CORE FUND PROJECT - FINAL REPORT FOR 2014/15

Please complete and email to ESR.research@esr.cri.nz by Friday 29th August 2015.
ESR is fully accountable for Core Funding. Information in this report will be used to demonstrate what ESR Core Funding has been invested in, and to quantify the benefit from the investment in e.g. the Board Report. It will also inform future investment of Core Funding.

Project title:

Centre for Integrated Biowaste Research (CIBR)

Project leader(s):
Dr Jacqui Horswell

Duration:
until 2017

Budget (amount allocated per year and total spent)

Allocated:	**Spent:**
CIBR: $1,626,877	**CIBR: $1,626,667**
Virus removal: $297,813	**Virus removal: $297,813**
Total =$1,924,690	**Total =$1,924,480**

List the capabilities developed and by whom (include students)

CIBR core capabilities

- Microbiology
  - Public and environmental health risk assessments.
  - Assessments of waste processing technologies for microbial reduction.
  - Generating environmental fate, transport and effects data for microbes.
  - Developing novel culture and molecular methods for microbial (bacterial and viral) identification and enumeration in wastes (wastewater, greywater and biosolids).
- Ecotoxicology Team - Building an ecotoxicological platform that provides the science to underpin risk assessments for contaminants found in biowastes:
  - Chemical and biological assays to characterise the effects of micro-pollutants;
  - Risk assessment and management of emerging organic contaminants in land applied biowastes, including the impacts of mixtures of contaminants;
  - Environmental fate, transport and toxicity risk assessments for the management of high priority chemicals.
- Cost benefit analysis (CBA)
  - Systematic process for calculating and comparing benefits and costs of a project, for example, using it to assess the economics of biosolids reuse

options.

- Soil science
    - Assessing fit for purpose re-cycling/re-use of biowastes.
    - How different waste treatment processes affect soil fertility and productivity.
    - Long-term field trials in a forest, glass house pot trials with native plants, and laboratory studies.
    - Use of biowastes in rehabilitating and restoring degraded soils - including agricultural, urban and industrial.
- Forest ecology
    - Impact of biowaste land application on forest biodiversity and functions.
    - Identifying and manipulating ecological processes for improving forest use of biowastes and minimising the environmental risks.
    - Enhancing carbon sequestration in forests and soils through beneficial use of biosolids.
    - Best management practices for applying biosolids to forest plantations.
- Social science and cultural knowledge and approaches
    - Community engagement methods including stakeholder analysis, relationship building, in-depth interview and survey design, collaborative planning hui, community dialogue workshop design and facilitation, collaborative hui informed by Tikanga.
    - 'Fit for purpose' community-engagement framework to support local council decision-making.
    - Sustainable behaviour change, new curriculum science education for engaging teachers, students, whānau and households in addressing wicked problems.
    - Supporting iwi development, enterprise and waste management.

Capability development – students

[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]

Students completed
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]
[Withheld under section 9(2)(a) of the OIA]

List the external research or grant proposals submitted (include $ value) and any research funding obtained that have been made possible as a result of CF investment in the project, include proposals awaiting funding decisions:

Grant proposals submitted

Funding body	**Project title**	**Funding requested**	**Successful/declined/pending**
[Withheld under section 9(2)(b)(ii) of the OIA]	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	pending
[Withheld under section 9(2)(b)(ii) of the OIA]	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	declined
The Faculty Research Development Fund, University of Auckland;	The occurrence, fate, and ecotoxicity of pharmaceuticals and personal care products in wastewater treatment plants of Auckland;	$30k	successful
[Withheld under section 9(2)(b)(ii) of the OIA]	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	declined
[Withheld under section 9(2)(b)(ii) of the OIA]	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	declined

[Withheld under section 9(2)(b)(ii) of the OIA]	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	declined
KCDC Waste Levy Fund for New Technologies and Seed Funding	Vermicomposting of Otaki biosolids	$40,000	successful
[Withheld under section 9(2)(b)(ii) of the OIA]	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	pending
[Withheld under section 9(2)(b)(ii) of the OIA]	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	declined
[Withheld under section 9(2)(b)(ii) of the OIA]	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	declined
[Withheld under section 9(2)(b)(ii) of the OIA]	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	pending

List all external research revenue obtained seeded by this CF project:

Co-funding and subcontracting

Funding type	Organisation name	Amount
Co-funding*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Co-funding*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Co-funding*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*

Co-funding*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Co-funding	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Co-funding	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Sub-contract*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Sub-contract*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*
Co-funding*	*[Withheld under section 9(2)(b)(ii) of the OIA]*	*[Withheld under section 9(2)(b)(ii) of the OIA]*

Show commercial benefits from the investment, list any new products or services made possible by CF, both actual and potential (*be realistic, not far fetched*) and estimate revenue, clients and timeframe for achieving this:

[Withheld under section 9(2)(b)(ii) of the OIA]

- .

Awards for science achievement

- Gerty Gielen was awarded Best Technical Paper' for her paper: "Seasonal effects on catchment scale nutrient removal in the Rotorua land application system" at the New Zealand Land Treatment Collective Annual Conference 25-27 March 2015, Wanaka.

- Jacqui Horswell was presented with an award "In recognition of her outstanding services to the New Zealand Land Treatment Collective" at the New Zealand Land Treatment Collective Annual Conference 25-27 March 2015, Wanaka.

- Jacqui Horswell was awarded the ESR Science Award for her work in biowaste research and leadership on improving the Centre for Integrated Biowaste Research (CIBR).

- The CIBR team was awarded 'Highly Commended' in the ESR Science Awards for their work to improve the safety of fresh water and ground water resources for human use and the safer use of biowastes

How does your research contribute to ESR's IMPACT/s?

The CIBR programme contributes specifically to **Outcome 4** "Improve the safety of freshwater and groundwater resources for human use and the safer use of biowastes"

Our work contributes to the ESR impacts:

► faster detection of and response to hazards

CIBR has extensive expertise in the detection of biological and chemical contaminants in waste – this is an incredibly difficult medium to work in and often traditional techniques are not applicable to this complex waste stream. Our extensive emerging organic chemical analysis capability coupled with our ecotoxicology platform allows us to characterise the range of contaminants commonly detected in biowastes including mixtures of chemicals. Our experience in isolating microbiological contaminants allows us to reliably detect and enumerate bacteria and viruses present in wastewater and solid wastes. Using these techniques we can improve knowledge on the effectiveness of waste treatment and use this enhanced knowledge to improve the effectiveness of treatment of waste for the future. We are developing methods to detect and identify pharmaceuticals, and enzymes present in wastewater, which will have a direct use for response to contamination in the environment in the future.

► improved water management practice from the perspective of the human use of water and public health impacts

Increasing knowledge of viruses present in wastewater and methods to enhance their removal offers improved management practices for public health impact mitigation. Improving the removal of viruses from the wastewater will reduce the risk of human use of water in environmental waters impacted by wastewater. Public health impacts will be improved by reducing the risk of virus contact in the environment both directly and indirectly.

► improved understanding of contaminant pathways in water systems, and the impacts of biowaste practices on waterways

In solid wastes we have characterised chemical and microbial levels and collected fate, transport and effects data. We have increased our understanding about the new emerging chemicals of concern in waste and how they interact as mixtures. We have found that compounds such as triclosan (an antimicrobial used in hand soaps and toothpastes) can cause ecotoxicological impacts in the environment and when mixed with heavy metals can increase the toxicity of both. The Ecotox team have found significant residual toxicity exists in mine sites rehabilitated with large amounts of biosolids, this may impact future rehabilitation plans of contaminated land. The team at Lincoln University has continued working on mitigating the environmental contamination risks associated with biowastes by using them to promote the growth of NZ native vegetation in degraded environments. Research has shown the strategic use of biowaste mixtures, such as biosolids and woodwaste, as well as plants can influence the nitrogen cycle and protect waterways.

Our research also adds to the understanding of the levels and occurrence of viruses in the environment from waste pathways (biosolids, greywater and wastewater) into waterways.

► support for effective regulation, standards and monitoring.

CIBR continues to provide the science that underpins the development of national guidelines and is jointly leading a review of the NZ Biosolids Guidelines. Programme leader Jacqui Horswell is a member of the steering group and CIBR team members (Tremblay, Gielen, Northcott, Horswell, Robinson and Esperschuetz) wrote gap analysis reports and literature reviews on aspects of the biosolids guidelines that need to be reviewed. Jacqui Horswell also represents the Australia/NZ Biosolids partnership on the new international ISO standard for biosolids application to land. CIBR has written the suggested section on community engagement for this international standard.

CIBR also continues to provide advice for resource consent applications and district planning, with respect to land application of wastes and has recently become involved in Gisborne District Council's planning and design of wetlands and sludge drying beds. Only by increasing our knowledge of virus levels in wastewater and the effluent from wastewater treatment will we be able to support effective regulation, standards and monitoring. Our research is adding to this knowledge base by increasing our understanding of the survival of viruses and their removal by wastewater treatment systems.

CIBR team members sit on national and international advisory groups, boards and Steering Committees (e.g. Australia/New Zealand Biosolids Partnership; NZ Land Treatment Collective; BRANZ).

List anything else that can demonstrate value from this CF investment:

Science Quality:

Indicator	**Number**
Peer-reviewed journal articles accepted for science publication	9
Masters or doctorate theses	1
Published conference proceedings	13
Keynote presentations	1
Commissioned Reports:	5
Workshop/hui	4
Number of non peer reviewed published articles	3

Please attach a copy of your final full year financial report with commentary. *Feel free to ask a Manage*
Kelvin) for help with this, if needed.

Commentary on budget:
CIBR – overall expenditure was on target.
Training and conferences was under budget due to *[Withheld under section 9(2)(a) of the OIA to protect privacy].* The overseas travel was under budget due to there being no ANZBP meeting this year in Australia, and no attendance at an overseas conference.
Local travel was higher than budget due to trips to Gisborne to set-up the new Gisborne project.
Total labour costs were on target with 102% used, there was some variance in who used hours.

CIBR 30 June 2015

Profit and Loss	YTD Actual	Variance	Total Plan	% Used	Commitmts
Commercial Domestic	46,201-	46,201			
CRI Capability Fund	1,626,667-	5-	1,626,672-	100	
External Income	**1,672,868-**	**46,196**	**1,626,672-**	**103**	
Grants/Scholarships					
Fringe Benefit Tax	49	49-			
Contract Personnel					
Training/Conferences	1,709	3,291	5,000	34	
Other Staff Expenses	1,153	847	2,000	58	
Cap Cost (Manual)					
Material/Consumables	17,303	2,508-	14,795	117	
Equipmnt Maintenance	2,287	713	3,000	76	
Equipment Hire					
Sub Contracted Work	1,070,072	940	1,071,012	100	
Freight & Courier	4,074	3,574-	500	815	
Postage	122	378	500	24	
Tolls/Local/Fax	35	35-			
Maintenance IT	122	122-			
Software					
Maintenance F&F	257	257-			
Rental Other Equip					
Vehicle Expenses	81	81-			
Travel Local	7,471	1,471-	6,000	125	
Travel Overseas	1,621	3,379	5,000	32	
Travel Allowances	335	665	1,000	34	
Advertising & PR		1,500	1,500		

Donations/Sponsorshi					
Entertainment	18	18-			
Entertainment Non De	18	18-			
Information Supply					
General Expenses	981	2,019	3,000	33	
Printing/Stationery	1,621	121-	1,500	108	
Memberships etc	687	687-			
Legal Fees					
Consulting Fees					
External Expense	**1,110,016**	**4,791**	**1,114,807**	**100**	
Labour Bands	143,332	3,095-	140,237	102	
Corp O/head Alloc	243,200	243,200-			
Program O/head Alloc	141,268	141,268-			
Alloc RC O/h Prog	2,155-	2,155			
EH GM O/head Alloc	19,745	19,745-			
Internal Cost	1,074	1,074-			
Internal Expenses	**546,464**	**406,227-**	**140,237**	**390**	
Expenditure	1,656,481	401,437-	1,255,044	132	
Margin	**16,387-**	**355,241-**	**371,628-**	**4**	

LABAST LABAST	112	2-	110
MGTGEN MGTGEN	5	5-	
SCNLDR SCNLDR	658	43	700
SCNTST SCNTST	557	535	1,092
SNRSCN SNRSCN	459	39-	420
SNRTEC SNRTEC	206	34	240
TECHN TECHN	1,549	829-	720
*** Hours**	**3,546**	**264-**	**3,282**

% Margin	1	22-	23
%Mgn ex Subcontracts	180	79-	260
% Consumables to Rev	1	0-	1
Band Multiplier	1	3-	4
Annual Rev per FTE	793	40-	833

Commentary on budget:
Virus removal – overall expenditure on track.
Training, conferences and travel were all under budget due to Louise Weaver being on maternity leave.
Materials and consumables were generally on-track as was sub-contracted work.
Total labour costs were on target with 87% used, there was some variance in who used hours.

Virus Removal 30 JUNE 2015

Profit and Loss	YTD Actual	Variance	Total Plan	% Used
CRI Capability Fund	297,813-		297,813-	100
External Income	**297,813-**		**297,813-**	**100**
Grants/Scholarships		5,000	5,000	
Contract Personnel				
Training/Conferences	326	3,674	4,000	8
Other Staff Expenses	471	471-		
Material/Consumables	21,149	4,215	25,364	83
Equipmnt Maintenance	585	585-		
Equipment Hire				
Sub Contracted Work	85,332	1,668	87,000	98
Freight & Courier	414	174-	240	172
Postage				
Tolls/Local/Fax				
Maintenance IT				
Software				
Rental Other Equip				
Vehicle Expenses	39	202	240	16
Building Services				
Travel Local	754	246	1,000	75
Travel Overseas		2,500	2,500	
Travel Allowances				
Advertising & PR				
Donations/Sponsorshi				
Entertainment		600	600	
Entertainment Non De				
Information Supply	26	26-		
General Expenses	340	340-		
Printing/Stationery	200	200-		
Memberships etc				

Legal Fees Consulting Fees				
External Expense	**109,635**	**16,309**	**125,944**	**87**
Labour Bands	30,983	16,105	47,088	66
Corp O/head Alloc	49,083	49,083-		
Program O/head Alloc	21,231	21,231-		
Alloc RC O/h Prog	22-	22		
EH GM O/head Alloc	1,947	1,947-		
Internal Expenses	**103,222**	**56,134-**	**47,088**	**219**
Expenditure	212,856	39,825-	173,032	123
Margin	**84,957-**	**39,825-**	**124,781-**	**68**

SCNLDR SCNLDR		12	12
SCNTST SCNTST	11	86	96
SNRSCN SNRSCN	185	111	296
SNRTEC SNRTEC	536	44	580
SSCNLR SSCNLR	1	1-	
TECHN TECHN	12	148	160
*** Hours**	**745**	**399**	**1,144**

% Margin	29	13-	42
%Mgn ex Subcontracts	80	20-	100
% Consumables to Rev	7	1	9
Band Multiplier	4	0	4
Annual Rev per FTE	672	235	437

Executive summary – *Three to four sentences giving an overview of your project and the results obtained. This will be used for the board report so keep in mind that not everyone is an expert in your field.*

Four key achievements:

1. **Mitigating environmental impacts of waste:** Land application of waste is a growing trend in New Zealand with many localities investigating land application as an alternative to ocean or river disposal. The CIBR team led by Lincoln University have been researching the use of antimicrobial/bioactive producing plants to reduce microbial and nitrogen contamination from land applied wastes. In particular we are focusing on protecting waterways from biowastes associated with dairy farming. Field trials have been established on the former Eyrewell forest soils, in collaboration with Prof. Nick Dickinson (dept of Ecology), to use NZ native plants to mitigate the negative environmental effects of dairy shed effluent while promoting the growth of honey and oil producing manuka and kanuka. This research will directly aid the primary sector to face its greatest challenge of increasing productivity without causing unacceptable harm to the environment.
2. **CIBR capability on risk characterisation and management of emerging contaminants**: CIBR continues to develop capability in the risk characterisation and management of emerging contaminants through the production of reports, organisation and participation in workshops, and continuing development of experimental capability. This expertise is essential to NZ. For instance, Auckland Council, Greater Wellington Regional Council and Environment Canterbury have all struggled to deal with issues around the management of emerging contaminants issues. This is the situation for many other councils across the country as there is an absence of direction from central government. CIBR (Grant Northcott and Louis Tremblay) are part of a small team of experts providing advice to councils and recently co-authored a report reviewing the state of knowledge regarding emerging contaminants and providing recommendations to councils on the prioritisation and selection of emerging contaminants to include in future environmental monitoring programs. Grant and Louis also co-authored a report for Watercare Services Limited summarising the current state of knowledge of emerging contaminants with an emphasis on the risk they pose to environments where wastewater treatment plant effluent is irrigated to land. The CIBR team were invited speakers at the EPA Tikanga and Technology workshop in Wellington where current research on emerging organic contaminants was reviewed and discussed by attending Maori delegates. The Ecotox team are organising the prestigious Society of Environmental Toxicology and Chemistry (SETAC) Australasia conference in August 2015 where CIBR research will be showcased in a conference

workshop. As part of the conference CIBR is coordinating the Australasian response to the Global Horizon Scanning Research Prioritisation Project. This SETAC initiative will prioritise the most important future research questions as recognized by scientists from around the globe working in government, academia and business. This exercise also identifies key research capability around the globe and future opportunities to participate in international collaborative research programs.

3. **Up the Pipe solutions** – The CIBR team have continued to develop the science outreach component of the programme. Using the resources developed under the Ministry for the Environment project 'up the pipe-solutions' the team have visited 5 schools in the lower North Island and 2 schools in the Nelson region. Although the grant proposals to secure funding for this work have been unsuccessful, a small amount of core funding from ESR allowed us to continue this important work. We have also taken part in Royal Society and Regional Council career fairs and education festivals and have developed a network of key stakeholder relationships in this area including New Zealand Centre for Educational Research (NZCER), Enviroschools, EcoStore, Porirua City Council and Gisborne District Council.
4. **Enhancing Pacific Island wastewater treatment:** Research has begun to assist Pacific Island communities to enhance their wastewater treatment using low cost, sustainable approaches. As a first step we have carried out initial assessment of the natural attenuation capacity of coral sand for bacterial and viral contaminants. The research is providing a platform for future funding opportunities in the Pacific through MFAT and other government agencies. We have presented the findings to Pacific government agencies and have published a journal article on the initial results. Feedback from the Pacific agencies is very positive and there is a good chance of us achieving future funding in the sanitation area based on these initial studies

.

Project report – *Make this a stand-alone final report suitable to include in a consolidated report to the ESR Board. Include brief background, what you did, what you found, conclusions (**2-3 pages**). This is the opportunity to tell a success story that ESR can use in Briefing and other communications.*

The CIBR is a virtual centre, combining the expertise of 8 New Zealand research institutes, universities and research partners dedicated to developing both the biophysical and social science behind appropriate and sustainable beneficial reuse of organic, biodegradable solid and liquid waste such as sewage effluent and sewage sludge, grey water, industrial and agricultural waste; kitchen/food waste; and green waste. Led by ESR, CIBR brings together a multi-disciplinary team of scientists and researchers from ESR, Scion, Cawthron Institute, Landcare Research, Lincoln University, NIWA, Lowe Environmental Impact, Northcott Research Consultants Ltd. and Kukupa Research.

CIBR science

We combine the expertise of our four specialised research groups (Social and Cultural Research, Soil Science, Microbiology and Ecotoxicology) to connect communities, regulators and industry with the science of organic waste management.

The social/cultural group have developed the CIBR "Community engagement framework for biowastes" to support local government staff, engineers and consultants in the biowaste and wastewater sector in guiding their endeavours to engage and consult with the community. Engagement with the community in Christchurch, Kaikōura, Mokai, Little River and Porirua undertaken by the team has laid the foundation to developing this framework and external review has assisted in tailoring it for end-users. The framework is underpinned by the social/cultural science recently published in a high ranking journal (Futures) outlining the transdisciplinary approach the CIBR takes to waste management in New Zealand and addresses interrelated challenges through indigenous partnership.

Following extensive community engagement with Māori, the social/cultural group have developed a report on Tapu to Noa - Māori cultural views on biowastes management, which is designed to support local government staff and engineers in better understanding and incorporating Māori worldviews into biowaste management negotiations and solutions.

The presence of micro-contaminants in waste has been described as one of the main challenges facing humanity. Our extensive ecotoxicology platform uses a suite of biological-based methods in model organisms ranging from the microbial level (e.g. bacterial biosensors) to the macro fauna level (e.g. zebrafish and earthworms) to characterise the risk of a range of contaminants commonly detected in biowastes such as biosolids. We have developed a new assay to assess effects of contaminants on thyroid function and recently took part in an international thyroid interassay comparison organised by Waterways Research Institute in the Netherlands as part of an EU funded project. The interassay comparison provides an assessment of the robustness and applicability of the included assays to determining effects on thyroid function. We are also working with international collaborators in China, as well as collaborators in New Zealand using next generation molecular sequencing approaches to provide new understanding of the effect of contaminants on earthworms that in turn can be used to provide understanding of the mechanisms of effects in humans – in particular multi-generational (epigenetic) effects.

The risk characterisation of micro-contaminants in biowastes is underpinned by the most extensive chemical analysis capability available in New Zealand. This capability continues to expand with new analytical methods under development for the analysis of pharmaceuticals and polybrominated flame retardants in biosolids and biowastes. These world leading innovations in chemical analysis and ecotoxicology allow us to provide biowaste producers and regulators with a comprehensive risk assessment of the environmental and public health impacts of waste water and solids. We are developing partnerships with industry to investigate the use of system approach to establish novel solutions. This requires working closely with CIBR colleagues and other organisations

with complementary expertise like green chemistry that will assist New Zealanders achieve their sustainability objectives.

Contaminants in biowastes are often present in complex mixtures that can act together to increase toxicity (synergism). A key focus of our research is to understand the impacts of mixtures of contaminants in biowastes on the environment. We have been investigating how the mixtures of copper, zinc, and triclosan (antimicrobial used in bodycare products) effects soil microbes and key indicator species (e.g. earthworms). We found that the presence of co-contaminants in complex waste materials such as biosolids may combine to produce synergistic or additive ecotoxicological impacts upon soil function and health indicators. This work and other studies looking at triclosan in isolation have strongly indicated that this chemical represents a high risk to the environment and should be removed from products. CIBR research has provided evidence in a case put to the EPA by the Green party to ban triclosan. As well as providing evidence to Government bodies such as the EPA the CIBR team have also produced a user friendly pamphlet aimed at the general public – providing information on chemicals of concern and more environmentally friendly alternatives.

Contaminant mitigation is a focus of the research group at Lincoln University. Nutrient loss from agricultural areas is a major source of pollution for freshwater and coastal systems worldwide. Coupling the properties of plants as natural biofilters, with additional bioactive producing capabilities may offer enhanced ecosystem protection by inhibiting nitrification and enhancing pathogen-die off. Riparian strips are commonly used in farming systems to take up nitrogen and phosphorus as they grow. However nitrate is able to elude the roots and travel through groundwater directly into the waterway. Combinations of glasshouse and field scale experimental blocks are demonstrating that the incorporation of native plants into agricultural landscapes can reduce the impact of land application of waste and produce valuable native products such as essential oils and honey.

Our long-term field trial on Rabbit Island is unique both nationally and internationally due to the comprehensive and long-term assessment. A key focus of our research is to investigate the sustainability of long-term land application of biosolids in plantation forests through assessing the ecological and environmental impact on the pine plantation ecosystem. Biosolids from Nelson wastewater treatment plant have been applied every three years to a radiata pine forest on Rabbit Island since 1997. Tree nutrition, growth, wood properties, soil and groundwater quality have been monitored over the period of 19 years. The research findings from this long-term forest field trial have supported and informed management practices for sustainable land application of biosolids, and provided direct evidence for waste managers/land owners in Nelson in particular and other regions in general to make informed decisions during the resource consent application process. This long-term trial has demonstrated the sustainability of land application of biosolids and its economic outcomes, resulting in improved soil fertility, stand productivity (by 26%) and carbon sequestration in the forest and soil. In conclusion, long-term land application of biosolids has transformed the forest site from

relatively low to moderately high productivity without causing significant adverse effect on the environment.

Recently Louise Weaver's ORI Virus Removal programme, another legacy programme, has joined CIBR bringing key collaborator NIWA to the team. The virus removal team's research aims to establish a more complete view of virus removal in waste stabilisation ponds, a common and sustainable treatment of wastewater in New Zealand and overseas. The team have found that there are more virus removal mechanisms in these systems than was first thought, including attachment and settlement, protozoan grazing, and biological enzyme activities. This knowledge will help underpin development of pond modelling, improved design information and capability reducing the inherent risks associated with the uptake and application of this technology.

The Virus removal team is also actively undertaking research in the Pacific, an expanding area for ESR. As low cost, sustainable solutions to waste management in the Pacific we have conducted experiments investigating the natural attenuation potential for coral sands. Results have so far shown that coral sand has the potential for indicator (*E. coli*, enterococci and MS2 bacteriophage) retention. We are now moving to investigate the removal potential of viral pathogens in coral sands.

A major focus for the CIBR team this year has been the development of new biowastes guidelines. In partnership with WaterNZ, WasteMinz and the Land Treatment Collective, CIBR scientists have been driving the long overdue update of the 2003 national biosolids guidelines. The new guideline will be broadened to encompass all organic or 'bio' waste with a beneficial re-use potential in an effort to enhance sustainable biowaste reuse. CIBR have been providing the science underpinning the new guidelines, a significant pathway to uptake of our research.

Capability development is a key focus of CIBR with 19 postgraduate students and postdoctoral fellows involved with the programme. To further encourage capability development and innovation in the programme CIBR has established the "Project Incubator Fund". The fund supports new ideas and initiatives that have the potential to lead on to the development of larger research proposals. This year grants were awarded to Gerty Gielen and Grant Northcott to "Development of a robust extraction procedure for acidic pharmaceuticals from sewage sludge and biosolids" and to Brett Robinson and Saloomeh Seyedalikhani to investigate "NZ native vegetation to improve the quality of biosolids-amended soils, while producing essential oils".