health strategy, policy and practices.

We delivered a dedicated, environmental health mobile laboratory with facilities for water quality testing to verify the safety of rural water supplies and supporting vector surveillance (predominantly mosquitoes) to prevent mosquito-borne illness such as dengue fever and the Zika and chikungunya viruses.

Providing rapid sample analysis and developing capability within Tonga was a key aim, saving time and costs by reducing the need to send samples to overseas laboratories. We continue to provide remote troubleshooting and technical support.

[3] *SPC. 2020.* Pacific High-level Dialogue on Water and Sanitation: A call to action. *URL: www.spc.int/sites/default/files/documents/blog/Call%20to%20Action%20High%20Level%20WASH%20Dialogue%202019.pdf (accessed 6 September 2020).*

Drug identification training in Tonga

To support efforts by the Tonga Police to reduce the harm caused by illicit drugs, our forensics chemistry team developed a training course to provide Tongan police officers with forensic skills and techniques to better identify cannabis. The course included training in forensic and quality control procedures when examining cannabis. Reflecting the ongoing partnership between Tonga Police and ESR, we trained seven police officers in Nuku'alofa in November 2019.

Research to understand the effects of microplastics on the environment

While initial national data shows that New Zealand's coastal and freshwater environments and biota are contaminated with microplastics, information is currently limited on the risks associated with microplastics. Understanding, reducing and mitigating the health and environmental threats and impacts of microplastics (and their macro sources) on the environment is a huge challenge. Although plastic is not considered a toxic pollutant, research is vital to examine all impacts with the aim of having it declared as such in relevant national and international policies where similar chemicals are increasingly recognised as contaminants of emerging concern.

The AIM^2 national research programme started in 2019 with funding from the Ministry of Business, Innovation and Employment's (MBIE's) Endeavour Fund. This collaborative and comprehensive five-year research project assesses the risks and impacts of microplastics on New Zealand's unique ecosystems and taonga. It positions a strong Vision Mātauranga and social science focus that is relevant to our Tiriti o Waitangi and community partners and is aligned with Māori aspirations and frameworks for environmental risk assessment and management to reduce the impacts of microplastics.

The AIM^2 team, co-led by ESR's Dr Olga Pantos and Dr Grant Northcott of Northcott Research Consultants Ltd, investigates the levels and effects of microplastics on New Zealand's freshwater, marine and terrestrial ecosystems and explore options for mitigation, removal and better management to reduce microplastic contaminants entering aquatic environments. The project team includes scientists from the universities of Auckland and Canterbury, Cawthron, Manaaki Whenua / Landcare Research and Scion.

Vision Mātauranga and community engagement to reduce plastics use

To reduce plastics use, communities and people need to be included in the science and solutions. The social and cultural research aims to integrate knowledge from communities to influence the science and support community leadership to identify solutions. Key to this approach is centring Te Tiriti o Waitangi to guide collaborative planning and education that can support community-led change and innovation within the AIM^2 programme.

We emphasise the importance of local people and indigenous knowledge in the environmental monitoring and management of microplastics. We involve mana whenua, schools and communities in our research around this topic and have established Te Kāhui Waiora as an advisory group of Māori experts, education specialists and mana whenua to help AIM^2 develop culturally informed models to support changes in practice.

The AIM^2 project team are also working closely with a range of primary sector industry bodies, regional councils and territorial authorities, non-governmental organisations, iwi and communities. Two key case studies support this inclusive aim:

- Whau / West Auckland – microplastics in an urban estuarine catchment
- Wakatu Inc, Waimea/Nelson – microplastics in the productive sector and Māori business setting.

Progress and highlights

Last year, the AIM^2 team conducted a pilot study at Lyttelton Port, Christchurch. They used the findings of this pilot study to help inform the methods for full-scale experiments at sites located at Lyttelton Port, the Nelson marina and Auckland's Viaduct to examine the interactions between five different plastics of two ages (virgin and aged) with their surrounding marine environments.

As well as co-leading the AIM^2 project, we are also involved with other research projects that contribute to the objectives of the AIM^2 research programme. This includes quantifying and identifying microplastics in the environment and the interactions between the plastics and the microbial world that underpin ecosystem health and function; and

Experiments under way to examine the interactions between different plastics types (virgin and aged) with their surrounding marine environments.

identifying microbes that have the potential to degrade plastics. Over the year, our research partner The University of Auckland has been studying the movement of microplastics down river.

We have also been working with the Ministry for Primary Industries (MPI) to access green-lipped mussel samples from across the country, allowing us to build a better picture of the variability of microplastic levels in this culturally, economically and ecologically important shellfish species. This will complement the work being done by our project partner Cawthron Institute, who is investigating the impacts on the health of endemic marine and freshwater species due to ingesting microplastics. The AIM² team are also working with Northland Regional Council to analyse beach sand samples for microplastics.

An area of research included in the wider AIM² project is considering the effect of microplastics on soil health, and subsequently impacts on plant health, with the main focus on horticultural soils.

In mid-2019, the United Nations Environment Programme created its scientific advisory committee on the assessment of sources, pathways and hazards of litter, including plastic litter and microplastic pollution. Dr Pantos is an invited member and contributes to this expert group. She was also a member of the Rethinking Plastics in Aotearoa New Zealand expert panel convened by the Prime Minister's Chief Science Advisor. The full report, *Rethinking Plastics in Aotearoa New Zealand,*[4] was presented to the Prime Minister in December 2019.

Project focus ahead

The AIM² project will continue to influence change in national policies though connections with the Emerging Organic Contaminants programme and its ongoing work to develop and implement a National Strategy for the Management of Emerging Contaminants led by Cawthron.

AIM² researchers will also continue to align with the Office of the Prime Minister's Chief Science Advisor's work on Rethinking Plastics and other relevant national policies. The team will continue to foster opportunities with international science and global policy initiatives to better understand and reduce the uses and impacts of microplastics and related chemicals of emerging concern in the environment.

Plans to start testing wastewater for microplastic pollution at the Christchurch wastewater treatment plant will start in early to mid-2020/21.

Starting in the summer of 2020, the project team will work with Northland Regional Council to analyse sea surface samples, using the manta trawls that were made for the project.

The project team is in the planning phase of working with Waikato Regional Council to collect beach sand samples for analysis.

[4] *Office of the Prime Minister's Chief Science Advisor. 2019.* Rethinking Plastics in Aotearoa New Zealand: A report from the panel convened by the Office of the Prime Minister's Chief Science Advisor, Kaitohutohu Mātanga Pūtaiao Matua kit e Pirimia. *Auckland: The University of Auckland. URL: https://cpb-ap-se2.wpmucdn.com/blogs.auckland.ac.nz/dist/f/688/files/2020/02/Rethinking-Plastics-in-Aotearoa-New-Zealand_Full-Report_8-Dec-2019-PDF-1.pdf (accessed 6 September 2020).*

He Pūtaiao, He Tāngata: embedding Vision Mātauranga in our work

At ESR, we recognise the value of creating meeting places for mātauranga Māori and Western knowledge systems. When we combine the two, we can achieve innovative and uniquely New Zealand solutions to increase the wellbeing of our people, communities and the environment. Growing and embedding Māori impact is foundational to our organisation-wide transformation programme.

We are investing in a new programme of work that is led by Māori, based in mātauranga and supported by Western sciences to deliver solutions, advice and expertise to iwi and hapū partners, Māori entities, key government agencies, local government and industry. Kelly Palmer (Ngāi Te Rangi) was appointed in June 2020 as the inaugural Kaihautū Wai Māori / Māori Director of Water. The Kaihautū Wai Māori will let us better partner with Māori to identify science and research solutions to their wai aspirations.

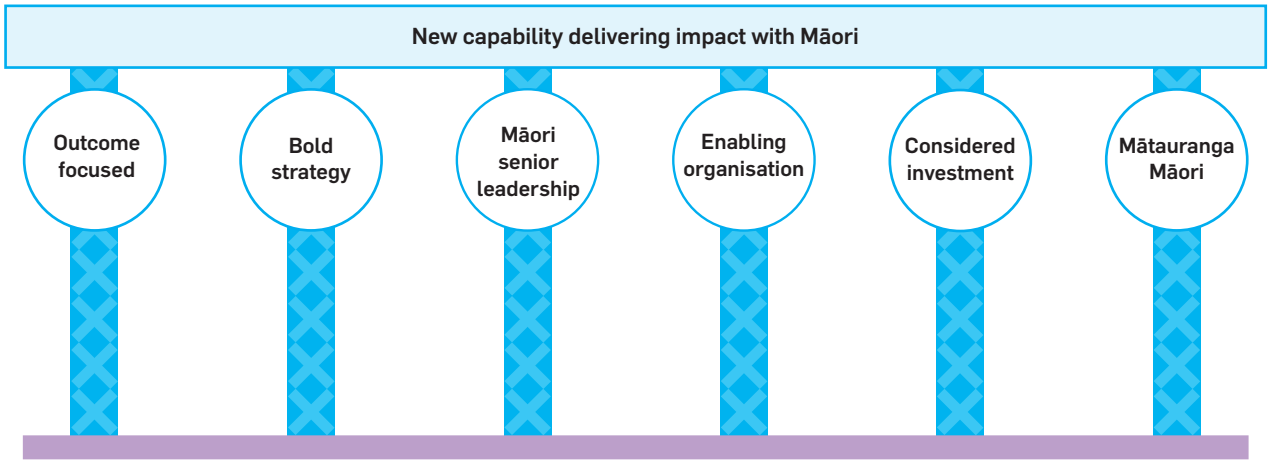
On 4 December 2019, we hosted our first ever te reo and mātauranga conference – Nga Reo o te Taiao. This wānanga brought together kaupapa Māori knowledge experts to kōrero and share perspectives of indigenous science and research, technology, innovation and entrepreneurship. It was conducted mainly in te reo Māori (with live translation provided) with presentations given by mātauranga Māori experts and iwi leaders. Common themes explored during the wānanga included: te reo Māori; whakapapa; the validation of indigenous and Māori science as bona fide fields of study and the need for Māori to have the opportunity to be Māori in any sector. We will continue to host and grow this initiative.

Over the year, we have focused heavily on activities designed to build and grow our long-term capacity to elevate our engagement with Māori as a very real and significant aspect of our identity as a leading New Zealand scientific research organisation. We refreshed our Māori impact strategy He Pūtaiao, He Tāngata, which seeks to grow our Māori engagement in an authentic, sustainable and connected way, focusing on deeper, more targeted co-development with regional partners and larger programmes of research. We worked with Māori language consultants Pae Tu Limited to develop our own te reo Māori strategy, providing more comprehensive options for staff development to grow our internal staff capability to engage with Māori.

Ongoing strategic guidance and coaching for our Senior Leadership Team will support general managers to gain collective confidence and awareness of how best to lead positive Māori engagement. In February 2020, 50 of our people leaders, along with Senior Leadership Team members, took part in mātauranga Māori workshops held across our three sites.

We are nurturing the next generation of Māori scientists through our ongoing commitment to and support of the Pūhoro STEM Academy. Pūhoro Academy is the mentoring, tutoring and wānanga (experiential learning) programme that works with secondary school students and their whānau to help them onto career paths for science, technology, engineering and mathematics (STEM) related industries. In addition, we are proud to support iwi-based interns from Rongowhakaata, and across the country.

We have developed our Six Pou model, which sets out the six areas of leadership and investment required to deliver and embed Māori impact across our organisation. These are:



- **Outcome focused:** aiming for a measurable success for Māori, our organisation and New Zealand
- **Bold strategy:** delivering deep impact through true partnerships with Māori
- **Māori senior leadership:** offering distinctive expertise to deliver shared kaupapa and goals
- **Enabling organisation:** aligning the whole organisation – from leadership to procurement, website, staff recruitment, SSIF funding, etc.
- **Considered investment:** creating a sustainable return on investment
- **Mātauranga Māori:** offering a valued scientific perspective with kaupapa Māori scientists driving authentic partnerships and discovery.

Core generic performance indicators

All CRIs report against the following core generic operating measures, and at ESR, we monitor our performance against these. Our results are reported as at 30 June 2020. We will be developing additional ESR-specific performance measures for the 2020/21 financial year.

Measure		Year-to-date actual	Full-year 2020 target
End-user collaboration	Revenue per full-time equivalent (FTE) from commercial sources	$157,700	$162,100
Research collaboration	Publications with collaborators	74	65
Technology and knowledge transfer	Commercial reports per scientist FTE	0.27	0.3
Science quality	Impact of scientific publications	3.6*	3.5
Financial	Revenue per FTE	$208,800	$204,800
	Total commercial revenue	$63.2m	$65.3m

** Although the result is reported as at the 30 June 2020, this result is calculated and reported for a calendar year (1 January – 31 December 2019).*

Strategic Science Investment Fund research

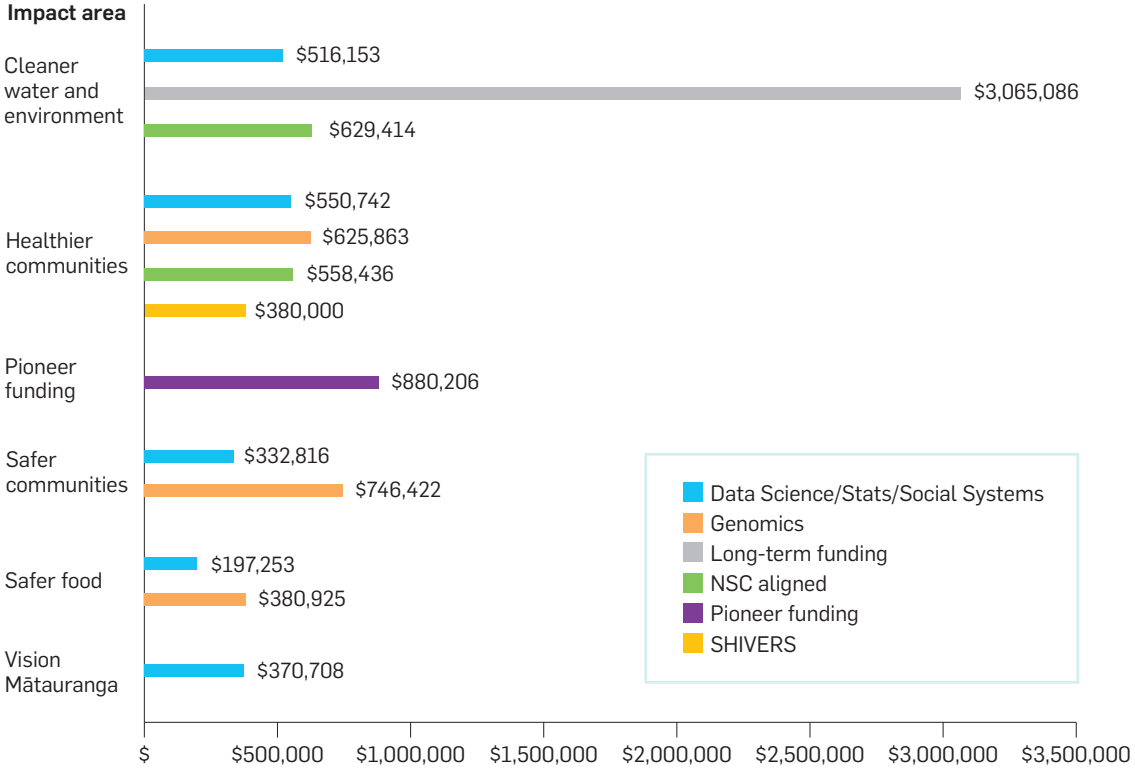
ESR receives assigned Strategic Science Investment Fund (SSIF) research funding across two platforms: Health and Environmental Health, and Forensic Science.

In the 2019–20 financial year, we received SSIF funding of $9,2m to build our capability in genomics, data science, statistics, informatics and social systems science. We are investing in a new programme of work to grow Māori impact and deliver solutions, advice and expertise that benefit Māori and all New Zealanders.

Long-term funding is for groundwater research, including funding for the Centre for Integrated Biowaste Research (CIBR). Pioneer funding is used to fund new research ideas to grow our key science capabilities and explore opportunities for commercial benefit, including sharing knowledge with the wider science system. Over 20 projects received Pioneer funding. These included research into developing digital technology tools for drug surveillance, such as the Lumi Drug Scan, developing our microbiological testing for medicinal cannabis and investigating the direct sequencing of viral RNA from environmental samples.

Funding aligned to National Science Challenges (NSCs) includes epigenomics research (Healthier Lives) and groundwater research (Our Land and Water).

Strategic Science Investment Fund research funding for 2019–20



Whole genome sequencing for COVID-19 pandemic response and contact tracing

Science for impact: Healthier communities

All ESR's work is aimed at safeguarding and enhancing the health of New Zealand's people and communities and improving wellbeing outcomes.

Our services are targeted at reducing the burden of infectious diseases (both communicable and non-communicable). We provide accredited antibiotic and enteric reference laboratories to track and monitor antimicrobial resistance (AMR) and confirm isolates of notifiable diseases. We collect, analyse and interpret data and information for several national intelligence networks under contract with the Ministry of Health. We use data, evidence and insights to develop and provide solutions and advice that advance New Zealand's public health surveillance capabilities and inform public health and environmental health policies, regulation and interventions to manage human biosecurity and threats to public health.

Whole genome sequencing statistics

We performed genome sequencing and data analysis for:

- **774 cultures** derived from clinical isolates for pathogen surveillance under Ministry of Health contract (369 VTEC[5], 304 *Salmonella*, 64 CPE, 29 *Listeria*, 8 extended-spectrum beta-lactamases (ESBL)[6]
- **343 cultures** derived from commercial isolates for MPI, independent clients and the New Zealand Food Safety Science Research Centre (220 *Listeria*, 94 *Cronobacter*, 27 *E. coli*, 2 *Campylobacter*)
- **833 COVID-19 clinical cases** for pandemic response and contact tracing purposes.

Our progress this year

We are expanding our expertise and capability in genomics and data science, focusing on human genomics, ESR's genome sequencing of pathogens, influenza and wastewater epidemiology.

Through our epigenomics work to identify genetic variations associated with hyperparathyroidism,[7] we have been working to extend our health and bioinformatics capabilities to provide faster and larger-scale genomic diagnostics that health care clinicians can use to improve health outcomes for their patients.

We have progressed several initiatives to grow our understanding of antimicrobial resistance (AMR). This includes developing testing methods that will help develop a more complete gene profile of infectious pathogens circulating in New Zealand, building our understanding of how the pathogens function and what causes them to become antibiotic resistant.

Following the outbreak of COVID-19, we developed and implemented protocols that allowed us to generate and share the first complete viral genome of COVID-19. Rapid genome sequencing, together with data science, allows us to clarify transmission chains and identify clusters of outbreaks.

We established the first diagnostic test for COVID-19 in New Zealand and shared our testing protocols throughout New Zealand's community of test laboratories. We also provide COVID-19 diagnostic testing for Pacific countries that did not have in-country testing capability.

Using data analytics, applied epidemiology and visualisation tools, we developed a COVID-19 dashboard to track the number of COVID-19 cases in near real time. Our work supports the government's COVID-19 response and is vital to preparing for and responding to future public health pandemics.

Our work is critical to ensure that New Zealand's scientific and clinical response capability in public and environmental health remains increasingly effective and on par with international standards.

Human genomics research

The overarching aim of our human genomics team is to conduct scientific research to improve the health of New Zealand's people. We seek to do this by growing our expertise, reputation and connections both nationally and internationally as a partner to clinical delivery.

Clinically relevant human genomics

In 2019, our human genomics team started a three-year, SSIF-funded, research project to establish genetic sequencing as an accessible tool for clinicians at Wellington Hospital (Capital & Coast District Health Board). Initially our research concentrated on identifying variants associated with hyperparathyroidism in patients. Anecdotally, this condition appears more prevalent in New Zealand. The clinical management of familial hyperparathyroidism differs significantly from sporadic disease, and the results from this project have the potential to impact clinical practices throughout New Zealand and overseas by enabling clinicians to identify genetic variations associated with the disease. Finding and identifying these genetic markers might also provide information into the underlying causes of the condition. Improving treatment options should result in better care and wellbeing outcomes for patients.

[5] *Verotoxin-producing Escherichia coli*
[6] *Bacteria that produce ESBL enzymes can use these enzymes to become antibiotic resistant.*
[7] *Hyperparathyroidism is a disease or disorder of the parathyroid glands (found in the neck) where the parathyroid glands produce too much parathyroid hormone, leading to increased calcium and phosphorous levels in the body. Excess calcium in blood and urine cause bones to lose calcium, leading to osteoporosis.*

Over the year, the team established bioinformatic pipelines, which process the raw sequence data and generate the final genetic variation information. By investing in more powerful technology for the analysis, the team substantially decreased processing and turnaround times. Faster analysis of the data generated from sequencing will help clinicians make decisions quicker. Faster decision-making is beneficial to both patient and clinician, improving patient health outcomes and reducing associated health care costs.

Our team designed the pipelines to be easily automated and deployed across a variety of computational platforms (e.g., servers, high-performance clusters, cloud-based systems). The pipelines are agnostic and can also be used for sequencing data from different organisms. For example, in May 2020, AgResearch started testing our genetic variant calling pipelines and is adapting them for research into livestock genetics.

In parallel with this SSIF project, we are strengthening our relationship with the Wellington Regional Genetics Laboratory, and are currently finalising contracts to deliver service work in clinical genetic diagnostics, encompassing both sequencing and bioinformatics. We are also assisting the Wellington Regional Genetics Laboratory in a Genomics Aotearoa, Clinical Genomics project. This clinical genomics project aims to develop New Zealand's workforce and skills to support large-scale genomic diagnostics in health care delivery. Our team are processing whole genome sequencing data through our pipelines and providing our genomic expertise to help with downstream clinical interpretation.

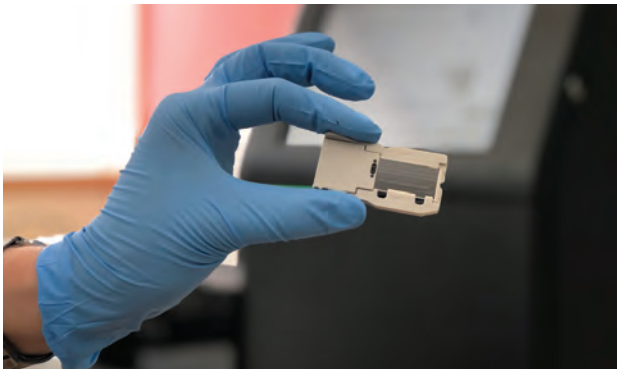
Applying epigenomics and social systems approaches to improving the metabolic health of New Zealanders

This long-term, collaborative research project is aligned to the Healthier Lives – He Oranga Hauora National Science Challenge (Healthier Lives).[8] Healthier Lives focuses on four of New Zealand's main non-communicable diseases: cancer; cardiovascular disease; diabetes and obesity, with the vision of achieving equitable health outcomes and substantially reducing the burden of non-communicable diseases for New Zealanders. Donia Macartney-Coxson (the science leader for our human genomics team) has been invited to a second term on the science leadership team of the challenge and is leading an SSIF project aligned to Healthier Lives.

This project focuses on obesity and type-2 diabetes. The epigenomics component aims to identify DNA methylation and small non-coding ribonucleic acid (sncRNA) biomarkers associated with metabolic disease. Some of our work on sncRNA in adipose tissue was recently published as an 'editor's choice' article in the international journal *Obesity*.[9]

During the year, the team started to analyse extremely rare clinical samples taken from part of the human blood circulation called the hepatic portal system. The aim is to compare samples from individuals with and without type-2 diabetes, as well as before and after a gastric bypass, which is the most effective treatment to date for type-2 diabetes. Healthier Lives National Science Challenge provided funding to assist this project, in particular, the analysis of metabolites, proteins, and peptides, and support young research scientists.

The RNA (extraction, sequencing and bioinformatics analyses) expertise of our human genomics team will also contribute to another upcoming SSIF-funded project called 'RNA for Concussion'. This project will be co-led by Donia with Rachel Fleming from our forensic research team.



Pathogen genomics research

We use whole genome sequencing to sequence pathogens that affect people, food and water, providing analysis and insights to keep people safe. ESR's genome sequencing helps us investigate and track disease outbreaks, such as COVID-19, in near real time, providing the most accurate information about the genetic makeup of infectious diseases and detailed insights into the way diseases are transmitted, how virulent these pathogens are, and how resistant they are to treatment.

Over the year, our genome sequencing team investigated the effectiveness of culture independent testing methods to build a more complete picture of the genomes of the infectious pathogens gonococci and meningococci circulating in New Zealand. This will help the team learn more about how the pathogens function and what causes them to become resistant to antibiotics. The team completed two research projects using genome sequencing of pathogens for infectious disease surveillance and control and determining the unintended consequences for public health surveillance due to current polymerase chain reaction (PCR) testing, which only looks at small pieces/segments of DNA. A third project looked at the direct RNA sequencing of a virus in a seafood sample.

[8] *Healthier Lives – He Oranga Hauora. URL: https://healthierlives.co.nz/*

[9] *Macartney-Coxson D, Danielson K, Clapham J, et al. 2020.* MicroRNA profiling in adipose before and after weight loss highlights the role of miR-223-3p and the NLRP3 inflammasome. Obesity: A research journal, *28: 3, 570–80. DOI: https://doi.org/10.1002/oby.22722 (accessed 6 September 2020).*

Improving culture independent testing

Genomics Aotearoa project

The aim of this project was to develop an amplicon panel to diagnose *Neisseria gonorrhoeae* from clinical samples and extract typing information (antimicrobial resistance and other) for epidemiological inference. Our genome sequencing team designed two multiplex amplicon panels (one for short sequencing and one for long) to target genetic regions of interest – in this case, a genetic region to identify *Neisseria gonorrhoeae* and any AMR genes it might carry. The panels were tested by building a dataset containing bacteria that are typically found in relevant body sites and spiked with genomes of the pathogen of interest. This ensured that the targets were specific to *Neisseria gonorrhoeae* and would not cross-react with other bacterial species.

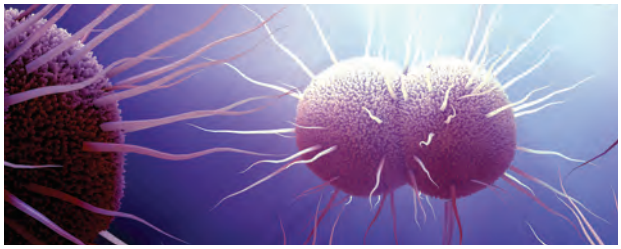
We can apply this synthetic approach to other amplicon-based approaches for our clinical metagenomics sequencing research.

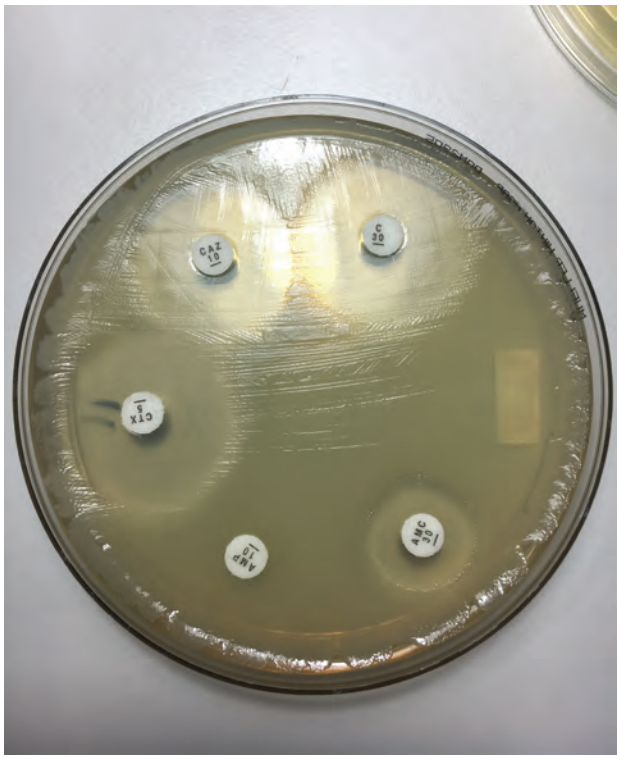
SSIF project: Preparing for the isolate-free future: better surveillance for clinical samples

During the second year of this project, our genome sequencing team tested the assays that amplified the regions of interest for assessing AMR in gonococci. They also investigated target enrichment methods to sequence the genomes of meningococcal from clinical samples without culture. The ability to obtain genome-level information from clinical samples will increase completeness of meningococcal surveillance. The team found the assay has good sensitivity and target enrichment for meningococci and although initial tests are promising, they will need further optimising.

Pioneer funding project: Direct RNA sequencing of virus

The team spiked a seafood sample with a positive control sample containing astrovirus and norovirus and subjected it to long-read direct RNA sequencing. Within five hours of starting the experiment, the team had obtained a positive species identification of the virus of interest. By optimising this testing protocol, they hope to reduce analysis to less than three hours. Faster sequencing and analysis will be a valuable tool for identifying viruses in outbreak scenarios and food safety investigations. The team is continuing their research in this area.





Tracking antimicrobial resistance

Our specialist antibiotic reference laboratory is responsible for the national surveillance of AMR in human pathogens. Providing high-quality and timely data about AMR is critical to improving health outcomes.

ESR tracks many microorganisms, including several so-called super bugs that are typically resistant to nearly all known antibiotics. Patients with infections caused by antibiotic-resistant microorganisms are at increased risk of worse clinical outcomes, and they often require more health-care resources than patients infected with strains of the same bacteria that are not antibiotic resistant.

Worryingly, few new antibiotics are currently in the development pipeline. Developing new antimicrobial antibiotics takes a long time (over a decade) and is very costly. This means that improved infection surveillance and control and the appropriate use of antibiotics is important to manage and mitigate AMR.

Carbapenemase-producing Enterobacterales (CPEs) are one particularly nasty family of super bugs whose prevalence has increased in New Zealand, reflecting a world-wide trend. They are very difficult to treat as they are resistant to carbapenem antibiotics and often a number of other antibiotics as well. Increasing rates of resistance to carbapenem antibiotics further reduce treatment options and present the very real possibility of a bacterial infection that is untreatable. CPEs were first identified

in New Zealand in 2009. Until recently, most CPEs were acquired overseas although we are now starting to see transmission occurring in New Zealand and carriers in the community. In 2019, diagnostic laboratories identified 118 distinct CPEs, which is the highest annual total found in New Zealand to date.

Surveillance of CPEs includes identifying the number of isolates found in New Zealand, the species and carbapenemase gene(s) present, the likely source of acquisition and any transmission networks that may be present in New Zealand. All CPEs identified by diagnostic laboratories in New Zealand are referred to our specialist antibiotic reference laboratory and all have been characterised using ESR's genome sequencing processes. The sequencing data is held in a national repository managed by ESR. The carbapenemase gene(s) that is present is assessed, as well as any mobile genetic elements called plasmids that are present. These extra chromosomal elements can transfer quickly between bacterial species and play a major role in the spread of antibiotic resistance.

We are working to increase awareness and further highlight the trend of increasing AMR in New Zealand. We will also be collaborating on updating testing guidelines and proficiency testing.

SHIVERS-II, the WellKiwis Influenza Study and COVID-19 research

The Southern Hemisphere Influenza and Vaccine Effectiveness Research and Surveillance (SHIVERS) programme is an award-winning research programme that is now in its eighth year. It receives significant international funding and investment from ESR and is led by ESR's Dr Sue Huang. It is a long series of international and national multi-centre, multi-disciplinary collaborations on influenza virus and vaccine. These studies aim to understand how an adult's previous (or a child's first) exposure to the flu virus shapes their immunity to future flu exposures. As a result, studies follow both adults and new-born babies, with the goal of developing a longer-lasting, more effective, universal influenza vaccine for global use. The first SHIVERS-I study ran from 2012 to 2017, and SHIVERS-II, funded by the United States of America (US) National Institute of Allergy and Infectious Diseases (NIAID), started in 2018 and is ongoing until 2021.

Based on the success of the SHIVERS-II study, we received a significant funding grant in June 2019 to conduct research for SHIVERS-III: the WellKiwis Influenza Study. This project continues the study into influenza immunity in infants and babies and will be conducted through to 2026. Research is being funded by NIAID through the St. Jude Children's Research Hospital in the US. The aim is to enrol 200 pregnant Wellington women yearly for three years to study their babies' immune system responses to flu viruses and flu vaccines. All 600 children enrolled will be monitored from birth up to seven years of age.

In April 2020, we received additional funding from the National Institute of Health and expanded both SHIVERS-II and WellKiwis (i.e., SHIVERS-III) to include the study of SARS-CoV-2, the virus that causes COVID-19. This quick expansion to include COVID-19 monitoring aims to understand how the virus might be spread through New Zealand homes, changes in the virus and population immunity. Participants in the expanded research will have swabs and blood taken during the winter season to monitor for influenza and COVID-19. The expanded study will be useful in understanding the proportion of asymptomatic or mildly ill cases to help researchers better understand what is driving the pandemic.

This expanded research is part of a global effort under the Unity Studies, coordinated by the World Health Organization. It is a multi-agency, multi-disciplinary collaboration that includes ESR, Capital & Coast and Hutt Valley district health boards, Auckland and Otago universities, the Malaghan Institute of Medical Research, participating Wellington general practices and leading maternity carers in the Wellington region.

Learning more about SARS-CoV-2 viruses will help provide vital intelligence to guide the development of a COVID-19 vaccine and immune therapy approaches. It will also be essential in alerting public health officials to people who have not yet been infected with the COVID-19 virus and could be susceptible in future. This intelligence will help inform better tailored public health responses to future outbreaks and the development of better public health measures.

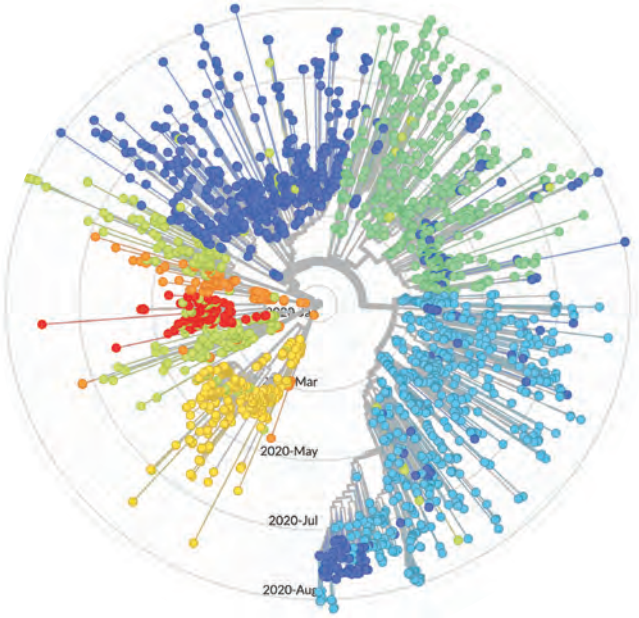
SHIVERS public health science contributions have informed policy changes both nationally and internationally; generated ground-breaking new knowledge and is establishing new surveillance methods that have become an essential national infrastructure and emergency response capability in New Zealand.

'Our tīpuna didn't live in the time we live in now – we have to make change' *Jamie*

WellKiwis
influenza study

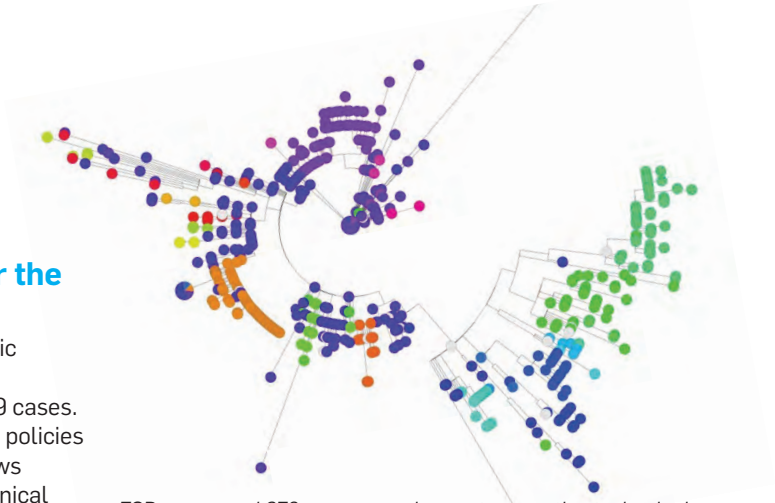
SARS-CoV-2 genome sequencing for the COVID-19 pandemic response

SARS-CoV-2 is an RNA virus. As part of the pandemic response, our genome sequencing team has been sequencing all RNA samples from positive COVID-19 cases. Strong international collaboration and open-sharing policies enabled the team to implement a protocol that allows whole viral genomes to be obtained directly from clinical samples. This implementation happened within weeks of the viral genome becoming known through the open sharing of protocols by the ARTIC network.[10] Within three days of the first positive COVID-19 case being detected in New Zealand, our scientists had implemented the protocols and started generating the first complete viral genome on 4 March 2020. We released the completed viral genome sequence to the Global Initiative on Sharing All Influenza Data (GISAID)[11] on 6 March 2020.



New Zealand's first completed viral genome sequenced by ESR's scientists and released to GISAID.

Our genome sequencing team received 833 samples out of the total 1,205 confirmed cases for sequencing and generated high-quality (>90% complete) genomes for 672 of those. We use next generation sequencing technologies that are capable of processing high volumes of isolates with rapid turnaround times, allowing our scientists to analyse and sequence genomes much faster to contribute to national and international research efforts into COVID-19. Genomes were directly uploaded and incorporated into a New Zealand-specific version of Nextstrain,[12] which was established with the support of



ESR sequenced 672 genomes using next generation technologies processing high volumes with rapid turnaround.

New Zealand phylogeneticist James Hadfield and ESR-affiliated viral phylogenetic expert at the University of Otago, Jemma Geogehgan. This interface was used to track the spread of COVID-19 and assist epidemiological investigations.

Using this genomic information, we were able to support and contribute to New Zealand's pandemic response by providing additional data on outbreaks as well as individual cases. Our data provided potential links for cases with an unknown source of infection, as well as clarifying transmission chains to identify clusters of outbreaks and understand how COVID-19 was spreading. It has been used to inform reports to the Ministry of Health, public health units, the epidemiological technical advisory group, COVID-19 All-of-Government Response Group and the Department of the Prime Minister and Cabinet.

Consistent testing standards across New Zealand's diagnostic laboratories, together with quality samples/isolates for sequencing and testing will play an important role in preparing for and responding to future public health pandemics. This work is funded by the Ministry of Health and the Ministry for Business, Innovation and Employment. The funding will also be used to support future research efforts to understand the SARS-CoV-2 virus and its spread. By publicly sharing genomes and data, we assist local and global efforts to develop drugs and vaccines.

[10] *The ARTIC network provides real-time molecular epidemiology in response to viral outbreaks via a mobile virus sequencing system and information sharing platforms, supported by statistically rigorous analysis frameworks. For more information on the SARS-CoV2 project, see: https://artic.network/ncov-2019*

[11] *See www.gisaid.org*

[12] *Nextstrain is an open-source project to harness the scientific and public health potential of pathogen genome data. For more information, see: https://nextstrain.org/*

Healthier communities performance indicators – results as at 30 June 2020

Output delivery measure	Actual 2019–20	Full-year 2020 target
Time-critical turnaround times are met	100%	100%
Ministry of Health's satisfaction with ESR's services	Good	Good or better
Ministry of Health's project brief milestones and deliverables are consistently met	100%	95%

Our specialised forensic, toxicology and chemistry teams provide services and research to a broad range of end users within New Zealand.

Science for impact: Safer communities

ESR works to support justice outcomes by making sure the right information is accessible at the right time and the right quality to improve decision-making at all stages of the frontline policing and justice investigation processes.

We constantly strive to increase the impact of our forensic science. Our services and research are targeted at developing and implementing innovative solutions that meet the needs of our customers and support their goal of keeping our communities safer.

We have the only forensic laboratories in New Zealand to hold American National Standards Institute National Accreditation Board (ANAB) accreditation. This accreditation ensures that all our forensic operations, across three sites and all nine forensic disciplines, comply with and are delivered to appropriate international standards, underpinning confidence and integrity in the justice system.

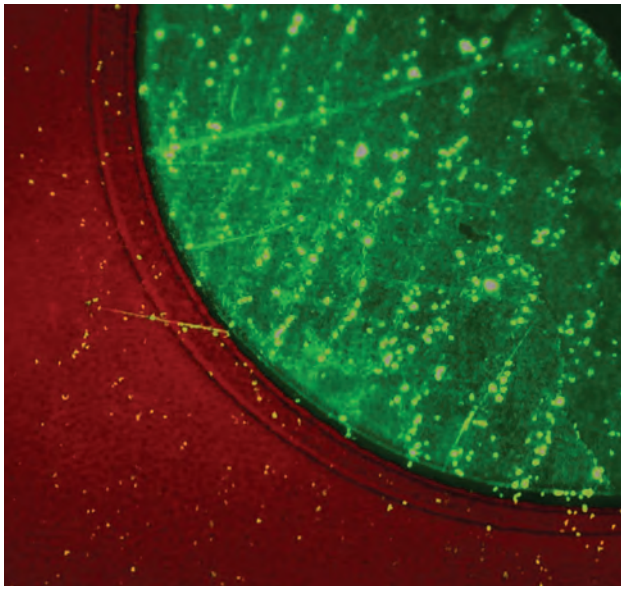
We provide forensic services and research to a broad range of end users nationally and internationally. We provide expertise to the New Zealand Police on a range of DNA techniques, including Y chromosome DNA profiling and low copy number profiling. We also use specialist techniques where these can be applied to obtain DNA profiles from small and even degraded samples when standard DNA profiling is not suitable or has failed. Using these specialist techniques, we have been able to assist in international cases. We have undertaken work with Australian Federal Police and forensic laboratories on a number of high-profile cases (including historic casework) and provided evidence in Australian courts.

Our forensic biology team was part of the disaster victim identification process for causalities of the Whakaari / White Island volcanic eruption on 12 December 2019. The team worked closely with New Zealand Police, Forensic Pathology and the Chief Coroner to identify the deceased using DNA. The Australian Federal Police provided considerable assistance by profiling reference samples from Australian nationals to help the speedy delivery of results.

Forensics statistics as at 30 June 2020*		
Description	**2019–20**	2018–19
Exhibits	**46,338**	50,776
Total DNA profiles on databank	**208,107**	202,140
Samples analysed	**116,823**	118,337
Homicide cases	**76**	67
Blood alcohol cases under the LTA[1]	**2,887**	3,316
Sexual assault	**441**	508
Coronial cases	**2,022**	1,993

[1] *LTA = Land Transport Act 1998*

** Volume is dependent on work passed on from New Zealand Police.*



Thumb print on a drinks can using Diamond™ Nucleic Acid Dye for targeting DNA.

Our progress this year

Our forensic teams progressed initiatives that will increase New Zealand's drug intelligence capabilities and reduce drug-related harm. Work this year included developing and testing the Integrated Drug Surveillance System (iDSS). Working with the New Zealand Police to develop 'Lumi Drug Scan' combined our extensive knowledge of drug chemistry, data science and machine learning capabilities with the latest developments in handheld technology to enable a new approach to screening drug samples.

Research is under way to develop a targeted approach to finding DNA and helping decide what samples should be taken for DNA testing. This research is evaluating Diamond™ Nucleic Acid Dye for targeting DNA on commonly found forensic exhibits from drug seizures, specifically plastic bags and containers and considering its use as a finger mark detection method as well as for locating DNA.

Another project is under way to develop a workflow that automates DNA profile analysis efficiently and with great accuracy. This automated workflow will also automate decision-making around the most suitable rework for producing a successful DNA profile, taking seconds rather than hours. This will improve the quality of analysis and interpretation. Collaborations with other ESR and Auckland University of Technology teams have been instrumental in progressing this work.

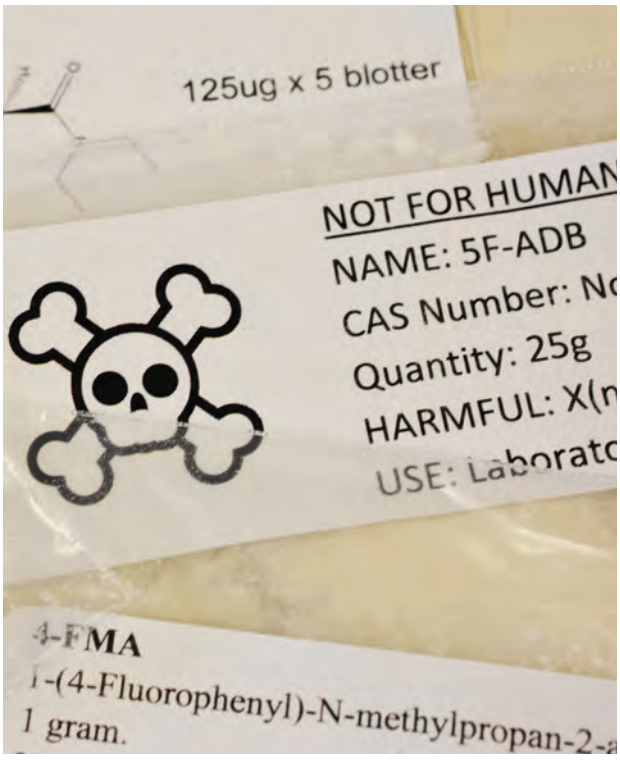
A new SSIF-funded research project started in 2020/21 to investigate the effects of vaping. This project, using analytical and research capability, will support any future regulatory framework for vaping products.

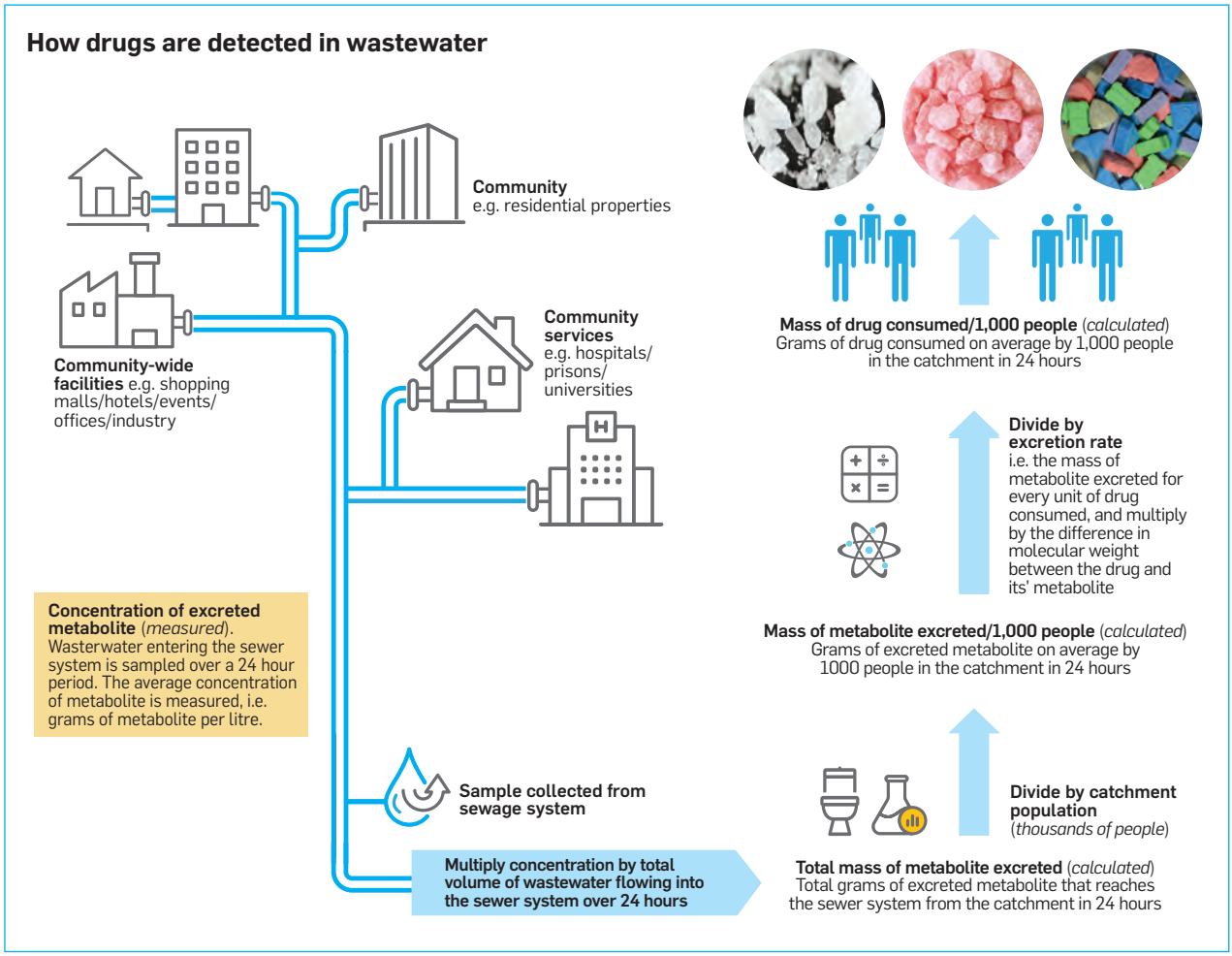
How drug surveillance and intelligence help improve decision-making and reduce harm

With rapid changes to illicit drugs, in terms of how they are made and used, and proposed changes to legalise cannabis for medicinal and personal use, the need for timely, reliable data sharing and surveillance, better insights and innovative science solutions is more important than ever to help improve the safety and wellbeing of people and protect communities from harm.

As the national and international drug market continues to change, with new psychoactive substances and more harmful drugs being introduced and readily available, we need to understand the make-up of these new drugs, predict their patterns of use and develop better ways of testing and monitoring them.

Our specialised forensic toxicology and chemistry teams provide services and research to a broad range of end users within New Zealand. Our key partners include New Zealand Police, the Ministry of Health and district health boards, the courts, defence and prosecution lawyers, the New Zealand Customs Service, coroners, pathologists, prisons and WorkSafe New Zealand. ESR scientist Diana Kappatos serves on the International Association of Forensic Toxicologists New Psychoactive Substances Committee, which contributes to the United Nations Office on Drugs and Crime.





Drug surveillance

During the year, our forensic team worked on the final testing phase of its Integrated Drug Surveillance System (iDSS). The iDSS is a specialised and centralised database used to capture and analyse data from our drug testing capabilities (such as the Drug Chemistry and Toxicology laboratories, and the Customs-ESR Screening Laboratory at the border) and different projects and drug analyses that we conduct. We use the iDSS to identify distinct geographical and temporal patterns of drug use. We conduct this research with multiple partners across the health and justice sectors. Once the final testing phase is completed, iDSS will feed into the multi-agency early-warning / high-alert system Drug Information and Alert New Zealand (DIANZ).[13] The team expects to complete the final testing phase of the iDSS system in 2020/21.

Our Drugs in Wastewater testing programme developed on behalf of the New Zealand Police plays a vital role in New Zealand's drug surveillance and intelligence capability.

Of the drugs monitored by the programme, methamphetamine has the highest use, followed by MDMA (also known as ecstasy or molly), and then cocaine as the most commonly consumed drugs in New Zealand.

Our forensic team has also carried out several projects and surveys to better understand trends in drug use in New Zealand. The analysis of suspected drugs seized at music festivals was another project undertaken to gain insight into drug use and trends. Survey findings have been published in international scientific journals, helping to increase awareness of the power of forensic science to inform and improve drug surveillance and intelligence capabilities.

Project Bubble, which began in May 2020, is monitoring changes in drug trends as a result of the changing social environment caused by COVID-19.

[13] DIANZ is a central point for all drug-related data. It monitors drug trends and issues notices when something is identified that is potentially dangerous, with the aim of quickly and effectively responding to risks.

ESR Drug Surveys: Project Sinnie survey results to understand synthetic cannabinoid trends

Drug surveys provide a better understanding of new substances emerging into the drug market and estimates of drug-use patterns, helping to identify potential causes of harm. These surveys help inform an effective response to drug-related harm and guide policy and legislative decisions.

New psychoactive substances (NPS) are the largest and most diverse group of recreational drugs to emerge over the last decade and are continually evolving. Synthetic cannabinoids are the largest group of NPS, with over 200 different types being reported since their emergence. They have the potential to cause users considerable harm due to unexpected psychoactive effects, increased potency, metabolic changes or interactions with other substances.

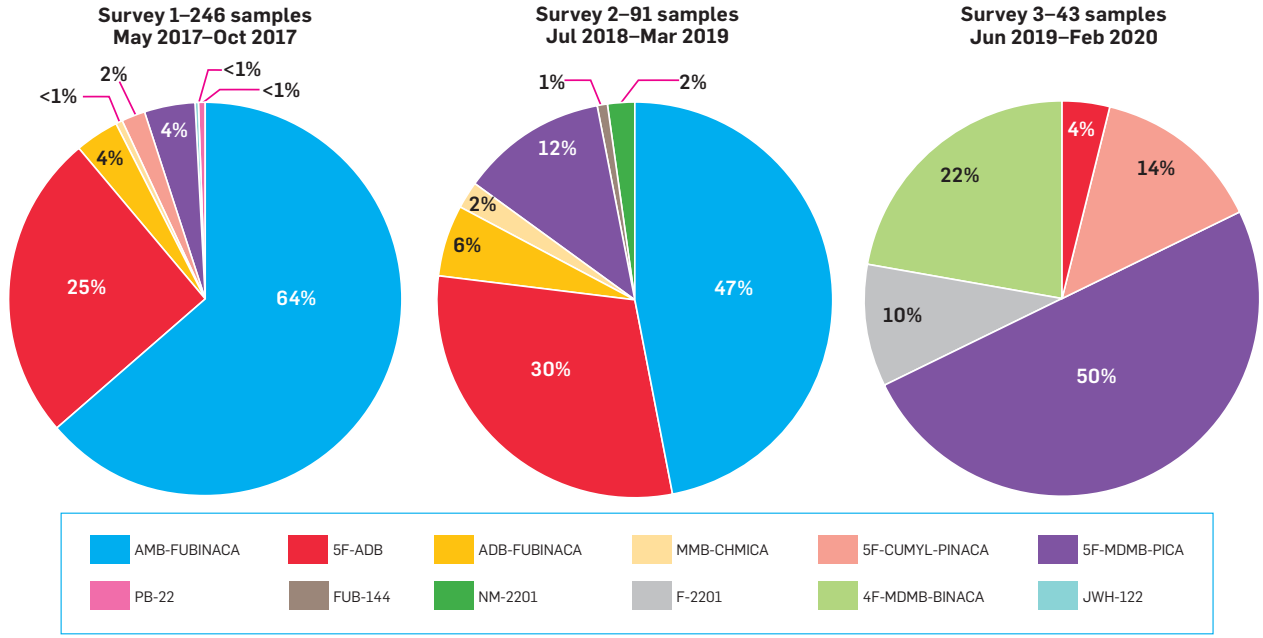
With the help of the National Drug Intelligence Bureau, New Zealand Police and New Zealand Customs Service, our drug chemistry team has conducted several surveys.

The team conducted three Project Sinnie surveys between 2017 and 2020 to determine which types of synthetic cannabinoids were most commonly used in New Zealand. The initial survey was initiated in response to significant harm, including multiple deaths, that was attributed to the use of products containing harmful synthetic cannabinoids, such as AMB-FUBINACA. The aim of the surveys was to better understand and track the geographical distribution and trends in substance use around the country.

Results of Project Sinnie surveys, May 2017–February 2020

A total of 12 synthetic cannabinoids were detected across the three surveys. The most popular synthetic cannabinoids from the initial surveys were AMB-FUBINACA and 5F-ADB. These substances appeared to be the cause of multiple deaths of synthetic cannabinoid users. There was a significant change in the types of synthetic cannabinoids detected in the most recent (third) survey. This emphasises the importance of carrying out such surveys, to monitor drug trends so that effective and coordinated action can be taken to reduce the potential for harm in New Zealand communities. Our scientists contributed to the research paper 'An outbreak of deaths associated with AMB-FUBINACA in Auckland NZ'. [14]

Project Sinnie surveys, May 2017–February 2020



[14] *Morrow PL, Stables S, Kesha K, et al. 2020.* An outbreak of deaths associated with AMB-FUBINACA in Auckland NZ. EClinicalMedicine, *25. DOI: https://doi.org/10.1016/j.eclinm.2020.100460 (accessed 7 September 2020).*

Medicinal cannabis and the need for robust regulations

It is important that patients who are prescribed medicinal cannabis are kept safe. Any new medicinal cannabis products that are marketed must be proven to be clinically safe and within the legal limits prescribed by law.

As experts in the field of pharmaceutical analysis of medical products, we play an important role in monitoring the quality standards of locally produced medicinal cannabis. Our testing of medicinal cannabis products has shown much variability in the quality and concentrations of the active ingredients.

Over the year, we worked with the Ministry of Health to help develop a regulatory framework to support legalising medicinal cannabis, including providing testing, analysis and advice on cannabis products that meet the minimum quality standards to ensure that these products do not harm patients.

We are well placed to analyse medicinal cannabis and currently provide regulatory advice and third-party testing services to companies licensed to cultivate cannabis for medicinal or scientific research purposes. Regulations allowing the local cultivation and manufacture of medicinal cannabis came into effect in April 2020.

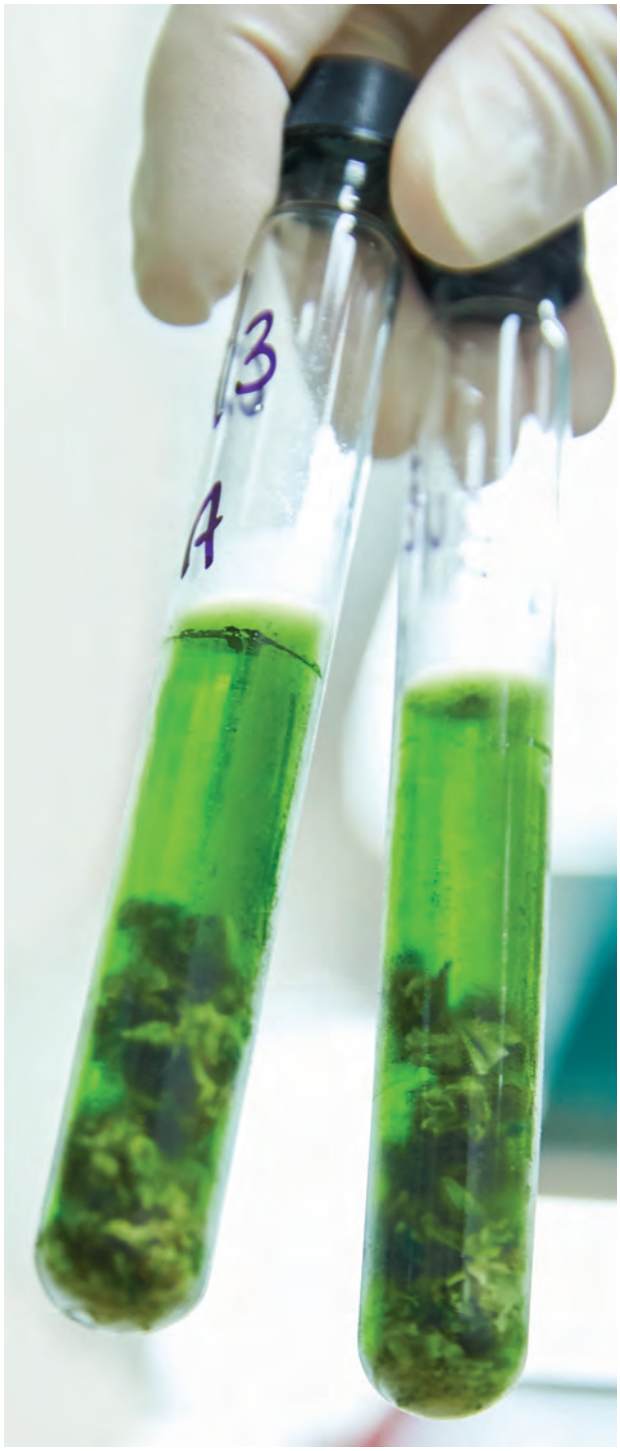
Cannabis reform is in the spotlight, with the amendment to the Misuse of Drugs Act 1975 allowing for a much broader use of medical marijuana, together with the referendum on legalising cannabis for personal use to be held in the October 2020 general election.

Future opportunities include undertaking a stability trial to test cannabis plant and extracted material, including cannabinoid content and microbiological testing.

New Zealand Customs Service and ESR Screening Laboratory (CESL)

We work with the New Zealand Customs Service to operate a rapid-screening drug testing laboratory at Auckland Airport. Timely information and advice are essential to ensure a coordinated response with multiple agencies to alert them of risks. The Customs Service/ESR Screening Laboratory (CESL) provides near real-time analysis and advice to help Customs officers identify new psychoactive drugs and other emerging drugs at the border. It plays an important role in drug intelligence and supporting New Zealand Customs officers to work safely. In January 2020, CESL reached a milestone with the testing of its 10,000th drug sample.

Chemical masking is an international development in the illegal importation of illicit drugs. It involves changing the chemical structure of drugs to mask their illegal status. When a masked drug is successfully smuggled into the country, the mask is chemically removed to restore the drug to its original, illicit state. We are collaborating with the New Zealand Customs Service on a project to identify, synthesise and characterise masked drugs so they can be rapidly identified and intercepted at the border before they can enter New Zealand.



Pioneering technology solutions for frontline police

Our forensic research team has been hard at work over the past 18 months, collaborating with the New Zealand Police to co-design and develop a new service for screening suspected drug samples on the street called Lumi Drug Scan (Lumi). The service combines a handheld device, a mobile app and a secure cloud service containing drug detection algorithms. This project is the first time that a police force and science organisation have collaborated to develop a technology solution specifically designed to meet the needs of New Zealand Police by allowing frontline police officers to screen and test drugs in real time. Through the combination of scientific expertise and police knowledge, Lumi delivers science to enable evidence-informed decision-making at the frontline.

This ground-breaking service can screen samples for three of New Zealand's most common and significant drugs: methamphetamine, MDMA and cocaine. Lumi uses near-infrared technology to scan substances such as pills and powders. Our drug detection algorithm, developed to detect the presence of drugs commonly found in street-level samples, then analyses the scan data and sends the results within seconds to the Lumi app on the police officer's iPhone. Lumi can scan through clear packaging, improving safety for frontline police officers by reducing their exposure to harmful substances as well as maintaining the integrity of the samples. This rapid screening allows officers to make decisions efficiently while at crime scenes.

We completed a forensic validation of Lumi by testing hundreds of samples that represent the types of drugs likely to be encountered in street interceptions. Results of this testing indicated that, as a screening tool, Lumi has a good accuracy of 95% over a range of drug and non-drug samples.

The New Zealand Police are running a six-month trial of Lumi that started in July 2020 across their districts of Tāmaki Makaurau (Auckland) and in areas of Canterbury and Central Districts. Any drugs seized that require testing for evidence and prosecutions will still be sent to ESR for chemical analysis.

Further research is under way to identify the next most important drugs to include for testing and detection using our iDSS database to expand Lumi's capability.

Forensic genomics

Advances in sequencing technologies are transforming forensic DNA profiling by providing cost-effective and efficient investigative tools. We always monitor the newest sequencing technologies available for both DNA and RNA sequencing because these tools can improve outcomes for the justice sector. Our forensic biology

team are undertaking multiple areas of research in this field to maintain our reputation as a leading forensic provider of specialist applications. One area of research is the estimation of biogeographic ancestry (eye and hair colour) from DNA left at a crime scene. In other research, we are evaluating sequencing methods to determine a DNA donor's age via blood, semen and saliva staining and the differentiation of monozygotic twins, both of which offer new insights. One challenge forensic scientists face is being able to analyse samples of very limited and degraded genetic material. Our scientists are developing mitochondrial DNA sequencing methods to aid the analysis of such samples, with the added benefit of providing additional biogeographical information.

Our forensic teams take a cross-discipline approach, collaborating with our own genomics researchers, bioinformaticians, data scientists and statisticians, including those from The University of Auckland Department of Statistics and School of Computer Science. The collaboration also extends to international colleagues, including the STRAND Working Group (working on the STR sequence nomenclature), the European DNA profiling group (EDNAP), King's College London, Netherlands Forensic Institute, the University of Technology Sydney (UTS) and the Australia New Zealand Policing Advisory Agency National Institute of Forensic Science (ANZPAA NIFS) through the Massively Parallel Sequencing Project working group.

Safer communities performance indicators – results as at 30 June 2020

Output delivery measure	Actual 2019–20	Full-year 2020 target
Police satisfaction with ESR's timeliness and quality of service	>94%	90%
Fulfillment of contractual obligations under the service level agreement	59%[a]	90%
Total number of cases where ESR provides Police with forensic evidence analysis	10,345 cases	N/A
Percentage of homicide investigations finalised within 12 months [b]	29%	N/A
Percentage of sexual assault investigations finalised within 12 months [b]	59%	N/A
Number of research projects undertaken by ESR for the EBPC [c]	1	N/A

[a] *This figure is reported on turnaround times for all cases.*

[b] *A large percentage of these cases can span multiple financial years before being closed. Further requests can often be made from New Zealand Police in relation to a closed case. When new exhibit submissions are made or additional analysis is requested, a case will be made active again.*

[c] *EBPC = Evidence-Based Policing Centre. This result only measures the projects we assist with or deliver on behalf of the EBPC. This result excludes our interactions with the EBPC that are aimed at contributing to and prioritising research objectives, including how the centre is managed.*

Science for impact: Safer food

New Zealand's food industry has an international reputation as a producer of quality foods – from meat products to dairy, fruit and vegetables, and food production along with food exports, which play important roles in our country's economy.

Our country's geography and relative isolation from the rest of the world has its benefits but also its drawbacks. These include challenges around keeping food in a healthy state as it travels through the production process to our tables – sometimes over large distances.

ESR's food safety work includes multiple risk-assessment projects for the Ministry for Primary Industries (MPI), collaborative research projects through the New Zealand Food Safety Science and Research Centre (NZFSSRC) and commercial contracts with the food industry. We provide a range of services focused on assessing, avoiding, mitigating and responding to foodborne hazards, such as *Campylobacter*. Our commercial contracts include food forensic investigations that determine where and when food contamination has occurred, identifying the type of contamination and its source and verifying the exact ingredients in a food product. These are all important for ensuring not only industry reputation (and liability) but ultimately consumer safety.

Our progress this year

We continue to support food safety regulators and the food industry by providing data and information to manage risk. Some projects are long term, such as contributing to MPI's efforts to reduce the incidence of campylobacteriosis. Other issues require a rapid response, such as when we provided a series of reports and updates through the NZFSSRC, advising the food industry on food safety and COVID-19. Through the NZFSSRC, we are engaging more and more with industry directly, and our work on the New Zealand Process Hygiene Index is a good example of this direct and active engagement.

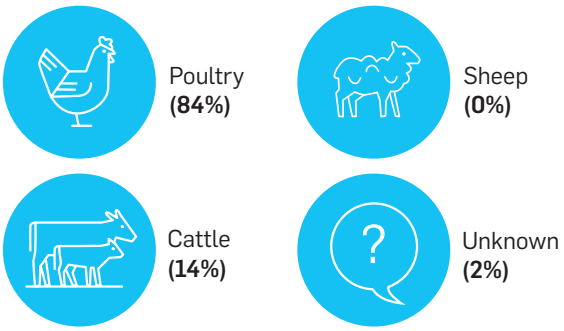
Helping with the goal to reduce foodborne *Campylobacter*

Campylobacter is the most common cause of notifiable enteric illness in New Zealand. Sentinel source attribution work has shown poultry to be the major reservoir for human infection in the country, followed by ruminants. The implementation of poultry food-chain interventions in 2006 resulted in an approximate 50% decrease in human campylobacteriosis notifications between 2006 and 2008. However, in recent years, the number of notifications annually has plateaued.

The understanding of the overall risk factors for foodborne campylobacteriosis in New Zealand was out of date. In 2018, New Zealand Food Safety (Haumaru Kai Aotearoa), a unit of MPI, commissioned ESR and Massey University to conduct a source-assigned case-control study of the disease. The aim of the study was to inform the development of a comprehensive national risk management strategy and action plan for foodborne campylobacteriosis. The study's results were published in March 2020 as *Source Assigned Campylobacteriosis in New Zealand Study.*[15]

The methodology incorporated a case-control study and a nested-source attribution study to estimate the relative contributions of different reservoirs of campylobacteriosis and exposure pathways to human illness. A total of 666 individuals who had been infected with the bacteria and age-matched controls were interviewed in the areas served by Auckland and MidCentral public health services. *Campylobacter jejuni* and *coli* were confirmed in faecal isolates from the cases. Isolates were similarly cultured from poultry, sheep and cattle processors serving these populations. DNA from each isolate was whole genome sequenced to enable modelling to assign a source of human infection.

It was estimated that the sources of the bacteria in the clinical cases of illness were:



Poultry was likely to have been the source of around 90% of illnesses in urban-dwelling people, while it was the likely source in almost 75% of rural-dwelling people.

The study also identified a number of significant risk factors for contracting campylobacteriosis. These were:

- eating undercooked poultry and eating poultry outside the home
- living and/or working on a farm and having direct animal contact, particularly for cattle-associated cases

[15] *New Zealand Food Safety. 2020.* Source Assigned Campylobacteriosis in New Zealand Study (SACNZS). *Wellington: MPI. URL: www.mpi.govt.nz/dmsdocument/39896-source-assigned-campylobacteriosis-in-new-zealand-study-sacnzs-report (accessed 7 September 2020).*

- drinking raw milk, for urban cases source-assigned to cattle
- using rainwater and/or roof tank water as a water source, either in the home or elsewhere
- using prescribed proton pump inhibitors as a medication, which reduces the acidity of the stomach – the barrier to infection
- having close contact with another person who had gastrointestinal symptoms.

When the study results were released on 9 March 2020, Deputy Director-General for New Zealand Food Safety (Haumaru Kai Aotearoa) Bryan Wilson, announced a new goal: of reducing foodborne *Campylobacter* poisoning in New Zealand by 20% by 2025.

Updating the Process Hygiene Index

In the 2018–2019 year, the New Zealand red meat industry exported $3.3 billion worth of beef meat, $3.8 billion worth of sheep meat and $1.6 billion worth of other products derived from carcasses (co-products). These red meat products were shipped in both chilled and frozen form to over 115 markets around the world, where they were valued for both their high quality and strong track record for food safety.

Food safety is largely achieved by good hygienic practices in the meat processing plants, which ensure there are minimal bacteria on carcasses and co-products after de-hiding and evisceration. However, there is always a community of bacteria on meat that have the potential to grow and spoil the product if the conditions are suitable. Cooling carcasses or parts of carcasses sufficiently quickly after slaughter is one way of reducing the potential for bacterial growth and therefore reducing the risk of food safety or spoilage issues.

The meat industry currently uses a tool called the New Zealand Process Hygiene Index (PHI) to inform suitable cooling time-temperature profiles. The PHI assesses the potential for growth of mesophilic bacteria (bacteria that grow well in warm environments) following cooling. Electronic data loggers collect multiple time and temperature recordings of products during the cooling process. The temperature profile data is then run through the PHI to verify that the cooling profile meets the PHI performance criteria to minimise the risk of bacterial growth during cooling.

The PHI was originally developed in 1997 and was then customised in 2007 to allow plant-specific microbiological data to be incorporated into the calculations (PHI Plus). While the meat industry is confident that the PHI is working well, the model has not been updated since 2007 and is based on calculations that provide a conservative estimate

of the effectiveness of cooling. The PHI Plus model is also not particularly user friendly and is limited to sheep and beef meat.

We have been working with MPI and the New Zealand Meat Industry Association (MIA) to review, evaluate and provide recommendations on pathogen control in food processing, including ways of improving the PHI.

In 2017, we took part in a joint 'intelligence-gathering' project with representatives from the meat industry, MPI, AgResearch and Massey University, administered through the NZFSSRC. The aim was to review the original PHI assumptions and model, assess whether microbiological processing data had changed since 1997 and come up with ideas for a PHI refresh. As a result of this project, it was agreed that there would be value in updating PHI to make it more robust for the industry.

In 2019–20, we were part of the NZFSSRC team working to create a PHI toolbox, including an updated version of the PHI model. In this project, our role was to create the new toolbox, including:

- updating the model to include a growth lag and helping MPI re-evaluate performance targets
- providing plain English factsheets on PHI and PHI Plus for MPI and meat processors, to explain the model to international regulators and customers

- supporting the update to industry and MPI code of practice
- providing a pilot web-based dashboard tool (PHI toolbox) that the meat industry can use to calculate the new PHI and PHI Plus to test against performance targets and to act as the go-to source of the latest PHI information
- evaluating industry offal data to see if the customised PHI methods could be applied to offal products.

Initial testing of the dashboard has been completed, and final user testing of PHI Plus took place in August 2020. There has been a great response from the meat industry in helping with the user testing, and the model is almost ready for roll-out to producers. The next step in the project is to look at the possibility of updating PHI Plus to include offal. We are looking to undertake this work in the next financial year once funding has been approved.

Safer food performance indicators – results as at 30 June 2020

Output delivery measure	Actual 2019–20	Full-year 2020 target
Number of projects delivered for the NZFSSRC	10	N/A
Number of projects delivered for MPI[a]	15	N/A

[a] *16 projects were delayed due to COVID-19 and are scheduled to be completed in 2020/21.*

Science for impact: Cleaner water and environment

ESR specialises in investigating water quality and identifying possible sources of water contamination. We aim to reduce the burden of waterborne illness outbreaks, address public health risks and contribute to the sustainable use and management of water systems.

Groundwater health and the quality of freshwater systems has featured significantly in our research over the past year.

New Zealand's freshwater and groundwater resources are fundamental to our way of life. Groundwater is critical to the health of our above-ground environments, communities and agricultural enterprises. The health of our surface and irrigation waters and our mahinga kai can be directly linked to the quality of the groundwater. Irrigation sourced from groundwater has been estimated to contribute around $2 billion annually to New Zealand's economy. Yet the country's groundwater resources, like other water sources, are under stress. Pressures from climate change and contaminants from urban, farming and industrial sources threaten its availability and quality, and the pollution is widespread and difficult to treat.

We continued to work with national and international partners on water safety and sanitation options as well as climate change resilience and adaptation measures. We provided advice and science support to regional and city councils around maintaining freshwater, groundwater and drinking-water quality for their communities. We also continued collaborative work on developing systems for sustainably managing biowastes.

We use our skills in science and research to develop new technologies that both are culturally appropriate and ensure strong and ongoing community support to protect and improve the quality of New Zealand's precious water systems.

Our progress this year

Our food, water and biowaste team has progressed research to develop DNA tracer technology that could offer more effective and environmentally friendly tools for investigating sources of water contamination and improve mitigation strategies for polluted freshwater sources.

Our environmental science team used genome sequencing to determine the true scale of the Havelock North campylobacteriosis outbreak, developing skills in environmental genomics. It also made progress on new ways to assess the risk of waterborne infections from drinking-water supplies.

Our groundwater team is researching the effects of intensified land use and the use of nitrates over the past

50–70 years on New Zealand's groundwater systems. Groundwater research, while longer-term, aims to deliver robust evidence and science to provide advice to regional councils and the government. Research findings will inform policy development to support the sustainable use and management of groundwater resources.

A project to understand the movement of contaminants, such as nutrients and pathogens within heterogeneous aquifers is under way. Understanding and modelling how these pathogens move and survive through groundwater is important for securing the safety of this important water source. The groundwater team is also collaborating with the Institute of Geological and Nuclear Sciences Limited (GNS) and Australia's Watermark Numerical Computing on an MBIE-funded project Te Whakaheke o Te Wai. This project aims to develop new and efficient methodologies for scientists, water providers and consenting authorities to understand the water sources and secure the drinking-water supplies of groundwater.

Work is also progressing on establishing a groundwater health index similar to the macroinvertebrate community index in surface water systems. Our research is identifying key species (micro and/or macro) present that can potentially act as tools for predicting the health of groundwater. Understanding the biological processes that are occurring in our groundwater will help us discover any beneficial organisms capable of remediating groundwater quality.

Assessing contamination levels in New Zealand's freshwater

During the past year, our environmental science team undertook a Ministry for the Environment-funded pilot study looking at the best way to assess the pathogen and indicator relationship in New Zealand recreational freshwater systems to determine the risk of infection to people.

The pilot consisted of collecting and analysing 51 samples across 16 recreational freshwater sites throughout New Zealand during February to March 2020. The team chose sites that were representative of waterways known to be contaminated by urban and farming sources. The COVID-19 level 4 lockdown cut short the sampling, but the team managed to collect some good data before the lockdown came into place. Almost half the samples exceeded recreational freshwater guidelines.

This project has been a true multi-disciplinary effort, using skills and expertise from across the organisation. Our staffers Margaret Leonard and Sarah Coxon visited council staff at each of the 16 sites to train them in sampling techniques. They also reached out to local iwi to inform them of the study and invite them to take part in the site assessments.

Water samples were analysed using culture-based methods for the indicator bacteria *Escherichia coli (E. coli)* and enterococci and the pathogens *Campylobacter*, *Salmonella* and shiga toxin-producing *E. coli* (STEC). The team then whole genome sequenced isolates of *Campylobacter*, *Salmonella* and *E. coli.*

Our Christchurch-based molecular biology team extracted DNA from each water sample. Using quantitative polymerase chain reaction assays (qPCR), they were able to detect and quantify *E. coli*, *enterococci*, *Campylobacter*, *Salmonella*, STEC, *Cryptosporidium* and *Giardia*, including a range of faecal source tracking markers indicative of human, ruminant and wildfowl faecal pollution.

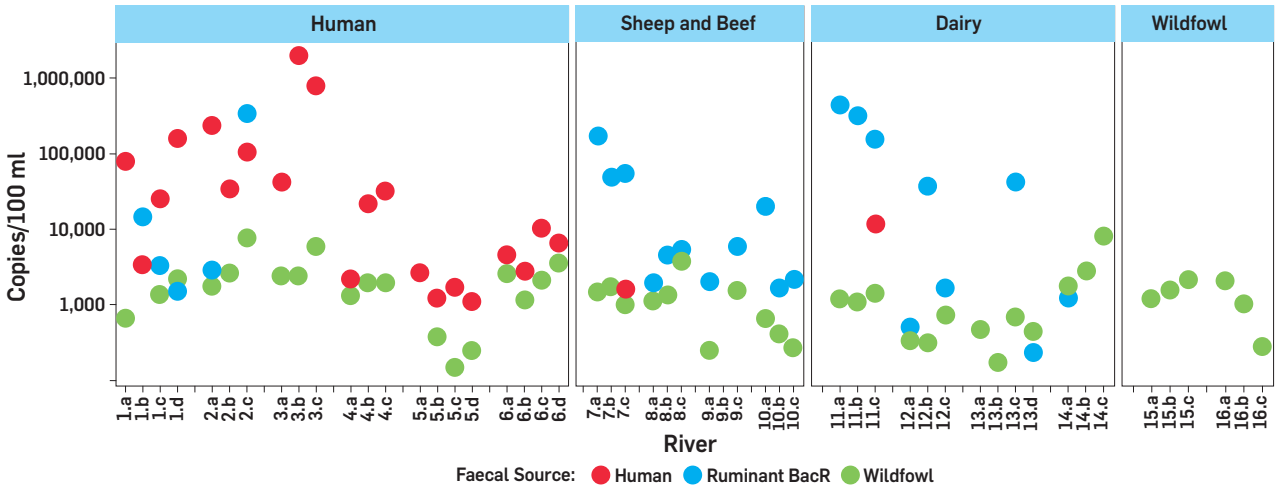
Our environmental virology laboratory, headed by Dr Joanne Hewitt, concentrated water by ultrafiltration and used qPCR to evaluate for the presence of norovirus, enterovirus and adenovirus. The team at Massey University used fluorescent microscopy to assess for *Cryptosporidium* and *Giardia.*

Our environmental science team first applied the faecal source tracking technology to characterise each sampling site according to the source of contamination. Almost every sample from every site contained indicators of faecal pollution from wildfowl. In two sites, wildfowl contamination was the only significant source in each sample tested. Farming contamination was only found in some of the samples where it was suspected. All the urban site samples had evidence of human contamination sources.

The team isolated *Campylobacter jejuni* from 14 of the 16 sample sites, and from three sites, they isolated what might be a new species of *Campylobacter*. They isolated *Salmonella* from seven sites, which our genome sequencing confirmed were serovars *Enteritidis*, *Typhimurium*, *Emek* or *Saintpaul*. Only one sample contained an STEC isolate.

No human adenoviruses were detected, but the team detected noroviruses and enteroviruses at very low levels at six sites. They also detected *Giardia* and *Cryptosporidium* frequently but at very low levels at most sites.

The study generated a wealth of data that the team is still preparing for publication. The results will inform how we assess the water quality of New Zealand's freshwater systems in the future and we think will make a significant contribution to changing the management of recreational freshwater systems around the country.



Tracking the sources and paths of water contamination

Intensified human activity around New Zealand has resulted in heavily polluted freshwater sources in many areas. Unfortunately, mitigation efforts have been hampered by the limited ability of current contamination tracking tools to trace water contamination paths and identify their source locations. These tools, which use fluorescent dyes and salts, are usually limited to one location at a time and can have an adverse impact on aquatic organisms if applied at high concentrations.

However, a newly developed tracer technology could offer a solution. Science lead in our health and environment team, Dr Liping Pang, has been leading an MBIE-funded Smart Ideas project, in collaboration with the universities of Canterbury and Calgary, in Alberta, Canada; Environment Canterbury and Waikato Regional Council, to look at new ways of tracking water contamination. To concurrently track multiple water contamination sources and paths, the team has developed a suite of 20 different DNA tracer sequences, each with a unique identifier. The new DNA tracers are either 'free' DNA molecules or encapsulated within microparticles of naturally occurring biopolymers. They are environmentally safe because they are not derived from the genomes of any organism and have no genetic function. They are also biodegradable and non-toxic, so they can be used in ecologically sensitive freshwater environments. The 'free' DNA tracers can diffuse into the porous media of soils and aquifers, while the microencapsulated tracers are protected from environmental stresses, such as ultraviolet (UV) radiation, microbial activity, enzymes and chemicals, which are often present in surface water and effluent.

In collaboration with Environment Canterbury and Waikato Regional Council, the team conducted proof-of-concept field validations in groundwater, surface water and soil systems, and these field trials showed great promise. The team published the article 'Water tracking in surface water, groundwater and soils using free and alginate-chitosan encapsulated synthetic DNA tracers' in *Water Research*, a leading international journal in the field of water science and technology.[16]

Dr Pang said the DNA tracer technology could offer more effective and environmentally friendly tools for investigating water contamination events, such as the Havelock North drinking supply contamination of 2016. These DNA tracers are detectable and identifiable in the field conditions the team investigated, and they were able to track them in a surface stream for at least 1 kilometre. The quantities of free DNA tracers required for water tracking were significantly lower compared with traditional salt or dye tracers.

The team will continue to work with end-users to validate the new tracers in field conditions. With further up-scaling, the new DNA tracer techniques have a bright future as new tools that can concurrently track multiple pollution sources and paths in freshwater environments and facilitate hydrological investigations in complex natural environments and engineered systems. The technology will help water authorities identify which of multiple potential sites are responsible for a contamination so that they can act promptly to deal with events that may affect water quality. This will ultimately lead to the development of better mitigation strategies that will protect New Zealand's precious freshwater resources.

Assessing pathogen removal in drinking-water filtration systems

It is estimated that, each year, tens of thousands of people in New Zealand contract gastroenteritis from pathogen-contaminated drinking-water supplies, resulting in substantial societal and economic impacts. Infections caused by protozoa and viruses are particularly problematic as they do not respond well to antibiotic treatment.

The current tools for assessing microbial pathogen removal from water supplies are based on *E. coli* bacteria for indicating bacterial removal and turbidity for assessing the performance of the treatment systems for protozoan removal. However, water turbidity and oocyst concentration are not necessarily linked, and international studies have demonstrated that protozoa can break through filters even when the turbidity is within the guideline targets. Likewise, the absence of *E. coli* does not guarantee the absence of viruses.

[16] *Pang L, Abeysekera G, Hanning K, et al. 2020.* Water tracking in surface water, groundwater and soils using free and alginate-chitosan encapsulated synthetic DNA tracers. Water Research, *184. DOI: https://doi.org/10.1016/j.watres.2020.116192 (accessed 7 September 2020).*

ESR's Dr Liping Pang has been leading a Health Research Council-funded study that is looking at new ways to assess the risk of waterborne infections from drinking-water supplies. The research team developed an innovative surrogate technology, which they used to assess how effective different water filtration systems are at removing protozoan *Cryptosporidium spp*. Their assessments included real-world pilot trials in rapid sand filtration systems and point-of-use (POU) domestic filters.

The team also tested 10 different types of commonly used POU domestic filters to better understand the filters' effectiveness at removing rotavirus, adenovirus and norovirus. These pathogens have extremely high infectivity and are frequently present in environmental waters. Rotavirus and adenovirus are the primary causes of gastroenteritis in children. Along with *Cryptosporidium*, norovirus results in acute gastroenteritis in all age groups.

The team incorporated the results of their experiments into quantitative microbial risk assessments. They then identified possible health risks from drinking-water supplies and recommended ways that the water treatment options could be improved to protect the public's health.

Whole genome sequencing provides a breakthrough in the Havelock North campylobacteriosis outbreak

In August 2016, Havelock North, in the Hawke's Bay, experienced a serious campylobacteriosis outbreak. A heavy rainfall event sent water contaminated with sheep manure into an untreated groundwater-derived drinking-water supply for the town. The campylobacteriosis outbreak is recognised as the largest in the world. Until June this year, the true scale of the outbreaks has not been fully known.

Waterborne illness imposes a significant health burden, with waterborne outbreaks regularly reported in Europe, North America and elsewhere. *Campylobacter* has been identified as a contributing pathogen in many of these outbreaks and poses a significant risk for unchlorinated groundwater systems due to its ability to survive several weeks in cool, wet environments and infect at low doses. Campylobacteriosis is the most frequently notified disease in New Zealand, with 6,000–7,000 cases notified each year.

The Havelock North outbreak cost about NZD 21 million – with about half this cost borne by local households, which each lost an estimated NZD 2,440 from time off work and having to buy bottled water. This prompted public protests and a lengthy Government inquiry.

The Ministry of Health, Health Research Council, ESR Strategic Science Investment Fund (SSIF) and the Royal Society Te Apārangi provided funding for a joint research

project, involving ESR, Massey and Otago universities, the Hawke's Bay District Health Board and the Eastern Institute of Technology, into the Havelock North campylobacteriosis outbreak. The project was led by our environmental science team leader Dr Brent Gilpin and used cutting-edge technology to find that the outbreak was larger than first estimated. In June 2020, the research team published the article 'A large scale waterborne campylobacteriosis outbreak, Havelock North, New Zealand' in the monthly peer-reviewed *Journal of Infection*, the official publication of the British Infection Association.[17]

The team used whole genome sequencing to effectively decode *Campylobacter's* full genetic make-up and link cases based on the genetic similarity of the organism between people, from the water and from sheep in the paddocks to provide a fuller picture of the outbreak.

Initially, New Zealand was reporting around 5,500 cases from this outbreak, which was based on a telephone survey of people living in Havelock North. The study has allowed the researchers to confirm that *Campylobacter* cases from outside Havelock North were also part of the outbreak, and not the result of some other cause of infection, as a result of visiting the area while the water was contaminated, and some could have contracted the illness as a result of consuming food or beverages that contained contaminated water.

The researchers now estimate that between 6,260 and 8,320 cases of illness – including up to 2,230 people who lived outside the reticulation area – were linked to the contaminated water supply. Of these, 953 cases were reported by doctors, 42 cases were hospitalised, three

[17] *Gilpin BJ, Walker T, Paine S, et al. 2020.* A large scale waterborne campylobacteriosis outbreak, Havelock North, New Zealand. Journal of Infection*, 81: 3, 390–5. DOI: https://doi.org/10.1016/j.jinf.2020.06.065 (accessed 7 September 2020).*

developed Guillain-Barré syndrome (a rare disorder in which the body's immune system attacks the nerves), and *Campylobacter* infections contributed to at least four deaths. An unknown number of people continue to suffer health complications as a result of their link to the outbreak.

Of the 12 genotypes the researchers observed in cases, four were also observed in water, three were observed in sheep and one was observed in both water and sheep.

Linking an environmental investigation to the investigation of an illness is critical to understanding sources of infection and any system failures that might contribute to such illness outbreaks. This approach can be applied to much smaller outbreaks and will be critical in helping authorities develop rapid and effective responses to future outbreaks of illness. It is a similar approach to that being used to sequence viral genomes from positive COVID-19 cases, where the sequencing helps define who is part of each outbreak.

The study also reinforces the importance of having a nationwide approach to safe drinking-water and, given expected increases in heavy rainfall events and intensification of agriculture, suggests that more safeguards are needed to protect populations from future outbreaks of drinking-water-borne infection.

Groundwater pesticide and emerging organic contaminant surveys

Since 1990, our groundwater team has been coordinating a four-yearly, nationwide groundwater survey on behalf of 15 out of the 16 regional and unitary councils. We provide advice around well selection, collate and interpret survey results and provide a national summary report. The latest survey results were released in October 2019.

Most of the wells in the current survey showed no change in the amount of pesticides present compared with previous surveys, with low levels detected in less than one-quarter of the wells. Herbicides were the most frequently detected pesticides group (88% of detections with 17 different herbicides and their metabolites). None of the sampled wells exceeded safe drinking-water standards, and most pesticides were detected at less than 0.5% of the maximum acceptable value.

As well as pesticides, for the first time, the survey tested for glyphosate (the active ingredient in a popular weed killer) and a suite of emerging organic contaminants (EOCs) for the councils.[18] Glyphosate was found in only one well from the 135 wells tested, with the level detected well below the World Health Organization recommended health-based value.

EOCs are a class of compound used for everything from food production and preservation to human and animal health care. They include products such as caffeine and artificial sweeteners as well as pharmaceuticals like pain-relief products, contraceptive pills and sunscreen. There is growing concern about EOCs and their potential impact on human and aquatic health, and little is known about their concentrations in groundwater. Overseas research links the discovery of EOCs in groundwater to wastewater sources, including municipal treatment plants, septic tanks, farming activities, as well as indirectly from surface water.

Environmental or ecological impacts are the main concerns with EOCs. There have been very few studies completed to date on the ecological impacts and no or very few guideline values for safe levels of EOCs in groundwater. A key question is whether the levels of bisphenol A (BPA) and some of the other compounds found in groundwater might impact aquatic organisms (protozoa and tiny crustacea) living there.

A highly sensitive analytical technique that measures EOCs at extremely low concentrations was used to test for 29 different EOCs in 121 wells. EOCs were detected in all regions where wells were sampled for them. Low concentrations of 25 of the 29 organic contaminants tested for were found in close to two-thirds (70 percent) of the wells. The most commonly found EOCs were:

- BPA detected in 40 wells (BPAs are widely used in packaging and plastic products)
- UV filter compounds (such as sun protection products for the skin)
- EOCs originating through human use and body metabolisms, for example, caffeine, sucralose, ibuprofen, or steroidal hormones released in human waste (which can act as tracers of the presence of human activity or wastewater impacts in the groundwater system).

Local communities are expressing a growing interest in understanding what contaminants are reaching the groundwater. Yet little is known about the transport characteristics of EOC compounds and, before this survey, almost nothing about their occurrence in New Zealand groundwater systems. More research is needed into these areas, and our groundwater survey is becoming increasingly important in helping everyone understand what and how contaminants are moving within these crucial groundwater systems.

[18] *AsureQuality carried out the pesticide and glyphosate analyses. They analysed for acidic herbicides, a suite of organochlorine, organophosphorus and organonitrogen pesticides, and for glyphosate, glufosinate and their major metabolites. The EOCs were analysed by Northcott Research Consultants Ltd.*

Woodchip denitrification wall pilot two years on

In November 2018, our groundwater team installed an experimental woodchip denitrification wall in the shallow gravel aquifer[19] at Silverstream Reserve, North Canterbury. The aim was to explore ways of maintaining freshwater quality, particularly in rural locations, by naturally reducing the strength and presence of nitrates in groundwater. It was the first time that a denitrification wall had been trialled in a gravel aquifer anywhere in the world.

The new technology involved placing a wall of solid, porous, organic woodchip substrate within a nitrate-contaminated aquifer. Native microbes in the woodchip are stimulated to strip out the nitrates before the aquifer's groundwater reaches critical waterways.

Over 2019–20, groundwater monitoring and assessment continued at the site, and the site itself developed into a field laboratory for hands-on teaching in the University of Canterbury's earth science courses.

Our team collaborated with world-leading professionals (Dr Andrew Binley, Lancaster University, United Kingdom and Dr Giorgio Cassiani, University of Padova, Italy) and Southern Geophysical Ltd, Christchurch, to develop the capability for hydro-geophysical methods for characterising groundwater contaminant transport in New Zealand. The team used advanced time-lapse electrical resistivity methods to track the transport of nitrate through the gravel aquifer alongside the woodchip wall nitrate treatment system at Silverstream Reserve. Results have shown the woodchip wall to be functioning effectively.

In its first year of operation, the 25-metre-long wall removed more than 542 kilograms of nitrate-nitrogen from the groundwater, converting it to benign nitrogen gas. The nitrate removal rates for the wall rank as some of the highest ever reported for woodchip denitrifying bioreactor systems. Initial costing models of the nitrogen-removal efficiency have shown that the wall ranks favourably as a cost-effective 'edge-of-field' nitrate mitigation option. Findings have been presented at domestic and international conferences, and the first papers from the project have been published in international scientific journals such as *Ecological Engineering*.

In addition to water chemistry monitoring, greenhouse gas emissions (GHGs) from the system have been measured and show that compared with alternative nitrate mitigation practices, the woodchip wall is a low emitter of GHGs. The team will continue to monitor the woodchip wall's impact on the groundwater ecosystem to assess the wall's viability over the longer term.

Work also continues on exploring alternative, more cost-effective ways of constructing the woodchip denitrification walls in shallow gravel aquifer settings to improve the viability of this nitrogen-mitigation practice and encourage landowners to implement the technology to reduce the impacts of high nitrates on surface waters.

[19] *Aquifers are bodies of saturated rock or sediment from which groundwater is extracted. Gravel aquifers contain much of New Zealand's usable groundwater and are particularly vulnerable to nitrogen contamination.*

Cleaner water and environment performance indicators – results as at 30 June 2020

Output delivery measure	Actual 2019–20	Full-year 2020 target
Number of territorial local authorities we provide with water quality advice	13	15
Annual Report[a] on Drinking-water Quality delivered on time	1	1
Number of publications of our water and environment research	25	N/A

[a] *We manged the annual survey to collect all data for this annual report and provided analysis to enable the Ministry of Health to deliver this report.*

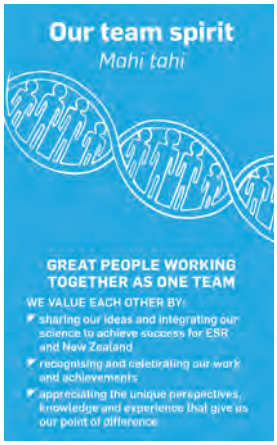
One ESR – He waka eke noa

Our people are our greatest asset and are vital to ESR's success. We will need the skills, leadership and commitment of all our people to build a collaborative culture aligned to our purpose and strategy.

We are committed to empowering our people to build new capabilities, generate new ideas and solve problems by challenging old ways of thinking. We encourage collaborative working so that we are customer, solutions and outcomes focused. We are committed to developing leadership capability across our organisation and providing opportunities for growth.

Our values

Our values are our shared principles and beliefs that guide the way we work and meet challenges, how we interact with our customers and each other, and what we do to make a difference. Our values express the qualities we strive for to ensure we are seen as a trusted advisor, recognised both nationally and worldwide as a leader in the fields of forensic, health and environmental sciences, keeping New Zealanders safe and healthy, supporting the economy and protecting the environment.



Growing our culture, leaders and people

We will provide our people with the right tools, support, skills, and training and development opportunities to ensure they can collectively and individually grow our organisation's culture and success.

To attract, retain and develop a high-performing and collaborative workforce aligned with our culture, we have started developing a workforce strategy. We are committed to growing our Māori impact by developing and building Māori concepts into the organisation, which includes attracting and appointing Māori scientists to roles. We established a new business unit at the Senior Leadership Team level. Our Māori Impact Unit focuses on our Māori impact strategy and will show us the way to achieve greater benefits for and encourage engagement with and from tangata whenua.

Growing our Māori capability

We recognise that, throughout our organisation, learning te reo and tikanga Māori is vital to supporting meaningful Māori community engagement. It will help us deepen our connections as we work with Māori to co-develop science solutions that combine Māori knowledge and Western science to make a greater difference to Māori wellbeing. We encourage all staff to be curious about and open to learning te reo.

During the year, we held weekly te reo classes at our Auckland, Kenepuru and Christchurch science centres. These classes continued online while we operated during the different COVID-19 alert levels. To build confidence in speaking te reo, those involved learnt a variety of karakia, waiata, whakataukī and conversational te reo. Our people have also been on 45 noho marae experiences.

Developing our leaders

We recognise effective leadership as being crucial to supporting and championing a high-performing, customer-centric culture and organisation. We implemented our new performance experience framework Te Kāpehu and are in the process of identifying a performance management system to support that framework. We will also be holding targeted workshops and coaching for people leaders with a focus on strengthening the capability of our leaders.

Engaged people

We seek to understand and improve our engagement and culture on an ongoing basis and continually improve the way we track and measure our progress. We have invested in Qualtrics, a new survey platform that will provide real-

time reporting for leaders. It includes dashboards that generate personalised action plans for every leader based on the results and priorities. These action plans can be shared to enable more collaboration across the business, ensuring everyone plays a part in building an employee experience that attracts, engages and retains the best people.

Expectations of behaviour

The nature of our work requires us to uphold the highest standards of integrity, discretion and ethical conduct. To create and maintain a workplace that is safe and healthy, underpinned by equity and respect; our people treat each other fairly, respectfully and professionally in a way that reflects our values. Our code of conduct and acceptable behaviour policy set the required standards of behaviour for all our people.

Protected disclosures: raising concerns about wrongdoing

Promoting integrity, accountability and acceptance of our values is core to our culture. We are committed to ensuring our people have the confidence and support to report a real or potential wrongdoing. Our protected disclosures policy provides information about how to recognise what serious wrongdoing looks like, and the steps to follow when reporting a wrongdoing. This policy is supported by our Speak Up external reporting channel provided for staff to report wrongdoings in a private and secure way. Both the policy and the Speak Up channel help contribute to a safe and lawful workplace that reflects our values and code of conduct. The policy was updated in March 2020 in line with the Ombudsman guidelines *Protected Disclosures: Guidance on internal policies and procedures*[20] and the Te Kawa Mataaho Public Service Commission model standards.[21]

Being a good employer

We are committed to being a good employer and advocating organisation-wide equal employment opportunity (EEO) practices around recruiting and developing, managing and retaining all staff.

We aspire to be a diverse and inclusive workplace where all our staff have equal opportunities to fulfil their potential and make a contribution. We are making progress to building an engaged, diverse and inclusive workforce that reflects the communities we serve. We believe that leveraging the diversity of our people will allow us to innovate and improve customer experience. We are a member of New Zealand's national body for workplace diversity and inclusion, Diversity Works NZ, and an accredited employer with Immigration New Zealand.

All our policies and practices are based on the principles of fairness, equity and non-discrimination. We regularly

review and refresh these to ensure they remain relevant and fit for purpose.

We continue to work closely with the Public Service Association (PSA) to ensure our employees have a channel where they can communicate recommendations or suggestions for policies, practices and programmes. Our Partnership for Quality forum is offered jointly with the PSA and is a way for our people to discuss issues affecting staff and feel listened to and validated.

The table on the next page outlines our achievements against the seven key elements of being a good employer, as set out by the New Zealand Human Rights Commission.[22]

[20] *Office of the Ombudsman. 2019.* Protected Disclosures: Guidance on internal policies and procedures: A guide for organisations. *Wellington: Office of the Ombudsman. URL: www.ombudsman.parliament.nz/resources/protected-disclosures-guidance-internal-policies-and-procedures (accessed 8 September 2020).*

[21] *Te Kawa Mataaho Public Service Commission. 2019.* Positive and Safe Workplaces: Acting in the spirit of service. *Wellington: State Services Commission. URL: www.publicservice.govt.nz/assets/SSC-Site-Assets/IES/Model-Standards-Positive-and-Safe-Workplaces.pdf (accessed 8 September 2020).*

[22] *Human Rights Commission, Good employers' advice, URL: www.hrc.co.nz/resources/business/reporting-crown-entities-good-employers/*

Good employer elements	What we delivered in 2019–20
Leadership, accountability and culture	• We launched our new performance experience framework, Te Kāpehu, in September 2019. Te Kāpehu is based around having meaningful development conversations. It is designed to build a collaborative, high-performing culture through clear accountability and defined work outputs aligned to business plans and our strategic objectives. • Our leadership team communicates the strategic direction and organisational goals to staff at all levels. • We are on a journey to review and evolve our internal capabilities to ensure we are set up with an organisational culture that will operate effectively in a future working environment of constant change.
Recruitment, selection and induction	• We have recruitment and selection processes in place that foster EEO principles. Recruitment is focused on competencies, values, skills and experience and is backed by appropriate assessment and selection tools to ensure the best candidate is selected in a fair and equitable manner. • Our new employees receive a thorough induction programme that includes familiarisation with key policies and processes. We are currently implementing a new digital onboarding system that will engage new employees before they start with the organisation. • We continued to systemise our recruitment practices and approvals in order to expand consistency across the organisation.
Employee development, promotion and exit	• Our new performance experience framework, Te Kāpehu, encourages employees' development by providing clear and achievable progression through building technical skills and behavioural competencies. • We offered on-the-job opportunities, internal secondments and attendance at national and international science conferences. • Our annual science promotions process supports staff career progression. • We offer employees who leave us the opportunity to participate in either an online or a face-to-face exit interview. The feedback is consolidated and used to assess how we can build on areas of strength and improve our working environment.
Flexibility and work design	• In response to COVID-19, we focused on remote working and the future of work. We introduced 'dynamic working' to support our people while working away from the office. We developed policy, rules, guidelines and principles to support flexible working arrangements. • We promote flexible working arrangements with our flexible hours, extended flexi-time, and other flexible working arrangement polices, which are outlined in our employee handbook. We support parents returning to work by offering part-time and gradual return to full-time work arrangements. As at 30 June 2020, 18% of our employees work part time. • We introduced a leaders' forum, hosted on the new Microsoft Office Teams channel, providing us with another valuable platform to host calls, deliver information and collaborate in a remote environment. • We continue to encourage employees to take their volunteering day, which aims to support staff who wish to contribute to the wider community through volunteer work. Our people donated 16 days to voluntary activities in the community. • We recognise that it is important that all staff are able to take planned leave. Time away from work contributes to physical, mental and emotional wellbeing. We launched the 'Take 20 in 20' campaign (Take 20 days in 2020). This campaign focuses on ways we can work together to support leave management.

Good employer elements	What we delivered in 2019–20
Remuneration, recognition and conditions	• Our terms and conditions of employment are consistent with the good employer philosophy, with a range of benefits that our employees value. • We reward people fairly and equitably based on contribution, regardless of gender, age or ethnicity. Our Te Kāpehu and remuneration frameworks ensure staff feel valued, recognised and appropriately rewarded for their contribution to nurturing a high-performance culture.
Harassment and bullying prevention	• Our code of conduct and acceptable behaviour policy set out the standards of behaviour we expect of all our people, how to deal with unacceptable behaviour (including harassment and bullying) and where to access further information and support if required, including the Employee Assistance Programme (EAP). • New employees are introduced to the policy and given training as part of their induction. We review the policy regularly. • We align our approaches with the bullying guidelines produced by WorkSafe [23] to ensure we are following best practice.
Safe and healthy environment	• We had an external reviewer conduct a review of our health and safety systems against WorkSafe's SafePlus health and safety performance framework. As a result of their recommendations, we developed a programme of work to implement in 2020/21. • We continue to review and update our policies and procedures in line with best practice. • We are currently undertaking a full review of our existing incident reporting management system. • Our Employee Assistance Programme was extended to include a trauma support programme, providing tailored support to assist staff in dealing with the physical and psychological symptoms associated with exposure to traumatic events, unpleasant information or ongoing traumatic experiences as part of their roles. • Our health and safety team pivoted to assist the welfare structure of our crisis incident management response team to ensure the safety and welfare of our people during the COVID-19 crisis. • We launched an app called ROUK to give us a daily pulse of our staff's wellbeing and health during COVID-19 alert levels 4, 3 and 2 restrictions. • In addition to the RUOK app, we put a wellbeing structure in place to connect with staff who need additional support. • We tracked staff who were being tested for COVID-19.

[23] *See Worksafe, Bullying, at: https://worksafe.govt.nz/topic-and-industry/bullying/*

Health and safety of our people

At ESR, health and safety is everybody's responsibility. We are committed to continual improvement and excellence in the management of health and safety in the workplace. Our aim is to provide and maintain a healthy and safe working environment for all employees, contractors and visitors.

We continue to work within WorkSafe's SafePlus health and safety performance framework, which offers a government-endorsed model of what 'good health and practices and performances look like. We are focusing our performance around the three key elements of health and safety: leadership, risk management and worker engagement.

We are increasing our focus on employee wellbeing to ensure it encompasses mental, physical, social and financial wellbeing.

Workforce profile

We employ 432 expert minds, whose independent scientific advice and services help improve our collective economic and social wellbeing. Most of our staff (82%) are employed in science or science support roles. We value diversity and benefit from the knowledge and unique perspectives of a workforce that includes people of New Zealand European, Māori, Pacific peoples and Asian origin. Women represent nearly two-thirds of our employees and work at all levels and in all roles in our organisation. We have a high-performance culture but encourage work-life balance and enable flexible work practices. Just under 18% of our staff work part time.

Workforce statistics

The following statistics are as at 30 June 2020.

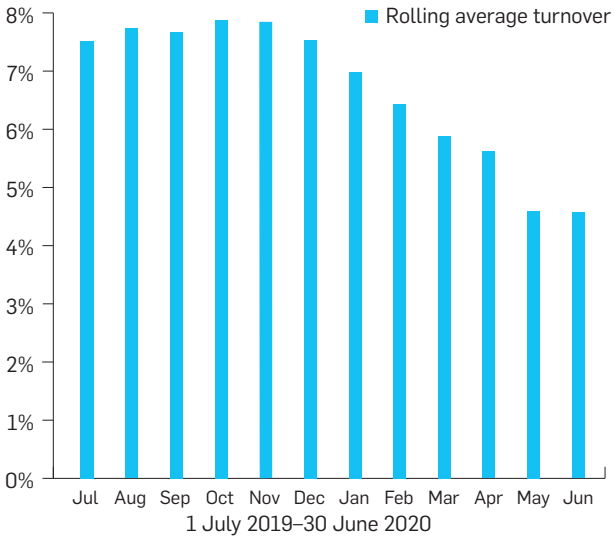
Head count

We have a total head count of **432 employees** as at 30 June 2020. This is an **increase of 2.9%** since 30 June 2019. **78 staff work part time**.

More than 80% of our staff are engaged in science and research.

Rolling average turnover

Our annual rolling average turnover based on headcount is 4.57%, 3.64 percentage points lower than the same time last year.



Self-identified ethnic profile

Ethnicity profile	Percentage of workforce as at 30/06/2020	Actual as at 30/06/2020	Actual as at 30/06/2019
NZ European	57%	246	246
Māori	2%	10	11
Asian	16%	67	56
Pacific peoples	1%	5	8
Other European	23%	98	95
MELAA[1]	1%	6	4

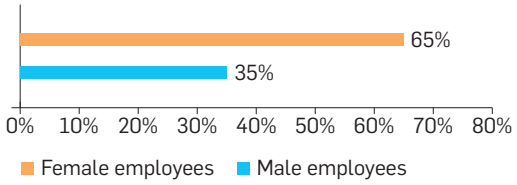
[1] *MELAA = Middle Eastern, Latin American and African*

Disability profile

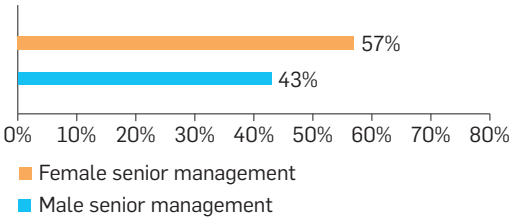
Disability profile	Percentage of workforce as at 30/06/2020	Percentage of workforce as at 30/06/2019
NZ European	≤1%	≤1%

Gender profile

We have more female than male employees (65% and 35% respectively). This is 2 percentage points higher for female employees and 2 percentage points lower for male employees than last year.



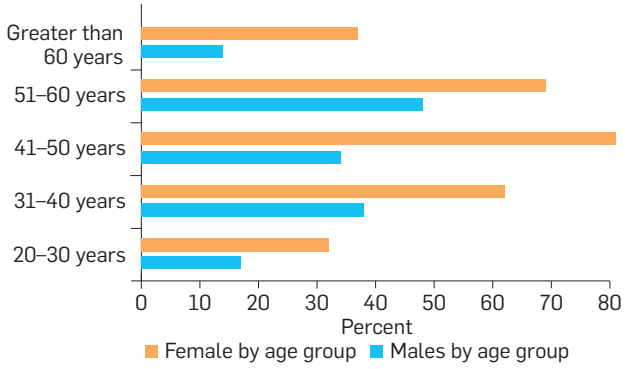
Senior management roles in tiers 3 and above are 57% female and 43% male.



Age and gender

The largest age group of our employees, at 27.1%, is the 31–40 years group. The second largest, at 26.6%, is the 41–50 years age group. Employees aged 20–30 years make up 11.8% of our employees.

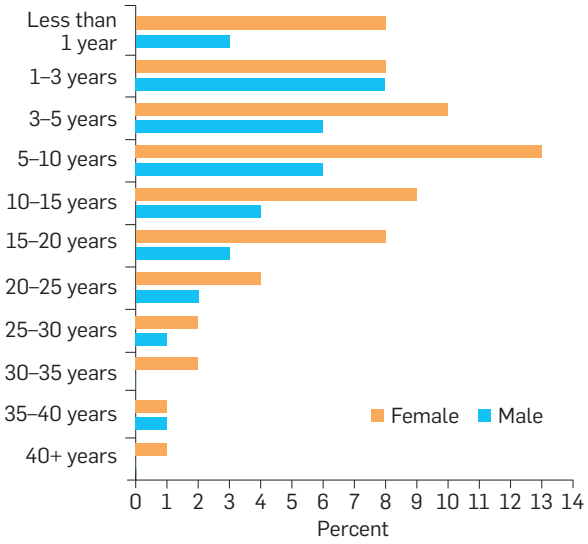
ESR employees by age and gender group



Length of service

The largest group of our employees, 19%, have worked with us for five to ten years. The smallest group, 5%, have worked with us for more than 30 years, while 11% of staff have worked with us for less than one year.

ESR employee length of service by gender



Pay profile by gender

Many organisations, including the Te Kawa Mataaho Public Service Commission and Statistics New Zealand consider that median hourly earnings is the best measure for calculating the gender pay gap. This measure is recommended because:

- hourly earnings measure pay for a fixed quantity of work
- the median is a better measure of 'typical' pay than the average (mean).

Our gender pay gap is shown in the following table. A negative percentage means that the average pay for male employees is higher than the average pay for female employees. This information shows us where we need to concentrate our efforts.

Pay scale	Female–male median comparison	Gender gap
Laboratory Assistant	2.2%	No
Technician	-0.1%	No
Senior Technician	13.1%	No
Principal Technician	1.1%	No
Scientist	0.3%	No
Senior Scientist	0.6%	No
Science Leader	3.1%	No
Science Leaders*	4.8%	No

**Median of Science Leader and Senior Science Leader pay scales*

Our scientists continue to be among the best in the world.

Celebrating success

We boast the largest team of forensic, social, radiation, environmental and infectious disease scientists and epidemiologists in New Zealand, and all our people are dedicated to making a real impact on the safety, health and wellbeing of New Zealanders and communities globally.

Many of our scientists have been invited to present papers and collaborate on their work nationally and internationally multiple times over the past year. The number of awards our people have received and the invitations to participate in programmes of work around the country and internationally bears testament to the respect that is held for their skills and commitment to their work.

On Monday 11 November 2019, ESR scientists were the recipients of three separate Science New Zealand 2019 awards.

Science New Zealand Lifetime Contribution to Science Award

Dr Rob Lake was honoured for his 30-year contribution to the field of food safety. The Science New Zealand Lifetime Contribution to Science Award 2019 recognises the impact Rob's work has had on enhancing the wellbeing of New Zealand consumers and protecting this country's access to international food markets.

His achievements include over 60 published papers and leadership roles for two of the largest foodborne illness epidemiology studies in New Zealand. Rob and his ESR colleagues developed burden estimates for foodborne diseases, which help to prioritise efforts by New Zealand food safety regulatory authorities. Rob's international collaborations led to an invitation to join the World Health Organization project to estimate the global burden of foodborne disease, with the results published in 2015.

Science New Zealand Early Career Research Award

Environmental Scientist **Dr Maria Gutierrez-Gines** received a Science New Zealand Early Career Research Award 2019 recognising her as a key emerging researcher in phytoremediation (the use of living plants to clean soil, air and water contaminated with hazardous substances), plant root system-soil interactions, the re-use of biowaste for growing economically important native plants, such as mānuka (including using mānuka in riparian plantings as an effective way of reducing farm run-off), the physical and chemical properties of soils, and microbial communities. Much of her work is being used by regional and district councils, farmers and iwi. Maria has published 14 scientific papers, one book and 17 independent book chapters, presented at 30 conferences and currently leads the Centre for Integrated Biowaste Research, a multi-disciplinary collaboration that provides solutions to the sustainable management of biowaste.

Science New Zealand Team Award

The multi-award winning **STRmix™ team** has worked for several years to develop the world's most advanced DNA profiling forensic software. Their efforts help solve crimes throughout the world. Within New Zealand, use of the software has resulted in a two-fold increase in the number of unsolved crime samples that can be searched against the national DNA database of known individuals. Internationally, STRmix™ results have been reported in over 220,000 criminal cases and used as evidence presented in 3,600 court cases globally.

The programme works by unravelling the DNA from multiple individuals recovered from a crime scene and uses biological modelling and probabilistic methods not possible with traditional DNA interpretation methods. The software package includes a comprehensive training and support package.

The STRmix™ team, which has grown from four to eighteen over the last seven years, comprises: **Hannah Kelly**, **Catherine McGovern**, **Duncan Taylor** (co-developer, Forensic Science South Australia), **Maarten Kruijver**, **Kevin Cheng**, **Jo-Anne Bright,, Rena Lawless**, **Björn Sutherland**, **Meng-Han Lin**, **Shan-I Lee**, **Laura Russell**, **Judi Morawitz**, **Stuart Cooper**, **Richard Wivell**, **Xinlong Zhang**, **Zane Kerr**, **John Buckleton** and **Adam McCarthy**.

New Zealand Winston Churchill Memorial Trust Fellowships

Senior forensic scientist, **Cameron Johnson** was named a 2020 recipient of the prestigious New Zealand Winston Churchill Memorial Trust Fellowships. The fellowship will allow Cameron to travel to the United States to study performance and image-enhancing drugs (PIEDs) as well as the latest techniques for detecting such drugs.

We have extensive expertise in the field of illicit drugs and lead several research initiatives, including developing a designer drug database. The opportunity to consult with experts in the field will give Cameron new insights and understanding that will benefit our organisation and New Zealand, keeping us up to date with current technologies and drug trends experienced internationally and helping us apply these to the New Zealand landscape.

The Adelaide Medal

Dr John Buckleton has been awarded the Australian and New Zealand Forensic Science Society Adelaide Medal, acknowledging scientific work that has resulted in a change of direction, new thinking or significant improvement in existing forensic methodologies internationally.

John is considered a world leader in the interpretation and analysis of forensic evidence and is one of the developers of STRmix™, the software that analyses complex DNA samples faster and more accurately. Over the course of his career, John has examined more than 2,000 cases, given evidence about 200 times and co-authored more than 200 significant publications in forensic science.

For John, forensics is everything. "It's my whole life. I wake up and do it, and I dream about it at night. It's just fantastic – the problem-solving aspects, the camaraderie of working on important issues. And if I go to my grave thinking, I've made some contribution to justice, that would be good."

Data science accelerator programme

In September 2019, we celebrated the graduation of our inaugural data science accelerator programme. The graduates were **Maria van der Salm** and **Anna Lemalu** from our forensic team and **Sarah Bakker**, **Giles Graham** and **Lucia Rivas** from our health and environment team. Both the graduates and their mentors learnt a lot from the experience. The mentors included **Pierre Dupont**, **Miles Benton**, **Mark Hareb** and **Janet Stacey**. The programme was inspired by **Richard Dean**. Another data science programme is being planned for early 2020/21.

ESR's STRmix team from left: Judi Morawitz, Maarten Kruijver, Stuart Cooper (back), Zane Kerr (front) Richard Wivell (back), Jo-Anne Bright, Laura Russell (back), Catherine McGovern, Meng-Han Lin. Absent: Hannah Kelly, Duncan Taylor, Kevin Cheng, Rena Lawless, Björn Sutherland, Shan-I Lee, Xinlong Zhang, John Buckleton and Adam McCarthy.

Governance

ESR's Board is appointed by the Minister of Science, Innovation and Research. Directors' remuneration is set by shareholding ministers under the fees framework approved by Cabinet. The Board is responsible for ensuring our governance is purposeful, robust and accountable. Their responsibilities include acting on behalf of, and being accountable to the Minister of Research, Science and Innovation, and the Minister of Finance. Our Board fulfils regulatory expectations under the Companies Act 1993, the Crown Research Institutes Act 1992, Crown Entities Act 2004 and the Public Finance Act 1989, including helping to establish strategic policy.

The Board and its two committees, Audit and Risk Committee and People, Performance and Remuneration Committee, are supported by our Senior Leadership Team and an independent Strategic Science Advisory Panel. The Board and its committee members are subject to ESR's code of conduct. Board meetings are scheduled monthly, or more often as required, and committee meetings are scheduled to coincide with Board meetings where possible.

Principal activity

We are a Crown research institute, providing specialist scientific services and research, particularly to the health and justice sectors. Our purpose is to deliver enhanced scientific and research services to the public health, food safety, security and justice systems, and the environmental sector to improve safety and contribute to the economic, environmental and social wellbeing of people and communities in New Zealand.

COVID-19

ESR continued to deliver essential service operations during COVID-19 Alert Level 4 to the New Zealand Police, the Ministry of Health, the Ministry of Primary Industries, the Ministry of Foreign Affairs and Trade, and the New Zealand Food Safety Science and Research Centre. ESR's staff safety protocols were implemented promptly, ensuring all staff continued to be kept safe whether they were working at an ESR site, in the field (i.e. at a crime scene) or from home. As the country moved through to Alert Level 3, the focus was on bringing back non-essential services and preparing for the safe return of staff to all ESR sites.

Outside essential services, the Group had significantly limited operations during Level 4 and had continued limitations in place at Level 3. This resulted in reduced revenues from commercial and government customers. This was offset by revenue generated from additional services provided to the Ministry of Health in support of the COVID-19 response, and COVID-19 Response and Recovery Funding provided by the government.

The Directors anticipate a continued reduction in some revenue streams over at least the next 12 months.

Our Board of Directors

Denise Church QSO, CFInstD, Chair

Denise Church is a Wellington-based company director and consultant who was appointed as Chair of the ESR Board in July 2015. She is also Chair of Airways New Zealand and serves on the boards of Predator Free Wellington and Scouts New Zealand.

Denise has wide ranging governance experience, including as Chair of Karori Sanctuary Trust and the Wellington Zoo Trust. Other Board roles have included the National Health IT Board, Ako Aotearoa, the Science Board and Manaaki Whenua / Landcare Research. In her consulting practice, Leadership Matters, Denise focuses on strategy and leadership.

Denise has also been Chief Executive of the Ministry for the Environment.

Professor Cristin Print

Professor Cristin Print is a medically qualified biomedical scientist who joined the ESR Board in August 2017. He has a 25-year career in academic medical research and biotechnology, including work in Australia, the United Kingdom and Japan.

He is a professor in The University of Auckland's Department of Molecular Medicine and Pathology, where he uses genomic and bioinformatic technologies alongside traditional pathology to better understand human disease.

Cris is currently Chair of the Auckland Regional Tissue Bank's Scientific Advisory Board, a principal investigator in the Maurice Wilkins Centre and leads the Genomics Into Medicine Strategic Research initiative in Auckland.

Kate Thomson

Kate Thomson was appointed to the ESR Board in July 2018. Currently, she is the General Manager at Te Aka Matua o te Ture – Law Commission. Most recently Kate was based in Australia working in the engineering and research sectors as a senior executive. She is also an independent member of the Indigo Shire Council Audit and Risk Committee.

Kate is a chartered accountant and an experienced chief financial officer and has held a number of senior roles in the commercial sector during her career. Kate holds a post-graduate certificate in science and technology and is a graduate of the Australian Institute of Company Directors.

Richard Gill

Richard Gill is a technology innovator and serial entrepreneur who has more than 30 years' experience founding and growing high-tech start-ups serving a wide range of industries, including broadcasting, manufacturing, finance, education, health care and water. Richard has worked extensively in technology development, product conceptualisation, early stage commercialisation and high-growth execution. He is Chief Executive of events technology start-up Blerter.

Dr Andy Shenk

Dr Andy Shenk graduated with a PhD in biological sciences from the University of Delaware, Newark, United States, and has had a 30-year career spanning academic research, management and governance in biotechnology and nutrition start-up companies and senior management in a major corporate.

Andy currently works across many fields of research, development and commercialisation of intellectual property, including early-stage investment in new technologies here in New Zealand and overseas.

Dr Helen Darling served as an ESR Board member until she retired from the Board in September 2019.

Quentin Hix served as an ESR Board member until he resigned in March 2020 following his appointment as a District Court Judge.

Access to independent professional advice

It may be necessary, from time to time, for directors to seek independent professional advice, either individually or collectively, to help them fulfil their duties and obligations. This advice, with the approval of the Board Chair, is at ESR's expense.

Directors' use of information

No member of the Board of ESR, or any subsidiary, issued a notice requesting to use information received in their capacity as directors that would not otherwise have been available to them.

Directors' development

Directors can access ESR-funded development opportunities to support their practice and ensure ESR maintains strong governance arrangements. The Board has a budget of $20,000 to cover Directors' development. Any such costs are authorised by the Chair or in the case of the Board Chair, the Chair of the Audit and Risk Committee.

Board activity in 2019–20

During this period, a total of 23 Board and Committee meetings were held. Meetings were a mix of in person meetings across ESR's sites and video conferences. Video conferences were the necessary method of engagement during the COVID-19 lockdown period. Weekly or fortnightly Board meetings were held between March and June 2020 to manage strategic and operational issues arising from COVID-19. Directors met frequently in the first half of 2020 to oversee the appointment of ESR's new Chief Executive.

The Board includes self-review as part of its regular meeting process. A structured self-review was conducted in August 2019 and an externally facilitated skills audit in December 2019. An external Board review is planned during FY21.

Board and Board committee attendance for the year ending 30 June 2020

This table includes attendance by Board committee members only and does not include attendance by other Board members who are not members of the committee. Weekly Board meetings were held in April 2020 to manage strategic and operational issues arising from COVID-19.

Total number of meetings attended			
Board of Directors	Board meetings *(out of 17)*	Audit and Risk Committee *(out of 4)*	People, Performance and Remuneration Committee *(out of 2)*
Denise Church *(Chair)*	17	4	2
Cristin Print	17	–	2
Kate Thomson	17	4	–
Andy Shenk	17	–	1
Richard Gill	17	1 of 1	1 of 1
Quentin Hix [a]	8	3 of 3	–
Helen Darling [b]	3	–	1

[a] *Quentin Hix resigned in March 2020.*
[b] *Dr Helen Darling retired in September 2019.*

Audit and Risk Committee

The objective of this committee is to assist the Board in discharging its responsibilities in relation to the oversight of ESR's risk management policies and processes, internal and external audit and control functions, and overseeing financial information for reporting purposes.

Members are:

- Kate Thomson (Chair)
- Denise Church
- Quentin Hix (until February 2020)
- Richard Gill (from May 2020).

People, Performance and Remuneration Committee

The objective of this committee is to assist the Board in discharging its responsibilities in relation to overseeing ESR's people and performance strategies, principles and frameworks that support a high-performance culture, including the remuneration of the Chief Executive and ESR staff.

Members are:

- Dr Helen Darling (Chair until September 2019)
- Prof Cristin Print (Chair and member from September 2019)
- Denise Church
- Richard Gill (until June 2020)
- Andy Shenk (from June 2020).

Dividends

No dividends have been declared or paid in respect of the 2020 financial year.

Donations

Koha and donations totalling $1,960 were made during the year.

Directors' disclosure of interests

Directors complete a declaration of interests at the start of their appointment.

At each Board meeting, the directors are asked to check and update (as necessary) the register of interests declared that the Board secretariat maintains. Declaration of interests is a standing item on the agendas for all Board and Board committee meetings. Any changes to Board members' interests are tabled and reviewed at the opening of every Board meeting.

For Board decisions relating to significant matters, any potential conflict issues are discussed with the Office of the Auditor-General, or independent legal advice is sought with the previous approval of the Board Chair at ESR's expense.

Directors' interests

No director held any interest in the shares of ESR. ESR has funding contracts with the Marsden Fund of the Royal Society and the Ministry of Business, Innovation and Employment, which are negotiated at arm's length with appropriate directors' interests being declared. Except for these contracts, no material contracts involving directors' interests were entered into during, or subsequent to, the period covered by this report.

As at 30 June 2020, the following directors had made the following general disclosures:

Denise Church (Chair)

Director and Shareholder, Leadership Matters Limited

Member, National Board, Scouts New Zealand

Trustee, Scout Youth Foundation, including related appointments to SANZ Trustee Company Limited *(Director)*

Brookwood Estate Ltd *(Director) (Lorna Maisie Eade Memorial Trust)*

Te Roto Ltd *(Director) (Mathias Paulson Memorial Trust)*

Jack and Tui Lucas Trust

Tatum Scout Memorial Trust

Director, Predator Free Wellington Ltd

Chair, Airways NZ

Chair, Trustee, J Illott Trust

President, Rotary Club of Wellington

Member, CoRE Review Advisory Committee.

Richard Gill

Director, shareholder and CEO, Cloud M Limited

Director and shareholder, Richard Gill Limited

Director, Richard Gill Trustees Limited

Director and shareholder, Sumfood Limited

Director and President, Blerter Inc.

Cristin Print

Member, Science Leadership Team of Genomics Aotearoa

Professor, Dept of Molecular Medicine and Pathology, The University of Auckland, and lead of The University of Auckland Genomics Into Medicine programme

Standing member, Assessment Committee of the Cancer Research Trust New Zealand

Principal investigator, Maurice Wilkins Centre

Member, New Zealand eScience Infrastructure Research Reference Group

Chair, Auckland Regional Biobank Scientific Advisory Board *(working in the COVID-19 biobanking field in which ESR also works)*

Research collaboration with LabPlus clinical laboratories in the Auckland District Health Board research involving microbiological collections for *N. gonorrhoeae, Tuberculosis sp.* and *Acientobacter sp.*

Co-leader, MBIE/Genomics Aotearoa Precision Medicine Pathfinder Project *(including planned collaboration with ESR staff)*

Scientific director for solid tumours, Grafton Clinical Genomics

HRC-funded project in collaboration with Dr Siouxsie Wiles to identify antibiotic resistance genes in sewage *(an area in which ESR is also active)*

Member, Genomics Aotearoa project for 'graph-based' genome alignment.

Andrew Shenk

Chief Executive, Auckland UniServices Limited

Director, The Icehouse Limited

Advisor, Zino Ventures Limited

Advisor, Matū Fund Limited

Advisor, 88Kiwis Limited

Director, Hop Revolution Limited

Director, Hop Garden Services Limited

Director, Hop Revolution Trading Company Limited.

Kate Thomson

Director, IRSM

Shareholder, Dandaloo Farming Company Limited

General Manager, Te Aka Matua o te Ture – Law Commission

Independent member, Indigo Shire Council Audit and Risk Committee Board, Endangered Species Foundation New Zealand.

Directors' indemnity

ESR has arranged for directors' and officers' insurance for any act or omission in their capacity as a director of the company.

Disclosure of Directors' and executive employees' remuneration

Directors' remuneration

As at 30 June 2020, the Directors who held office in the period of this report and their total remuneration and other benefits were:

Directors' remuneration

Denise Church *(Chair)*	$48,064
Cristin Print *(People, Performance and Remuneration Chair)*	$24,032
Kate Thomson *(Audit and Risk Chair)*	$24,032
Richard Gill	$24,032
Andrew Shenk	$24,032
Quentin Hix *(Deputy Chair, retired 29 February 2020)*	$20,027
Dr Helen Darling *(retired 30 September 2019)*	$6,008
Total	$170,227

Chief Executive's remuneration

The remuneration of our Chief Executive is reviewed annually by the Board and is determined by a range of factors including advice from external remuneration specialists, including job sizing and market relativity exercises. These are also undertaken on a regular basis and drawn on to inform the determination of salary package.

Chief Executive remuneration summary 2016–2020

Financial year	Salary [a]	STI [b]	Percentage STI against maximum	Benefits [c]	Total
2020	$508,210	n/a	n/a	$533	$508,743
2019	$394,746	$89,200	81%	$599	$484,545
2018	$379,256	$80,000	73%	$644	$459,900
2017	$359,086	$95,000	100%	$523	$454,609
2016	$345,501	$55,250	85%	$470	$401,221

[a] *CE remuneration in 2020 did not include an STI component.*

[b] *Short-term incentives (STI) are shown for the year to which they relate but were unpaid as at that balance date.*

[c] *Benefits comprise insurance cover.*

Senior Leadership Team remuneration

The total combined remuneration of our Senior Leadership Team (excluding the Chief Executive's remuneration) from 2016–2020 was:

Senior Leadership Team remuneration summary 2016–2020			
Financial Year	Salary & STI [a]	Benefits [b]	Total
2020	$1,463,900	$42,189	$1,506,089
2019	$1,827,863	$55,489	$1,883,352
2018	$1,681,556	$45,248	$1,726,804
2017	$1,587,967	$40,664	$1,628,631
2016	$1,359,914	$55,768	$1,415,682

[a] *SLT remuneration in FY20 did not include an STI component. Short-term incentives (STI) are shown for the year to which they relate but were unpaid as at that balance date*

[b] *Benefits comprise insurance and employer Kiwisaver contributions*

Employee remuneration

As at 30 June 2020, the following total remuneration above $100,000 was paid to 134 employees:

Remuneration range	No. of staff
$100,000–$109,999	39
$110,000–$119,999	27
$120,000–$129,999	17
$130,000–$139,999	9
$140,000–$149,999	13
$150,000–$159,999	7
$160,000–$169,999	3
$170,000–$179,999	6
$180,000–$189,999	3
$200,000–$209,999	1
$220,000–$229,999	1
$240,000–$249,999	1
$250,000–$259,999	2
$260,000–$269,999	1
$270,000–$279,999	1
$290,000–$299,999	1
$300,000–$309,999	1
$590,000–$599,999 *	1
Total	134

* *The remuneration paid during FY20 is higher than the total value of the FY20 salary package (as shown on page 64) because it includes the payment of the FY19 STI.*

Strategic Science Advisory Panel

Our Strategic Science Panel (SSAP) is appointed by our Board. The primary role of the panel is to provide independent, high-level strategic advice to the Board and management relating to our science, research, and innovation activities. This advice will assist us to identify any gaps in our activities and the place of these activities within the context of international best practice. The SSAP will also provide comment on the competitiveness and quality of our science activities with suggestions for improvement and any other matters as agreed with the Board.

Members are:

Dr Ian Elsum, Australian National University

Dr Ian Elsum (PhD, BSc Hons) is an honorary Associate Professor, Research School of Management, at the Australian National University and an Adjunct Professor in the Centre for Transformative Innovation at Swinburne University of Technology. His research and teaching are focused on the management of innovation. He is a member of Innovation Research Interchange (previously the Industrial Research Institute), where he has co-chaired projects to improve the management of radical/breakthrough innovation and the challenges of business model innovation in established firms. Past positions include 28 years with The Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO), where he gained extensive experience in the strategic management of applied research and membership of a number of boards and advisory committees in the area of science and technology-based innovation. Before joining CSIRO, Ian carried out fundamental research in chemistry at universities in Australia and the United States of America.

Dr Elizabeth Jazwinska, independent Board member and science advisor

Dr Liz Jazwinska (PhD, MBA, GAICD, BSc Hons) has more than 30 years' experience in research and development (R&D) management and business development and has held senior positions in academia, industry and government internationally. Liz is currently an independent board member and science advisor to various boards in both Australia and New Zealand. In this role, she focuses on growing strategic R&D partnerships between academic groups, industry and government, focusing on increasing the impact of research outcomes through translation into commercial products. Liz has held senior leadership positions at Monash University (Director, Business Development), RMIT University (Director Research, Innovation and Entrepreneurship), Agency for Science, Technology and Research (A*STAR) in Singapore (Director Industry Engagement), the Ministry of Science and Innovation in New Zealand (Deputy Chief Executive Science Strategy and Investment), the Australian Research Council (Executive Director Biological Sciences and Biotechnology) and Johnson & Johnson Research (Executive Director, Strategic Alliances). She founded the molecular diagnostics company SpeeDx and established and chaired the Governance Board of the Australian Phenomics Network, a National Collaborative Research Infrastructure Strategy-funded infrastructure facility supporting phenomics research for national and international research and industry users.

Before joining the industry, Liz established a substantial academic portfolio in human molecular genetics and authored more than 62 publications in high-ranking peer-reviewed journals. She holds a BSc (Hons) from the University of Aberdeen, a PhD from the University of Edinburgh and an MBA from the Australian Graduate School of Management. She is also a graduate of the Australian Institute of Company Directors.

Professor Bruce Weir, University of Washington

Professor Bruce Weir (PhD, BSc Hons) is Professor of Biostatistics and Adjunct Professor of Epidemiology and of Genome Sciences at the University of Washington, Seattle, United States of America. He is also Director of the Institute of Public Health Genetics and of the Genetic Analysis Center at that university. He has a BSc (Hons) with First Class Honours in mathematics from the University of Canterbury and a PhD in statistics, with a minor in genetics, from North Carolina State University. He is a Fellow of the American Association for the Advancement of Science, the American Academy of Forensic Sciences and the American Statistical Association and an Honorary Fellow of the Royal Society Te Apārangi. Bruce has held numerous editorial positions with journals in genetics, statistics, biometrics, heredity and epidemiology. He has supervised more than 35 PhD students. His research interests are in statistical genomics, with applications to human disease studies and forensic science. He has published more than 200 peer-reviewed journal articles, which have gathered over 75.000 citations. He is author of the textbook *Genetic Data Analysis* and co-author of *Interpreting DNA Evidence.* For the past 25 years, he has directed the annual Summer Institute in Statistical Genetics (SISG).

Our Senior Leadership Team

ESR's Senior Leadership Team (SLT) use their science and business expertise to provide strategic and operational advice and support to the ESR Board and its committees. The role of the Chief Executive and ESR's SLT is to manage the day-to-day operations of ESR on behalf of the Board and the shareholding Ministers. The period from July 2019 to the present has been one of significant transition, with ESR's long-standing CE Dr Keith McLea leaving in early July 2020 and our new CE Peter Lennox arriving.

Dr Keith McLea, Chief Executive (Chief Executive until 10 July 2020)

Dr Keith McLea was ESR's Chief Executive from July 2014 until 10 July 2020. He has worked across a number of government ministries, providing strategic and policy advice. Keith has a PhD in human genetics and has trained as a toxicologist. Keith has spent much of his professional career working in the personal injury insurance and injury prevention sectors and has been a Director at Cranleigh Strategic Limited.

Peter Lennox, Chief Executive (from August 2020)

Peter Lennox took up the role of Chief Executive at ESR in August 2020. Peter brings with him many years of experience working in global biotechnology and meteorology sectors, as well as a well-balanced blend of commercial and scientific disciplines.

Born in Northern Ireland, Peter spent much of his early working life in Scotland, where he was the director of biotechnology networks for Scottish Enterprise, the national economic development agency of Scotland, from 1999 to 2002. After emigrating to New Zealand in 2010, Peter took up the post of Director for Industry New Zealand's biotechnology sector.

From 2011 to 2020, he was the Chief Executive of MetService and its international subsidiary MetraWeather. During his tenure at MetService, he was New Zealand's designated Permanent Representative with the United Nations World Meteorological Organization (WMO).

Peter has post-graduate degrees in biochemistry and biological sciences from Queen's University (Belfast) and Heriot-Watt University (Edinburgh), as well as an MBA in finance and strategy from the University of Glasgow. He has also studied at the London Business School.

Amber McEwen, General Manager Business Services

Amber McEwen has over 20 years' experience in business-to-business service industries, with a proven track record in generating revenues and creating brand differentiation through the development, implementation and management of services over networks ranging from telecommunication to energy. Recently returned from the United Kingdom, Amber held the role of Marketing Director at UK energy company SSE plc. Before that, she worked for Vodafone, where she had responsibility for product, strategy and planning and service delivery.

Her expertise covers the entire customer lifecycle from brand and proposition, development, design and implementation of globally managed services frameworks to ensure customer expectations are met and maintained. Amber says her key strength is her ability to see the big picture, design the appropriate strategy and then convert this vision into reality.

Dr Libby Harrison, General Manager Health and Environment

Dr Libby Harrison held various consulting and management roles before joining ESR, including serving as General Manager at both Manaaki Whenua / Landcare Research and the Environmental Protection Authority. Originally from the United Kingdom, Libby earned her PhD in insect pest control from University College London (UCL).

John Bone, General Manager Forensics

John Bone's passion for technical innovation, customer relationships and commercial enterprise has been applied to a number of roles across the commercial sector, including chemical, oil, technology and telecommunications. John oversees all of ESR's forensic business group activities.

Dr Brett Cowan, Chief Scientist, General Manager Research and Commercialisation

Brett Cowan has a diverse background including an honours degree in mechanical engineering, registration as a medical practitioner, studies in theology and ancient history, and an MBA from The University of Auckland.

Brett was previously the General Manager of Business at Auckland UniServices Limited, the commercial arm of The University of Auckland. Prior to this he was Associate Professor and Head of Radiology also at The University of Auckland where he set up and directed the internationally

recognised Centre for Advanced MRI. He has published over 100 peer-reviewed papers in clinical trials, medical imaging, machine learning and computational modelling, and is the recipient of over 30 academic and business awards, including innovation in medicine for neurosurgical equipment and medical diagnostic software. He practiced emergency medicine for over a decade and remains a New Zealand registered medical practitioner.

Based at the Mt Albert science centre, Brett is responsible for overall science and research strategy and commercialisation for ESR.

Trish Bolger, General Manager People, Culture and Communications

Trish Bolger has a broad human resources background and brings with her considerable management experience in this area. Trish's philosophy is that data and evidence should drive the strategic agenda for a business and its people. Before joining ESR in 2018, Trish was General Manager, People, at the New Zealand Racing Board. Previously her HR management roles included working at Phillips Consumer Electronics in the Netherlands, the ANZ Banking Group (New Zealand) and KPMG New Zealand. She has a master's degree in industrial and organisational psychology. Trish manages her own 17-acre olive grove, which has produced award-winning olive oil.

Deidre Hill, General Manager Strategy and Transformation

Deidre Hill is a senior leader with extensive experience in reputation management, crisis and issues management, strategy development and communications strategy and delivery, including stakeholder and community engagement programmes. Deidre is also an experienced mentor and coach. She has been an independent management and communication consultant, providing management and strategic communications counsel to public and private sector clients, with a focus on leading and communicating strategy, change management and functional reviews. She has held previous director roles in marketing and communications and strategy development.

Jymal Morgan, General Manager Māori Impact

Tangata i ākona ki te kāinga, tūngia ki te ao, tau ana

An individual versed in their own customs, rooted in the depth of their own values, will excel and succeed no matter the situation.

Jymal comes to the role of General Manager Māori Impact Group as an experienced professional leading our organisational drive to re-orientate and support increased impact with Māori through investment in, with and alongside Māori. This will be a culture shift in terms of our way of thinking and behaving to ensure our culture responds explicitly to the aspirations and needs of Māori communities and makes the space for Māori to lead. With 15 years' experience in science, research and innovation, Jymal works with and alongside Māori organisations at the interface of the wider economy to create sustainable futures, mō tātou ā mō ka uri ā muri ake nei, for us and for those who come after. He is passionate about advancing Aotearoa New Zealand's social, cultural and economic prosperity through leveraging the cultural assets of both Māori and non-Māori.

Jymal is a graduate of Te Panekiretanga o te Reo Māori (Institute of Excellence in Māori Language) and holds post-graduate qualifications in Development Studies and Strategic Management from the University of Waikato. He has attended executive courses at Sloan Management School – Massachusetts Institute of Technology and Stanford Woods institute for the Environment, and has a growing catalogue of governance and advisor roles across the Māori economy sector.

Financial statements

Financial statements

Contents

Independent auditor's report 71

Financial statements 74

Statement of Profit or Loss and Other Comprehensive Income 74

Statement of Changes in Equity 75

Statement of Financial Position 76

Statement of Cash Flows 77

Notes to the Financial Statements (notes 1–21) 78

Statement of responsibility 100

Independent auditor's report

To the readers of the Institute of Environmental Science and Research Limited's Group financial statements for the year ended 30 June 2020

The Auditor-General is the auditor of the Institute of Environmental Science and Research Limited and its subsidiaries (the Group). The Auditor-General has appointed me, Christopher Ussher, using the staff and resources of PricewaterhouseCoopers, to carry out the audit of the financial statements of the Group on his behalf.

Opinion

We have audited the financial statements of the Group on pages 74 to 99, that comprise the statement of financial position as at 30 June 2020, the statement of profit or loss and other comprehensive income, statement of changes in equity and statement of cash flows for the year ended on that date and the notes to the financial statements that include a statement of significant accounting policies and other explanatory information.

In our opinion, the financial statements of the Group:

- present fairly, in all material respects:
  - its financial position as at 30 June 2020; and
  - its financial performance and cash flows for the year then ended; and
- comply with generally accepted accounting practice in New Zealand in accordance with New Zealand Equivalents to International Financial Reporting Standards and International Financial Reporting Standards.

Our audit was completed on 27 August 2020. This is the date at which our opinion is expressed.

The basis for our opinion is explained below, and we draw your attention to a matter. In addition, we outline the responsibilities of the Board of Directors and our responsibilities relating to the financial statements, we comment on other information, and we explain our independence.

Emphasis of matter – Impact of COVID-19

Without modifying our opinion, we draw attention to notes 2, 8, 12 and 15 to the financial statements, which explain the impact of the COVID-19 pandemic on the Group. Primarily revenue from the Group's commercial science research and services was negatively impacted. This revenue reduction was offset by the increase in revenue generated from services provided to the Ministry of Health to support their work on the pandemic and from the COVID-19 Response and Recovery Funding provided by the Government. In addition, there was an income tax change which reinstated tax depreciation on buildings resulting in a decrease in the Group's deferred tax liability.

Basis for our opinion

We carried out our audit in accordance with the Auditor-General's Auditing Standards, which incorporate the Professional and Ethical Standards and the International Standards on Auditing (New Zealand) issued by the New Zealand Auditing and Assurance Standards Board. Our responsibilities under those standards are further described in the Responsibilities of the auditor section of our report.

We have fulfilled our responsibilities in accordance with the Auditor-General's Auditing Standards.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Responsibilities of the Board of Directors for the financial statements

The Board of Directors is responsible on behalf of the Group for preparing financial statements that are fairly presented and that comply with generally accepted accounting practice in New Zealand.

PricewaterhouseCoopers, PwC Centre, 10 Waterloo Quay, PO Box 243, Wellington 6140, New Zealand
T: +64 4 462 7000, pwc.co.nz

The Board of Directors is responsible for such internal control as it determines is necessary to enable it to prepare financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, the Board of Directors is responsible on behalf of the Group for assessing the Group's ability to continue as a going concern. The Board of Directors is also responsible for disclosing, as applicable, matters related to going concern and using the going concern basis of accounting, unless the Board of Directors has to cease operations, or has no realistic alternative but to do so.

The Board of Directors' responsibilities arise from the Crown Research Institutes Act 1992.

Responsibilities of the auditor for the audit of the financial statements

Our objectives are to obtain reasonable assurance about whether the financial statements, as a whole, are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion.

Reasonable assurance is a high level of assurance, but it is not a guarantee that an audit carried out in accordance with the Auditor-General's Auditing Standards will always detect a material misstatement when it exists. Misstatements are differences or omissions of amounts or disclosures and can arise from fraud or error. Misstatements are considered material if, individually or in the aggregate, they could reasonably be expected to influence the decisions of readers taken on the basis of these financial statements.

For the budget information reported in the financial statements, our procedures were limited to checking that the information agreed to the Group's statement of corporate intent.

We did not evaluate the security and controls over the electronic publication of the financial statements.

As part of an audit in accordance with the Auditor-General's Auditing Standards, we exercise professional judgement and maintain professional scepticism throughout the audit. Also:

- We identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- We obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances but not for the purpose of expressing an opinion on the effectiveness of the Group's internal control.
- We evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by the Board of Directors.
- We conclude on the appropriateness of the use of the going concern basis of accounting by the Board of Directors and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the Group's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the Group to cease to continue as a going concern.
- We evaluate the overall presentation, structure and content of the financial statements, including the disclosures and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

- We obtain sufficient appropriate audit evidence regarding the financial statements of the entities or business activities within the Group to express an opinion on the consolidated financial statements. We are responsible for the direction, supervision and performance of the Group audit. We remain solely responsible for our audit opinion.

We communicate with the Board of Directors regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

Our responsibilities arise from the Public Audit Act 2001.

Other Information

The Board of Directors is responsible for the other information. The other information includes the information included on pages 1 to 70 and 100 to 101, but does not include the financial statements, and our auditor's report thereon.

Our opinion on the financial statements does not cover the other information and we do not express any form of audit opinion or assurance conclusion thereon.

In connection with our audit of the financial statements, our responsibility is to read the other information. In doing so, we consider whether the other information is materially inconsistent with the financial statements or our knowledge obtained in the audit, or otherwise appears to be materially misstated. If, based on our work, we conclude that there is a material misstatement of this other information, we are required to report that fact. We have nothing to report in this regard except that not all other information was available to us at the date of signing.

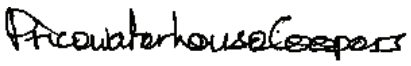
Independence

We are independent of the Group in accordance with the independence requirements of the Auditor-General's Auditing Standards, which incorporate the independence requirements of Professional and Ethical Standard 1: International Code of Ethics for Assurance Practitioners issued by the New Zealand Auditing and Assurance Standards Board.

Other than the audit, we have no relationship with, or interests in, the Group.

Christopher Ussher

On behalf of the Auditor-General Wellington, New Zealand



PricewaterhouseCoopers

Statement of Profit or Loss and Other Comprehensive Income

For the year ended 30 June 2020

Group	Note	Group Actual 2020 $'000s	Group Budget 2020 unaudited $'000s	Group Actual 2019 $'000s
Revenue				
Operating revenue	2	74,516	73,635	69,350
Strategic science investment funding		9,234	9,234	9,234
		83,750	**82,869**	**78,584**
Operating expenses				
Scientific materials		6,733	6,600	5,604
Subcontracting, commissions and royalties		8,570	9,106	8,554
Personnel		43,999	44,178	41,566
Depreciation and amortisation	5/6	7,032	6,932	5,706
Other expenses	3	16,003	16,542	15,281
		82,337	**83,358**	**76,711**
Operating profit		**1,413**	**(489)**	**1,873**
Interest income		876	770	863
Finance expense		(28)	(1)	(10)
Share of net loss of associate accounted for using the equity method	15	(64)	–	(57)
		784	**769**	**796**
Profit before income tax expense		**2,197**	**280**	**2,669**
Income tax (benefit) / expense	4	(447)	78	811
Profit for the period attributable to the shareholder of the parent		**2,644**	**202**	**1,858**
Other comprehensive income		–	–	–
Total profit or loss and other comprehensive income for the period attributable to the shareholder of the parent		**2,644**	**202**	**1,858**

The accompanying notes form an integral part of these financial statements.

Statement of Changes in Equity

For the year ended 30 June 2020

Group	Share capital $'000s	Retained earnings $'000s	Total equity $'000s
Balance at 30 June 2018	**8,494**	**45,776**	**54,270**
Change in accounting policy NZ IFRS 15	–	189	189
Restated total equity at the beginning of the financial year	**8,494**	**45,965**	**54,459**
Profit for the period	–	1,858	1,858
Other comprehensive income	–	–	–
Total comprehensive income	**–**	**1,858**	**1,858**
Transactions with owners:			
Dividend	–	–	–
Balance at 30 June 2019	**8,494**	**47,823**	**56,317**
Balance at 30 June 2019	**8,494**	**47,823**	**56,317**
Profit for the period	–	2,644	2,644
Other comprehensive income	–	–	–
Total comprehensive income	**–**	**2,644**	**2,644**
Transactions with owners:			
Dividend	–	–	–
Balance at 30 June 2020	**8,494**	**50,467**	**58,961**

The accompanying notes form an integral part of these financial statements.

Statement of Financial Position

As at 30 June 2020

Group	Note	Group Actual 2020 $'000s	Group Budget 2020 unaudited $'000s	Group Actual 2019 $'000s
Non-current assets				
Property, plant and equipment	5	29,047	31,741	29,933
Right-of-use assets	7	1,334	–	–
Investments accounted for using the equity method	15	228	490	442
Other investments		30	30	30
Investment cash		5,000	8,000	8,000
Intangible assets	6	7,459	8,798	8,485
		43,098	**49,059**	**46,890**
Current assets				
Cash and cash equivalents		3,333	634	509
Investment cash		24,000	17,000	22,000
Trade and other receivables	8	10,447	8,500	8,680
Contract assets	2	1,052	–	626
Inventories – scientific materials and consumables		889	1,100	1,042
Income tax receivable		–	408	–
		39,721	**27,642**	**32,857**
Current liabilities				
Trade and other payables	9	7,871	7,700	7,659
Contract liabilities	2	5,717	5,000	6,439
Employee benefits	10	4,441	3,600	3,778
Lease liability	7	578	–	–
Income tax payable	11	1,438	–	479
		20,045	**16,300**	**18,355**
Net current assets		**19,676**	**11,342**	**14,502**
Non-current liabilities				
Lease liability	7	768	–	–
Employee benefits	10	1,886	1,500	1,688
Deferred taxation	12	1,159	3,700	3,387
		3,813	**5,200**	**5,075**
Net assets		**58,961**	**55,201**	**56,317**
Equity				
Share capital	13	8,494	8,494	8,494
Retained earnings		50,467	46,707	47,823
Total equity		**58,961**	**55,201**	**56,317**

The Board of Directors of the Institute of Environmental Science and Research Limited authorised these financial statements for issue on 25 August 2020. On behalf of the Board:

Denise Church QSO Chair

Cris Print Deputy Chair

The accompanying notes form an integral part of these financial statements.

Statement of Cash Flows

For the year ended 30 June 2020

Group	Note	Group Actual 2020 $'000s	Group Budget 2020 unaudited $'000s	Group Actual 2019 $'000s
Cash flows from/(used in) operating activities				
Cash was provided from:				
Customers and strategic science investment funding		81,749	82,868	81,830
Interest received		876	770	598
		82,625	**83,638**	**82,428**
Cash was applied to:				
Suppliers and employees		(73,960)	(76,425)	(70,141)
Interest paid		(1)	(1)	(9)
Income tax paid	11	(823)	(52)	(1,573)
		(74,784)	**(76,478)**	**(71,723)**
Net cash inflow from operating activities	14	**7,841**	**7,160**	**10,705**
Cash flows from/(used in) investing activities				
Cash was provided from:				
Term deposit maturities		22,000	–	20,000
		22,000	**–**	**20,000**
Cash was applied to:				
Purchase of property, plant and equipment		(4,477)	(5,934)	(3,820)
Purchase of intangible assets		(948)	(2,007)	(1,028)
Investments		–	–	(240)
Investment in term deposits		(21,000)	–	(26,000)
		(26,425)	**(7,941)**	**(31,088)**
Net cash outflow from investing activities		**(4,425)**	**(7,941)**	**(11,088)**
Cash flows from/(used in) financing activities				
Cash was provided from/applied to:				
Repayment of finance lease liabilities		(592)	–	(68)
Net cash outflow from financing activities		**(592)**	**–**	**(68)**
Net increase/decrease in cash held		**2,824**	**(781)**	**(451)**
Cash and cash equivalents at the beginning of the period		509	1,415	960
Cash and cash equivalents at the end of the period		**3,333**	**634**	**509**

The accompanying notes form an integral part of these financial statements.

Notes to the financial statements

1. Statement of significant accounting policies

Reporting entity

These financial statements of the Institute of Environmental Science and Research Limited (the 'Parent') and its subsidiaries ('ESR' and the 'Group') are for the year ended 30 June 2020.

ESR is a Crown entity incorporated and based in New Zealand. Its registered office is 34 Kenepuru Drive, Porirua.

ESR is a Crown research institute that provides specialist scientific services and research to the public health, food safety, security and justice systems, and the environmental sector.

Statement of compliance

The financial statements have been prepared in accordance with the requirements of the Crown Entities Act 2004, the Crown Research Institutes Act 1992, the Companies Act 1993 and the Financial Reporting Act 2013.

These financial statements have been prepared in accordance with Generally Accepted Accounting Practice in New Zealand (NZ GAAP). They comply with New Zealand equivalents to International Financial Reporting Standards (NZ IFRS), International Financial Reporting Standards and other New Zealand accounting standards and authoritative notices as appropriate for for-profit entities.

Basis of preparation

The financial statements are prepared on the basis of historical cost, except for financial instruments and long-service leave as identified in the specific accounting policies and accompanying notes.

The financial statements are presented in New Zealand dollars and all values are rounded to the nearest thousand dollars ($000).

The budget and target figures presented in these financial statements are unaudited.

Critical accounting estimates and judgements

The preparation of financial statements requires judgements, estimates and assumptions that affect the application of policies and reported amounts of assets and liabilities, income and expenses. The estimates and associated assumptions are based on historical experience and various other factors that are believed to be reasonable under the circumstances. Actual results may differ from these estimates. The estimates and assumptions are reviewed on an on-going basis.

The judgements that have the most significant effect on amounts recognised in the financial statements are applied in the determination of revenue, service leave accrual and investments accounted for using the equity method.

Strategic science investment funding

ESR receives strategic science investment funding from the government in order to perform scientific research activities. Strategic science investment funding is treated as a government grant and recognised at fair value in the statement of profit or loss and other comprehensive income when the requirements under the funding agreement have been met.

Inventories

Stocks of consumables and work in progress are stated at the lower of cost and net realisable value. Cost is determined on a first-in, first-out basis.

Interest income

Interest income is recognised in the statement of profit or loss and other comprehensive income on a time proportion basis, using the effective interest rate method.

Foreign currency

Items included in the financial statements of each of the Group's entities are measured using the currency of the primary economic environment in which the entity operates. The Group financial statements are presented in New Zealand dollars, which is ESR's functional currency.

Foreign currency transactions are recorded at the foreign exchange rates in effect at the dates of the transactions. Monetary assets and monetary liabilities denominated in foreign currencies are translated at the rates of exchange ruling at the end of each reporting period.

Other accounting policies

Other significant accounting policies adopted in the preparation of these financial statements are provided throughout the notes to the financial statements.

Changes in accounting policies

Accounting policies have been applied on a basis consistent with the prior year except where they are impacted by the adoption of NZ IFRS 16 *Leases* (NZ *IFRS* 16). The nature and effect of the changes resulting from the adoption of NZ IFRS 16 are described below.

NZ IFRS 16 Leases

NZ IFRS 16 replaces NZ IAS 17 *Leases* (NZ IAS 17), NZ IFRIC 4 *Determining whether an Arrangement contains a Lease* (NZ IFRIC 4), NZ SIC 15 *Operating Leases-Incentives* and NZ SIC 27 *Evaluating the Substance of Transactions Involving the Legal Form of a Lease.* The new standard has been applied using the modified retrospective approach. There was no adjustment required to the opening balance of retained earnings for the current period when adopting NZ IFRS 16. Prior periods have not been restated.

For contracts in place at the date of initial application, 1 July 2019, the Group has elected to apply the definition of a lease from NZ IAS 17 and NZ IFRIC 4.

Instead of performing an impairment review on the right-of-use assets at that date of initial application, the Group has relied on its historic assessment as to whether leases were onerous immediately before the date of initial application of NZ IFRS 16.

On transition, for leases previously accounted for as operating leases with a remaining lease term of less than 12 months and for leases of low-value assets, the Group has applied the optional exemptions to not recognise right-of-use assets but to account for the lease expense on a straight-line basis over the remaining lease term.

As at 1 July 2019, the right-of-use assets are measured as the amount equal to the lease liability.

On transition to NZ IFRS 16, the weighted average incremental borrowing rate applied to lease liabilities recognised under NZ IFRS 16 was 1.7%.

The Group has benefited from the use of hindsight for determining lease term when considering options to extend and terminate leases.

The lease liabilities as at 1 July 2019 can be reconciled to the operating lease commitments as at 30 June 2019 as follows:

Group	**$'000s**
Operating lease commitments as at 30 June 2019	454
Weighted average incremental borrowing rate as at 1 July 2019	1.7%
Discounted operating lease commitments at 1 July 2019	446
Add: Leases not recognised as at 30 June 2019	1,463
Lease liabilities as at 1 July 2019	**1,909**

Adoption status of relevant new financial reporting standards and interpretations

The Group has elected not to early adopt any other new standards and amendments to existing standards that have been issued as at 30 June 2020 but are not yet effective. It is anticipated that these standards will not significantly affect the financial statements of the Group once adopted.

2. Operating revenue

a) Total operating revenue

COVID-19

On 11 March 2020, the World Health Organization declared coronavirus (COVID-19) a pandemic. The New Zealand government created the COVID-19 Alert System in response to the pandemic and placed the country at alert level 4 of this response system on 25 March 2020. This put the country into lockdown, requiring all businesses that were not deemed essential services to close, and placed severe restrictions on travel and public gatherings. Aspects of the Group's operations were deemed essential services: the provision of forensic science services to the New Zealand Police and sample testing, analysis and advice relating to COVID-19 for the Ministry of Health. On 28 April 2020, the New Zealand government moved the country from level 4 to level 3 of the alert system, reducing some of the restrictions on business operations and travel. At this time, the other Group operations were able to re-commence.

Outside of essential services, the Group had significantly limited operations during level 4 and had continued limitations in place at level 3. This had the greatest impact on the sale of the Group's forensic analysis software and the provision of science services, including training, water quality, radiation monitoring, forensic science, drug testing and analysis, pharmaceutical testing, food chemistry and health science (including culture collection, legionella, virology and bacterial testing). Revenue from these services from commercial and government customers reduced by an estimated 2% compared to pre-COVID-19 expectations.

This revenue reduction was offset by the increase in revenue generated from the service provided to Ministry of Health for COVID-19 and COVID-19 Response and Recovery Funding provided by the government.

Some operating costs fell compared to pre-COVID-19 expectations due to a reduction in variable costs associated with lost revenue and much reduced travel, however, these reductions were more than offset by additional costs to deliver services to the Ministry of Health and COVID-19 related overhead costs.

The Group anticipates there will be a continued reduction in some revenue streams over at least the next 12 months.

Group	2020 $'000s	2019 $'000s
Revenue from contracts with customers	71,358	68,850
Other revenue	3,158	500
Total operating revenue	**74,516**	**69,350**

b) Revenue from contracts with customers

Revenue from contracts with customers is recognised when control of the goods or services is transferred to the customer at an amount that reflects the consideration to which the Group expects to be entitled in exchange for those goods or services.

For some contracts, revenue is recognised based on the actual service provided to the end of the reporting period as a proportion of the total services to be provided, as the customer receives and uses the benefits simultaneously or the Group has an enforceable right to payment for performance completed to date. The revenue recognised is typically determined based on actual labour hours and other costs incurred.

Estimates of revenues, costs or extent of progress toward completion are revised if circumstances change. Any resulting increases or decreases in estimated revenues or costs are reflected in profit or loss in the period in which the circumstances that give rise to the revision become known by management.

In case of fixed-price contracts, the customer pays the fixed amount based on payment schedule. If the services rendered by the Group exceed the payment schedule, a contract asset is recognised. If the payments exceed the services rendered, a contract liability is recognised.

Sale of software

The Group sells expert forensic analysis software. Contracts for the sale of this software comprise several deliverables: software license, software upgrades, training and support.

Revenue for each deliverable is recognised as the related performance obligation is satisfied, either at a point in time or over time. Revenue from software licenses and training is recognised at a point in time when, respectively, the customer has been provided with access to the software licenses and training has been delivered. Software upgrades and support revenues are recognised over time. Software upgrade revenue is recognised over time as the Group has a stand-ready obligation to provide software upgrades and enhancements as and when they are available. Software support revenue is recognised as the customer utilises the support purchased with the software license.

Invoicing or payment for software upgrades and support is generally made in advance of the satisfaction of these performance obligations. A contract liability is recognised to the extent payment received or due exceeds the services rendered by the Group.

The transaction price is allocated to each performance obligation based on the stand-alone selling price or estimated based on industry benchmarks.

Satisfaction of performance obligations

Revenue for contract deliverables is recognised as the related performance obligation is satisfied, either at a point in time or over time.

The Group has determined that the various deliverables included within a contract for the sale of forensic analysis software are capable of being distinct.

For the majority of other contract deliverables, the Group has concluded that the satisfaction of performance obligations occurs

over time. In these circumstances, the Group has determined that an input method is most appropriate in measuring progress on a contract as there is a direct relationship between the Group's effort (i.e., labour hours and other costs incurred) and the transfer of services to the customer. In these circumstances, the Group recognises revenue on the basis of labour hours expended and other costs incurred, relative to the total expected cost to complete the service.

Revenue from the balance of commercial and research activities is recognised at a point in time. This is the point at which the Group has determined it has transferred control of the related good or service to the customer.

Grant

During the 2020 financial year, the Ministry of Health funded the purchase of two items of scientific equipment to be used in relation to the response to COVID-19. This funding has been accounted for as a grant under NZ IAS 20 *Accounting for Government Grants and Disclosure of Government Assistance.* There are no conditions or other contingencies attached to this grant.

i) Disaggregated revenue information

Group – year ended 30 June 2020	**Domestic $'000s**	**International $'000s**	**Total $'000s**
Core government contracts	49,686	–	49,686
Research	5,883	2,226	8,109
Commercial products and services	4,355	9,208	13,563
	59,924	**11,434**	**71,358**

Group – year ended 30 June 2019	**Domestic $'000s**	**International $'000s**	**Total $'000s**
Core government contracts	47,068	–	47,068
Research	4,430	1,630	6,060
Commercial products and services	4,981	10,741	15,722
	56,479	**12,371**	**68,850**

Note that the overall research output of the Group includes activity funded by $9,234,000 (2019: $9,234,000) of Strategic Science Investment Funding. This funding is accounted for as a government grant and not included in the table above.

ii) Remaining performance obligations

The transaction price for bundled deliverables associated with software license sales is allocated to each performance obligation based on the stand-alone selling price or estimated based on industry benchmarks.

The transaction price allocated to the remaining performance obligations (unsatisfied or partially unsatisfied) was $15,942,000 as at 30 June 2020 (2019: $20,095,000), split between current and non-current as below:

	2020 $'000s	**2019 $'000s**
Current	8,186	9,175
Non-current	7,756	10,920
	15,942	**20,095**

The remaining performance obligations expected to be recognised in more than one year relate to multi-year research projects to be completed over the next five years and prepaid software upgrades. All other remaining performance obligations are expected to be recognised within one year.

The balance of current remaining performance obligations does not include obligations under contracts for periods of one year or less.

iii) Contract balances

Principal versus agent considerations

The Group has concluded that it is the principal in its revenue arrangements as it controls the goods or services before they are transferred to the customer.

Variable consideration

Where the consideration in a contract includes a variable amount arising from a value-based rebate, the Group estimates the amount of consideration to which it will be entitled in exchange for transferring the goods or services to the customer. The Group applies the most likely amount method to determine the amount to which it will ultimately be entitled.

Financing components

The Group does not have any contracts where the period between the transfer of the promised goods or services to the customer and payment by the customer exceeds one year. As a consequence, the Group does not adjust any of the transaction prices for the time value of money.

Group	2020 $'000s	2019 $'000s
Trade receivables	8,620	7,630
Contract assets	1,052	626
Contract liabilities	5,717	6,439

Trade receivables are non-interest bearing and generally on terms of 30–90 days.

Contract assets comprise revenue due from customers and capitalised costs of obtaining contracts for software sales:

- Revenue due from customers are balances recognised for services rendered where receipt of consideration is dependent on the completion of a project milestone and acceptance by the customer. Amounts initially recognised as contract assets are reclassified as trade receivables as milestones are completed and invoicing agreed with the customer.
- Incremental costs of obtaining contracts for software sales are $352,000 as at 30 June 2020 (2019: $405,000). These costs are initially capitalised and then amortised systematically as the related performance obligation is satisfied. Amortisation recognised in 2020 was $1,335,000 (2019: $1,807,000).

Contract liabilities represent amounts relating to research projects and software sales and support where the payment received or due under the contract exceeds the satisfaction of performance obligations by the Group. Contract liabilities are recognised as revenue when these performance obligations are satisfied.

The Group recognised revenue of $2,199,000 (2019: $4,058,000) during the period that was included in contract liabilities at the beginning of the period. No revenue was recognised in the period from performance obligations partially or fully satisfied in prior periods.

3. Other expenses

Group	Note	2020 $'000s	2019 $'000s
Bad debts written off		–	7
Communication costs (including network charges)		539	559
Depreciation expense on right-of-use assets		577	–
Directors' expenses		31	41
Directors' fees	17	170	198
Fair value loss/(gain) on forward exchange contract		35	(15)
Fees paid to PricewaterhouseCoopers for:			
– the audit of the statutory financial statements		141	146
– taxation compliance and advice		–	24
Impairment of investment		150	–
Impairment of receivables / (reversal of impairment)		48	(29)
IT systems maintenance and licence costs		1,901	1,764
Legal and consulting fees		3,641	2,563
Occupancy and insurance		3,334	3,004
Office and administration		1,325	1,499
Other operating costs		218	482
Outsourced costs		1,721	1,791
Rental and operating lease costs		146	759
Restructuring expense		307	178
Travel		1,719	2,310
Total other expenses		**16,003**	**15,281**

Given the nature of ESR's principal business activities, research comprises part of ESR's everyday business operations. As such, expenses relating to research are not separately identified. The cost of research to ESR is distributed between the relevant expense items, for example, employee benefits and scientific materials used.

4. Taxation

Group	Note	2020 $'000s	2019 $'000s
The taxation charge has been calculated as follows:			
Profit/(loss) before income tax expense		**2,197**	**2,669**
Prima facie taxation at 28%		615	747
Plus taxation effect of:			
Net prior years under/(over) estimation		26	–
Non-deductible/(assessable) items		136	64
Re-instatement of tax depreciation		(1,224)	–
Tax/(credit) expense for the year		**(447)**	**811**
The tax expense for the year is represented by:			
Current taxation	11	1,803	1,142
Deferred taxation	12	(2,250)	(331)
Tax/(credit) expense for the year		**(447)**	**811**

5. Property, plant and equipment

Items of property, plant and equipment are initially recorded at cost and subsequently at cost less accumulated depreciation and impairment. The cost of property, plant and equipment includes the value of consideration given to acquire the assets and the value of other directly attributable costs that have been incurred in bringing the assets to the location and condition necessary for their intended use.

The carrying amounts of property, plant and equipment are reviewed at least annually to determine if there is any indication of impairment. Where an asset's recoverable amount is less than its carrying amount, it will be reported as its recoverable amount and an impairment loss will be recognised.

Losses resulting from impairment are reported in the statement of profit or loss and other comprehensive income.

Realised gains and losses arising from the disposal of property, plant and equipment are recognised in the profit or loss and other comprehensive income in the periods in which the transactions occur.

Depreciation is charged on a straight-line basis at rates calculated to allocate the cost of an item of property, plant and equipment, less any estimated residual value, over its estimated useful life, as follows:

Type of asset	Estimated useful life
Land	Not depreciated
Freehold buildings and building fit out	1–50 years
Leasehold improvements	10 years
Plant, equipment and vehicles	3–10 years
IT equipment	3–12 years

Group	Freehold land	Buildings and leasehold improvements	IT equipment	Plant, equipment and vehicles	Assets under construction	Total
	$'000s	$'000s	$'000s	$'000s	$'000s	$'000s
At 1 July 2018						
Cost	476	31,855	8,015	35,139	351	75,836
Accumulated depreciation	–	(10,628)	(6,411)	(28,805)	–	(45,844)
Net book value at the end of the year	**476**	**21,227**	**1,604**	**6,334**	**351**	**29,992**
Year ended 30 June 2019						
Net book value at the beginning of the year	476	21,227	1,604	6,334	351	29,992
Additions	–	355	884	2,079	398	3,716
Transfers from assets under construction	–	–	353	–	(353)	–
Disposals	–	–	–	(5)	–	(5)
Depreciation for the year	–	(1,036)	(1,043)	(1,691)	–	(3,770)
Net book value at the end of the year	**476**	**20,546**	**1,798**	**6,717**	**396**	**29,933**
At 30 June 2019						
Cost	476	32,210	8,772	36,564	396	78,418
Accumulated depreciation	–	(11,664)	(6,974)	(29,847)	–	(48,485)
Net book value at the end of the year	**476**	**20,546**	**1,798**	**6,717**	**396**	**29,933**
Year ended 30 June 2020						
Net book value at the beginning of the year	476	20,546	1,798	6,717	396	29,933
Additions	–	976	1,400	1,502	302	4,180
Transfers from assets under construction	–	83	257	58	(398)	–
Disposals	–	–	–	(8)	–	(8)
Depreciation for the year	–	(2,196)	(1,133)	(1,729)	–	(5,058)
Net book value at the end of the year	**476**	**19,409**	**2,322**	**6,540**	**300**	**29,047**
At 30 June 2020						
Cost	476	33,269	10,429	37,751	300	82,225
Accumulated depreciation	–	(13,860)	(8,107)	(31,211)	–	(53,178)
Net book value at the end of the year	**476**	**19,409**	**2,322**	**6,540**	**300**	**29,047**

ESR does not have any property, plant and equipment used as security for liabilities.

ESR has plans to redevelop the Kenepuru Science Centre. Management has therefore reassessed the useful life of building and plant assets at this site and is accelerating depreciation on these assets to between one and five years. As at 30 June 2020, $1,155,000 additional depreciation has been expensed through the Statement of Profit or Loss and Other Comprehensive Income.

Restriction on title

In relation to the transfer of land owned by ESR, shareholding Ministers shall have regard to the principles of te Tiriti o Waitangi in accordance with section 10 of the Crown Research Institutes Act 1992.

Properties owned by ESR in Christchurch, Wellington and Auckland have caveats on the land as required by section 31 of the Crown Research Institutes Act 1992, which maintains the general provisions of the Public Works Act 1981. ESR complies with section 31 of the Crown Research Institutes Act 1992.

6. Intangible assets

Computer software

Items of computer software that do not comprise an integral part of the related hardware are treated as intangible assets with finite lives. Intangible assets with finite lives are recorded at cost and subsequently recorded at cost less any accumulated amortisation and impairment losses. Amortisation is charged to the statement of profit or loss and other comprehensive income on a straight-line basis over the useful life of the net asset (between 3 and 12 years).

Customer contracts

The intangible asset customer contracts present the fair value of future revenue streams from customer contracts acquired under business combinations. Initial recognition of the intangible asset is stated at fair value. Subsequent to initial recognition, acquired intangible assets are stated at initially recognised amounts less accumulated amortisation and any impairment. Amortisation of acquired intangible assets is made according to the straight-line method over their estimated useful life, not exceeding 10 years.

Research and development costs – internally generated intangible assets

Expenditure on research is expensed when it is incurred.

Development expenditure incurred on an individual project is capitalised if the process is technically and commercially feasible, future economic benefits are probable and ESR intends to, and has sufficient resources to, complete development and use or sell the asset.

Any expenditure capitalised is amortised over three years from the point the asset is ready to use, which is the point of expected future sales from the related project.

Impairment of non-financial assets

Intangible assets that have an indefinite useful life or intangible assets not yet ready to use are not subject to amortisation and are tested annually for impairment.

Assets that are subject to depreciation and amortisation are reviewed for impairment whenever events or changes in circumstances indicate that the carrying amount may not be recoverable. An impairment loss is recognised for the amount by which the asset's carrying amount exceeds its recoverable amount. The recoverable amount is the higher of an asset's fair value less costs to sell and its value in use. For the purposes of assessing impairment, assets are grouped at the lowest levels for which they are separately identifiable cash flows (cash-generating units).

Group	Computer software – externally purchased	Computer software – internally generated	Customer contracts	Assets under construction	Total
	$'000s	$'000s	$'000s	$'000s	$'000s
At 1 July 2018					
Cost	9,078	14,234	1,338	941	25,591
Accumulated amortisation and impairment losses	(7,786)	(7,074)	(1,338)	–	(16,198)
Net book value at the end of the year	**1,292**	**7,160**	**–**	**941**	**9,393**
Year ended 30 June 2019					
Net book value at the beginning of the year	1,292	7,160	–	941	9,393
Additions	347	19	–	662	1,028
Transfers from assets under construction	–	538	–	(538)	–
Disposals	–	–	–	–	–
Amortisation for the year	(519)	(1,417)	–	–	(1,936)
Net book value at the end of the year	**1,120**	**6,300**	**–**	**1,065**	**8,485**
At 30 June 2019					
Cost	9,419	14,791	1,338	1,065	26,613
Accumulated amortisation and impairment losses	(8,299)	(8,491)	(1,338)	–	(18,128)
Net book value at the end of the year	**1,120**	**6,300**	**–**	**1,065**	**8,485**
Year ended 30 June 2020					
Net book value at the beginning of the year	1,120	6,300	–	1,065	8,485
Additions	170	482	–	296	948
Transfers from assets under construction	–	434	–	(434)	–
Disposals	–	–	–	–	–
Amortisation for the year	(543)	(1,431)	–	–	(1,974)
Net book value at the end of the year	**747**	**5,785**	**–**	**927**	**7,459**
At 30 June 2020					
Cost	9,589	15,707	–	927	26,223
Accumulated amortisation and impairment losses	(8,842)	(9,922)	–	–	(18,764)
Net book value at the end of the year	**747**	**5,785**	**–**	**927**	**7,459**

ESR does not have any intangible assets for which title is restricted or used as security for liabilities.

Intangible assets include ESR's laboratory operating system with a net book value of $4,688,203 (2019: $5,656,000). The laboratory operating system has an estimated remaining useful life of four years.

7. Leases

The Group assesses at contract inception whether a contract is, or contains, a lease. That is, if the contract conveys the right to control the use of an identified asset for a period of time in exchange for consideration.

The Group applies a single recognition and measurement approach for all leases, except for short-term leases and leases of low-value assets. The Group recognises lease liabilities to make lease payments and right-of-use assets representing the right to use the underlying assets.

Right-of-use assets

The Group recognises right-of-use assets at the commencement date of the lease (i.e., the date the underlying asset is available for use). Right-of-use assets are measured at cost, less any accumulated depreciation and impairment losses and adjusted for any re-measurement of lease liabilities. The cost of right-of-use assets includes the amount of lease liabilities recognised, initial direct costs incurred and lease payments made at or before the commencement date less any incentives received. The recognised right-of-use assets are depreciated on a straight-line basis over the shorter of the assets estimated useful life and the lease term. Right-of-use assets are subject to impairment.

Lease liabilities

At the commencement date of the lease, the Group recognises the lease liabilities measured at the present value of lease payments to be made over the lease term.

In determining the non-cancellable term of a lease, the Group considers all relevant facts and circumstances that create an economic incentive for the lessee to either exercise an option to extend a lease or to terminate the lease.

In calculating the present value of lease payments, the Group uses the incremental borrowing rate at the lease commencement date if the interest rate implicit in the lease is not readily determinable. After the commencement date, the amount of lease liabilities is increased to reflect the accretion of interest and reduced for the lease payments made. In addition, the carrying amount of lease liabilities is re-measured if there is a modification, a change in the lease term or a change in the in-substance fixed lease payments.

Amounts recognised in the statement of financial position and statement of profit and loss and other comprehensive income

	Right-of-use assets			
	Buildings	Motor vehicles	Total	Lease liabilities
	$'000s	$'000s	$'000s	$'000s
As at 1 July 2019	**1,854**	**55**	**1,909**	**1,909**
Additions	2	–	2	2
Depreciation expense	(546)	(31)	(577)	–
Interest expense	–	–	–	27
Payments	–	–	–	(592)
As at 30 June 2020	**1,310**	**24**	**1,334**	**1,346**

The maturity of the lease liabilities is as follows:

Group	2020 $'000s
Less than one year	578
One to five years	768
Total lease liabilities	**1,346**

8. Trade and other receivables

Trade and other receivables are recognised initially at fair value and subsequently measured at amortised cost using the effective interest method, less any provision for impairment.

Collectability of receivables is reviewed on an ongoing basis. A provision for doubtful debts is established from day one in the acknowledgement that the expected credit losses model assumes that there are very limited circumstances under which a debt has no risk (implying a nil provision is not appropriate). Bad debts are written off in the period in which they are identified.

As a result of the COVID-19 pandemic, the Group has reassessed the credit risk for all its trade receivables balance. An assessment was undertaken to identify all trade receivables that posed a higher credit risk based on the Group's understanding and experience with the customer's ability to pay its debts given the current and forecast economic conditions. For these trade receivables, the Group has recorded additional provisions to account for the estimated exposure for any defaults.

The above reassessment has resulted in the Group increasing its expected credit loss provisions to $102,000 (2019: $50,000), to reflect the estimated exposure of any defaults.

Group	2020 $'000s	2019 $'000s
Trade debtors	8,722	7,680
Allowance for expected credit losses	(102)	(50)
	8,620	**7,630**
Prepayments	1,827	1,050
Total trade and other receivables	**10,447**	**8,680**

As at 30 June 2020, trade receivables of $1,654,000 (2019: $1,482,000) were past due but not impaired. These relate to a number of customers for whom there is no recent history of default. The ageing analysis of these trade receivables is as follows:

Group	2020 $'000s	2019 $'000s
Past due 1–30 days	434	992
Past due 31–60 days	302	296
Past due >61 days	918	194
Total past due trade receivables	**1,654**	**1,482**

9. Trade and other payables

Trade payables are obligations to pay for goods or services that have been acquired in the ordinary course of business from suppliers. Accounts payable are classified as current liabilities if payment is due within one year of less. If not, they are presented as non-current liabilities. Trade payables are recognised initially at fair value and subsequently at amortised cost, using the effective interest method.

Goods and Services Tax

Items in the statement of profit or loss and other comprehensive income and statement of cash flows are disclosed net of Goods and Services Tax (GST). All items in the statement of financial position are stated net of GST with the exception of receivables and payables, which include GST invoiced.

Group	2020 $'000s	2019 $'000s
Accrued expenses	2,009	1,977
GST payable	371	16
Trade payables	5,491	5,666
Total trade and other payables	**7,871**	**7,659**

10. Employee benefits

Wages, salaries and annual leave

Liabilities for wages and salaries, including annual leave, that are expected to be settled within 12 months of the reporting date are recognised in respect of employees' services up to the reporting date and are measured at the amounts expected to be paid when the liabilities are settled.

Obligations for contributions to defined contribution retirement plans are recognised as an expense in the statement of profit or loss and other comprehensive income as they fall due.

Long-service leave and retirement leave

Liabilities for long-service leave and retirement leave are recognised as employee benefit liabilities and measured as the present value of expected future payments to be made in respect of services provided by employees up to the reporting date. Consideration is given to the expected future salary levels, experience of employee departures and periods of service. Expected future payments are discounted using market yields at the reporting date for government bonds with terms to maturity and currency that match, as closely as possible, the estimated future cash outflows.

Group	2020 $'000s	2019 $'000s
Annual leave accrual	4,153	3,469
Service leave accrual	264	294
Other	24	15
Total current employee benefits	**4,441**	**3,778**
Service leave accrual	1,784	1,599
Retirement leave accrual	102	89
Total non-current employee benefits	**1,886**	**1,688**

11. Income tax payable

Current tax is calculated with reference to the current period's taxable profit or loss calculated using tax rates and tax laws that have been enacted or substantially enacted by reporting date. Current tax for the current and prior periods is recognised as a liability (or asset) to the extent that it is unpaid (or refundable).

Group	2020 $'000s	2019 $'000s
Balance at the beginning of the year	479	903
Current year charge	1,803	1,142
IFRS transition adjustment	–	72
Prior period adjustment	(21)	(65)
Provisional taxation payments	(823)	(1,573)
Total income tax payable	**1,438**	**479**

12. Deferred taxation

Deferred tax is calculated using the comprehensive balance sheet liability method in respect of temporary differences arising from differences between the carrying amount of assets and liabilities in the financial statements and the tax base for those terms.

Deferred tax assets and liabilities are not recognised if the temporary differences giving rise to them from the initial recognition of assets and liabilities (other than as a result of a business combination) affects neither taxable income nor accounting profit.

Deferred tax assets are recognised for deductible temporary differences and unused tax losses only if it is probable that future taxable amounts will be available against which deductible temporary differences or unused tax losses and tax offsets can be utilised.

Deferred tax assets and liabilities are measured at the tax rates expected to apply when the assets are recovered or liabilities settled using tax rates and tax laws that have been enacted or substantially enacted by the reporting date.

Group	2020 $'000s	2019 $'000s
Balance at the beginning of the year	3,387	3,653
Prior period adjustment	22	65
Charge to settlement of profit or loss and other comprehensive income	(2,250)	(331)
Total deferred taxation	**1,159**	**3,387**

	Accelerated tax depreciation $'000s	Employee benefits $'000s	Provisions and other items $'000s	Total $'000s
Year ended 30 June 2019				
Balance at the beginning of the year	5,109	(1,436)	(20)	3,653
Over provision in prior years	–	65	–	65
Current year charge/(credit) of statement profit or loss and other comprehensive income	(262)	(115)	46	(331)
Total deferred taxation	**4,847**	**(1,486)**	**26**	**3,387**
Year ended 30 June 2020				
Balance at the beginning of the year	4,847	(1,486)	26	3,387
Over provision in prior years	–	22	–	22
Current year charge/(credit) of statement profit or loss and other comprehensive income	(1,956)	(201)	(93)	(2,250)
Total deferred taxation	**2,891**	**(1,665)**	**(67)**	**1,159**

There are no unrecognised deferred tax assets or liabilities.

In 2010, legislation was introduced to remove tax depreciation for buildings with an estimated useful life of 50 years or more with effect from 1 April 2011. As part of the Government's COVID-19: Economic Response Package released on 26 March 2020, effective immediately, depreciation deductions were reintroduced for new and existing industrial and commercial buildings. For tax purposes where buildings had previously been depreciated at 0%, the Group will now be able to claim tax depreciation on a 1.5% straight line from the 2020–21 tax year. Due to the change in tax legislation, as at 30 June 2020, this has resulted in a reduction to the deferred tax liability and tax expense of $1,224,000.

13. Equity

Share capital

Ordinary shares are classified as equity. Incremental costs directly attributable to the issue of new shares or options are shown as appropriate in equity as a deduction, net of tax, from the proceeds.

Dividends

A provision is made for the amount of any dividend declared on or before the end of the financial year but not distributed at balance date.

Share capital Group	2020 $'000s	2019 $'000s
8,494,000 ordinary $1 shares (issued and fully paid)	8,494	8,494

All ordinary shares rank equally with one vote attached to each fully paid ordinary share.

No dividends were proposed or declared for the 30 June 2020 year (2019: nil).

14. Reconciliation of profit/(loss) after taxation to cash flows from operating activities

Cash and cash equivalents

Cash means cash on hand, demand deposits and other highly liquid investments in which ESR has invested as part of its day-to-day cash management. The following definitions are used in the statement of cash flows:

- Investing activities are those relating to the acquisition, holding and disposal of fixed assets and investments.
- Financing activities are those activities that result in changes in the size and composition of the capital structure of ESR, and this includes both equity and debt not falling within the definition of cash. Dividends paid in relation to the capital structure are included in financing activities.
- Operating activities are the principal revenue producing activities and other activities that are not investing and financing activities.

Investment cash

Investment cash represents cash held in bank deposits with original maturities of between 3 and 12 months. Investment cash movements are included in investing activities in the statement of cash flows.

Group	Note	2020 $'000s	2019 $'000s
Profit for the year after taxation		**2,644**	**1,858**
Non-cash items:			
Depreciation and amortisation expense	5/6	7,032	5,706
Depreciation on right-of-use assets	7	577	–
Equity accounted earnings from associate company investment		64	57
Impairment of equity accounted earnings from associate company investment		150	–
Transition to NZ IFRS 15		–	189
Bad debts written off	3	–	7
Increase/(decrease) in allowance for expected credit losses	8	48	(36)
(Decrease)/increase in deferred tax liability	12	(2,228)	(266)
Fair value loss/(gain) on derivative financial instruments		(6)	(5)
Other non-cash items		5	(9)
		5,642	**5,643**
Changes in working capital:			
(Increase)/decrease in trade and other receivables and contract assets		(2,241)	987
(Increase)/decrease in inventories		153	37
Increase in trade and other payables and contract liabilities		(510)	1,846
Increase/(decrease) in income tax payable		959	(424)
Increase in employment benefits		861	648
		(778)	**3,094**
Items classified as investing and financing activities:			
(Profit)/loss on disposal of property, plant and equipment		4	5
(Increase)/decrease in trade payables related to property, plant and equipment		302	104
Finance charge on leases		27	1
		333	110
Net cash inflow from operating activities		**7,841**	**10,705**

15. Investments

Subsidiaries

The consolidated financial statements incorporate the assets and liabilities of all subsidiaries of ESR as at 30 June 2020 and the results of the operations of all subsidiaries for the year then ended.

Subsidiaries are those entities controlled, directly or indirectly, by the 'Parent'. Subsidiaries are consolidated from the date on which control is transferred to ESR. They are de-consolidated from the date that control ceases.

The acquisition method of accounting is used to account for the acquisition of business by the Group. The cost of an acquisition is measured as the fair value of the assets given, equity instruments issued and liabilities incurred or assumed at the date of exchange. Identifiable assets acquired and liabilities and contingent liabilities assumed in a business combination are measured initially at their fair values at the acquisition date, irrespective of the extent of any non-controlling interest. The excess of the cost over the fair value of the Group's share of the fair value of the identifiable net assets of the subsidiary acquired the difference is recognised directly in the profit or loss.

ESR has two wholly owned subsidiary companies:

Name	Balance date	Country of incorporation
ESR Limited	30 June	New Zealand
STRMIX Limited	30 June	New Zealand

ESR's financial statements include the financial statements of ESR and entities controlled by ESR. All intra-Group transactions balances, income and expenses are eliminated in full on consolidation.

No stake in any subsidiary was acquired or disposed of during the year.

Associates

An associate is an entity over which the Group has significant influence. Significant influence is the power to participate in the financial and operating policy decisions of the investee but is not control or joint control over those policies.

The Group's investments in its associates are accounted for using the equity method. Under the equity method, the investment in an associate is initially recognised at cost and subsequently adjusted to recognise the Group's share of changes in net assets of the associate since the acquisition date. Goodwill relating to the associate is included in the carrying amount of the investment and is not tested for impairment separately.

In applying the equity method of accounting, the Group's share of the post-acquisition profits and losses of its associated companies is recognised in profit or loss and its share of post-acquisition other comprehensive income is recognised in other comprehensive income. These post-acquisition movements and distributions received from the associated companies are adjusted against the carrying amount of the investment.

Unrealised gains on transactions between the Group and its associated companies are eliminated to the extent of the Group's interest in the associated companies. Unrealised losses are also eliminated unless the transaction provides evidence of an impairment of the asset transferred.

After application of the equity method, the Group determines whether it is necessary to recognise an impairment loss on its investment in its associates. At each reporting date, the Group determines whether there is objective evidence that the investment in the associate or joint venture is impaired. If there is such evidence, the Group calculates the amount of impairment as the difference between the recoverable amount of the associate and its carrying value and then recognises the loss within the statement of profit or loss.

When the Group's share of losses in an associated company equals or exceeds its interest in the associated company, including any other unsecured non-current receivables, the Group does not recognise further losses, unless it has obligations or has made payments on behalf of the associated company.

AuramerBio Limited, a start-up company focused on the development of DNA aptamer sensors, is classified as an associate, with ESR holding 19.5% of the shares of the company.

As at 30 June 2020, AuramerBio Limited has total assets of $1,324,000 and net assets of $668,000.

Technical issues and the impact of COVID-19 led to AuramerBio Limited missing a key development milestone that would represent the cornerstone of AuramerBio Limited's next capital raise to obtain further development funding. This has led to significant uncertainty in respect to the valuation of ESR's investment in AuramerBio Limited. In assessing the recoverable amount of the investment, management have considered different scenarios regarding the achievement of future milestones.

Consequently, management has determined the valuation of ESR's investment in AuramerBio Limited to be impaired by $150,000. This impairment has been recognised in the Statement of Profit or Loss and Other Comprehensive Income.

The carrying amount of equity accounted investments has changed over the reporting period as below:

	2020 $'000s	2019 $'000s
Balance at the beginning of the year	442	250
Additions	–	249
Profit/(loss) for the period	(64)	(57)
Impairment loss	(150)	–
Total investments	**228**	**442**

16. Commitments

Capital commitments

Group	2020 $'000s	2019 $'000s
Property, plant and equipment	1,058	653
Intangible assets – software	36	258
Total capital commitments	**1,094**	**911**

Operating lease commitments

Group	2020 $'000s	2019 $'000s
Not later than one year	–	208
Later than one year and not later than five years	–	246
Total operating lease commitments	**–**	**454**

ESR leases land, buildings, equipment and vehicles. There are renewal options in respect of the land and building leases. There are no renewal options or options to purchase in respect of vehicles held under operating leases.

From 1 July 2019, the Group has recognised right-of-use assets for these leases, see note 7 above for further information.

ESR has a number of standard operational agreements for the purchase of materials and consumables that have both fixed and variable components, some of which extend beyond one year.

17. Related party transactions and key management personnel

Related party transactions

ESR is a wholly owned entity of the Crown. ESR receives Strategic Science Investment Fund funding from the Government and enters into transactions with other Crown entities on a commercial basis. In the year ended 30 June 2020, revenue from commercial transactions with Crown entities amounted to 67% of operating revenue (30 June 2019: 75%).

Related parties include the entities disclosed in note 15. A member of the key management personnel is a director of ESR's associate AuramerBio Limited.

The following transactions were carried out by ESR with related parties:

- Personnel and equipment were supplied to STRmix Limited to the value of $4,928,488. As at balance date, STRmix Limited owed ESR $1,453,847 (30 June 2019: $2,862,247).
- Professional services were supplied to AuramerBio Limited in the 2019 financial year to the value of $8,970. No professional services were supplied in the 2020 financial year. There was no debt owed by AuramerBio Limited as at balance date (30 June 2019: nil).

- Fees paid to directors during the year were $170,227 (30 June 2019: $198,264). There were no directors' fees payable at balance date (30 June 2019: nil).

No provision has been required, nor any expense recognised, for impairment of receivables from related parties.

Key management personnel compensation

Key management personnel comprise the Chief Executive Officer, members of the Senior Leadership Team and the directors. Key management personnel compensation is disclosed below:

Group	2020 $'000s	2019 $'000s
Salaries and other short-term employee benefits	2,129	2,246
Termination benefits	–	99
Other long-term employee benefits	–	2
Directors' fees	170	198
Total key management personnel compensation	**2,299**	**2,545**

18. Financial instruments by category

The designation of financial assets and financial liabilities by ESR into instrument categories is determined by the business purposes of the financial instruments, policies and practices of management, the relationship with other instruments and the reporting costs and benefits associated with each designation.

Financial assets

The Group classifies its financial assets either at amortised cost or at fair value through profit and loss. Management determines the classification of its financial assets at initial recognition.

Financial assets at amortised cost are non-derivative financial assets with fixed or determinable payments that are not quoted in an active market. They are included in current assets, except for maturities greater than 12 months after the reporting date, which are classified as non-current assets. ESR's financial assets at amortised cost comprise trade and other receivables, investment cash and cash and cash equivalents in the statement of financial position.

Regular purchases and sales of financial assets are recognised on the trade date – the date on which the Group commits to purchase or sell the asset. Financial assets are de-recognised when the rights to receive cash flows from the investments have expired or have been transferred and the Group has transferred substantially all risks and rewards of ownership. Financial assets at amortised cost use the effective interest method.

The Group recognises an allowance for expected credit losses (ECLs) for all financial assets at amortised cost or for all financial assets not at fair value through profit or loss. ECLs are based on the difference between the contractual cash flows due in accordance with the contract and all the cash flows that the Group expects to receive, discounted at an approximation of the original effective interest rate.

Financial liabilities

Financial liabilities held by ESR include trade and other payables, employee benefits and lease liabilities.

Such financial liabilities are recognised initially at fair value less transaction costs and subsequently measured at amortised cost using the effective interest rate method.

Derivatives

Derivative financial instruments are recognised both initially and subsequently at fair value. They are reported as either assets or liabilities depending on whether the derivative is in a net gain or net loss position. ESR does not use hedge accounting and, as such, derivatives are classified as held-for-trading financial instruments with fair value gains or losses recognised in the statement of profit or loss and other comprehensive income. Such derivatives are entered into for risk management purposes.

Group	Note	Financial assets at amortised cost $'000s	Financial assets at fair value through profit or loss $'000s	Total $'000s
30 June 2020				
Assets as per balance sheet				
Trade and other receivables excluding prepayments	8	8,620	–	8,620
Cash and cash equivalents		3,333	–	3,333
Investment cash		29,000	–	29,000
Total		**40,953**	**–**	**40,953**

		Financial liabilities at amortised cost $'000s	Financial liabilities at fair value through profit or loss $'000s	Total $'000s
Liabilities as per balance sheet				
Employee benefits		6,327	–	6,327
Trade payables and accrued expenses	9	7,500	–	7,500
Total		**13,827**	**–**	**13,827**

Group	Note	Financial assets at amortised cost $'000s	Financial assets at fair value through profit or loss $'000s	Total $'000s
30 June 2019				
Assets as per balance sheet				
Trade and other receivables excluding prepayments	8	7,630	–	7,630
Cash and cash equivalents		509	–	509
Investment cash		30,000	–	30,000
Total		**38,139**	**–**	**38,139**

		Financial liabilities at amortised cost $'000s	Financial liabilities at fair value through profit or loss $'000s	Total $'000s
Liabilities as per balance sheet				
Employee benefits		5,466	–	5,466
Trade payables, accrued expenses and derivative financial instruments	9	7,637	6	7,643
Total		**13,103**	**6**	**13,109**

19. Financial risk management

ESR's activities are exposed to a variety of financial risks, market risks (including cash flow and fair value interest rate risk), credit risk and liquidity risk. ESR's overall risk management programme focuses on the unpredictability of financial markets and seeks to minimise potential adverse effects on ESR's financial performance. The policies approved and financial instruments being utilised at balance date are outlined below.

a) Market risk

In accordance with its Treasury Management Policy, ESR uses derivative financial instruments to economically hedge its exposure to foreign exchange risks from its operational, financing and investment activities. These derivatives are classified at fair value through profit or loss, and gains and losses are recognised as profit or loss in the statement of profit or loss and other comprehensive income.

i) Foreign exchange risk

Foreign exchange risk occurs as a result of transactions denominated in a currency other than ESR's functional currency of New Zealand dollars. Currencies commonly transacted in, and giving rise to, foreign exchange risk include the United States dollar, Australian dollar, Euro and the Pound sterling. ESR is subject to foreign currency risk through its trade receivables and trade payables balances.

ESR is required by its Treasury Management Policy to hedge net foreign currency exposures greater than the equivalent of NZD $100,000, using approved treasury instruments.

At 30 June 2020, ESR did not hold any forward exchange contracts. At 30 June 2019, ESR held two forward exchange contracts with notional principal amounts totalling US$187,522.

The carrying amounts of the Group's trade and other receivables denominated in foreign currencies are:

Group	2020 $'000s	2019 $'000s
US dollar	1,714	3,001
Australian dollar	1	32
Euro	26	57

The carrying amounts of the Group's trade and other payables denominated in foreign currencies are:

Group	2020 $'000s	2019 $'000s
US dollar	349	544
Australian dollar	114	62
Pound sterling	–	5
Euro	–	2
Swiss franc	1	–

ii) Interest rate risk

As at reporting date, ESR is subject to interest rate risk through the holding of cash and cash equivalents and investment cash. ESR uses a mixture of call and short-term deposit investment accounts to hold excess funds. Available interest rates are monitored to ensure the best return on cash.

iii) Market risk sensitivity analysis

ESR is exposed to market risk through the holding of the following financial instruments: cash, trade receivables and trade payables. ESR management has analysed the sensitivities in market risk factors over a 12-month period below:

- proportional foreign exchange rate movement of -10% (depreciation of New Zealand dollar) and +10% (appreciation of New Zealand dollar) against foreign currencies
- a parallel shift of +1%/-1% in market interest rates in New Zealand.

If these movements were to occur (all other variables held constant), the impact on ESR's reported net profit after tax for the year ended 30 June 2020 would be:

- Foreign currency $131,000 (30 June 2019: $243,000)
- Interest rates $212,000 (30 June 2019: $194,000).

b) Credit risk

Credit risk refers to the risk that a counterparty will default on its contractual obligations, resulting in financial loss to ESR. The financial instruments that expose ESR to credit risk are, principally, cash and cash equivalents, investment cash and trade receivables.

Bank balances and short-term investments (comprising cash and cash equivalents and investment cash) are held with New Zealand registered banks in accordance with ESR's Treasury Management Policy.

The majority of high-value trade receivables comprise government entities, and therefore the potential risk of default is low. ESR has a Contract Management Policy, which requires assessment of the credit worthiness of potential clients where the value of the contract is material as defined in the policy.

A provision for doubtful debts is maintained in respect of trade receivables, and this is reassessed on a regular basis. No collateral is held by ESR in respect of cash and cash equivalents, investment cash and trade receivables as at 30 June 2020 (30 June 2019: nil).

The carrying amount of financial assets recognised in the statement of financial position best represents ESR's maximum exposure to credit risk at the reporting date.

As at 30 June 2020, the trade receivables balance included $4,292,847 (30 June 2019: $2,976,000) owed by entities within, or owned by, the New Zealand Government. It is not believed that there is any material risk of loss with these receivables.

c) Liquidity risk

Prudent liquidity risk management implies the availability of funding through adequate levels of committed credit facilities. Liquidity risk is monitored through the forecasting of cash flows and ensuring that the committed credit lines in place remain adequate for requirements.

The contractual undiscounted maturity analysis of financial liabilities is presented below:

Group 2020	Carrying value $'000s	Less than 1 year $'000s	1–2 years $'000s	2–5 years $'000s	Greater than 5 years $'000s
Trade payables	7,500	7,500	–	–	–
Employee benefits	6,327	4,441	150	48	1,688
	13,827	11,941	150	48	1,688

Group 2019	Carrying value $'000s	Less than 1 year $'000s	1–2 years $'000s	2–5 years $'000s	Greater than 5 years $'000s
Trade payables	7,637	7,637	–	–	–
Employee benefits	5,466	3,778	130	42	1,516
	13,103	11,415	130	42	1,516

d) Fair values

The carrying value of financial assets and liabilities recorded in the financial statements approximate their fair values.

Fair value is generally based on the contracted amount payable/receivable of financial assets and financial liabilities, being the amount for which the financial instrument is to be exchanged. Fair value includes the impact of any assessed impairment of the financial instruments – refer to the statement of significant accounting policies for details of each financial instrument and their recognition criteria.

e) Capital risk management

ESR objectives when managing capital are to maintain financial stability, achieve sustainable growth and realise its strategic goals and targets, all within the risk appetite of its shareholders and management.

In line with Government requirements, ESR monitors its capital structure through the return on equity and gearing ratios. Government provides ESR with guidelines, with the expectation that an appropriate average return is achieved over time, rather than requiring that ESR meet the specified targets annually.

Each year, ESR internally sets return on equity and gearing ratio targets, bearing in mind the overall results expected by Government. The ratios are reported in the Statement of Corporate Intent.

The return on equity and gearing ratios as at 30 June 2020 and 30 June 2019 were as follows, along with the relevant annual targets set by ESR.

Group **Return on equity ratio**	**2020** **$'000s**	**2019** **$'000s**
Profit/(loss) for the year	2,644	1,858
Average equity	57,639	55,294
Actual ratio	**4.6%**	**3.4%**
Target ratio	**0.4%**	**6.3%**
Gearing ratio		
Net debt		
Finance lease liabilities – current	578	–
Finance lease liabilities – non-current	768	–
	1,346	–
Equity	**58,961**	**56,317**
Actual ratio	**2.2%**	**0.0%**
Target ratio	**0.0%**	**0.0%**

20. Contingent liabilities

ESR is subject to a legal claim in the United States of America which alleges patent infringement related to aspects of the Group's commercial operations in that country. The Group is defending the action. The impact of these proceedings cannot be reliably quantified due to uncertainty around the outcome.

The directors are satisfied that there are no other claims outstanding that would have a material impact on ESR's financial position as at 30 June 2020 (30 June 2019: nil).

21. Subsequent events

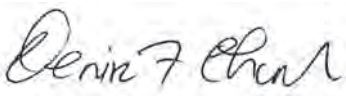
There were no events subsequent to reporting date that require disclosure in the financial statements.

Statement of Responsibility

We certify that the Institute of Environmental Science and Research Limited (ESR) has operated in accordance with the principles of the Crown Research Institutes Act 1992 and the Companies Act 1993. ESR has also complied with all statutory environmental regulations. We acknowledge responsibility for the preparation of these financial statements and for the judgements used therein.

Internal control procedures are considered to be sufficient to provide reasonable assurance as to the integrity and reliability of the financial reports.

In our opinion, these financial statements fairly reflect the financial position and operations of ESR for the year ended 30 June 2020.



Denise Church QSO
Chair

Cristin Print
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