NIWA
Taihoro Nukurangi

Half Yearly Report for the 6 months ended 31 December 2005

National Institute of Water & Atmospheric Research Ltd and Subsidiaries

Half Yearly Report For The Six Months Ended 31 December 2005

Financial Results

NIWA Group has made an operating surplus before tax of $1.5 million, against a budgeted surplus of $2.8 million for the 6 months ended 31 December 2005. Although our planned operating surplus is behind budget, profitability will improve as major milestones in research contracts (including the Capability Fund) are completed and usage of RV *Tangaroa* increases. Sufficient work has been secured to be confident that we will reach our year-end revenue target if all work can be completed as scheduled. Emphasis is currently being placed on employing more staff and ensuring all existing staff are working efficiently and effectively. Expenditure continues to track well with revenue, reflecting NIWA's 'cost-conscious' culture.

$3.8 million has been utilised on the acquisition of property, plant, and equipment, against a capital expenditure budget of $3.4 million for the 6 months to 31 December 2005.

The closing cash position on 31 December 2005 was $5.7 million. A dividend of $6.5 million was declared in December 2005 and paid in early January 2006.

The Board at this stage sees no reason to revise NIWA's budget forecast for the 2005–06 year.

Governance and Management

In this period NIWA has continued to operate in accordance with the Crown Research Institutes Act 1992 and the Companies Act 1993.

Increased effort has been placed on monitoring non-financial performance of each entity in the NIWA Group. Over 150 non-financial performance indicators are now reported on in detail at the end of each quarter to the NIWA Board.

Board meetings for each subsidiary in the NIWA Group have been increased from four to six a year to ensure our subsidiaries perform as planned. Detailed risk management strategies are being developed for each subsidiary to help mitigate impediments to growth and long-term viability.

Detailed service agreements between NIWA Corporate and each entity in the NIWA Group are now in place to ensure appropriate administrative/support services are provided.

Recruitment

Forty-eight permanent positions have been advertised this financial year. Twenty-four of these are new positions. To date 37 new staff have been appointed. Many of the new staff have replaced people who left NIWA and are bringing in new skills, or covering new areas, to meet changing client demand. Key appointments have been made in the following core areas: air quality, energy supply, aquaculture and fish health, environmental monitoring and real-time data provision, climate modelling, and natural hazards. International advertising, both in magazines for expatriates and on targeted scientific society websites, has been extremely

effective in attracting potential candidates, with over 300 expressions of interest from people wanting to work for NIWA.

Contracted Obligations
NIWA is on target to meet all its public good science, fisheries research, and commercial consulting obligations. Some notable achievements are described below.

Aquaculture
NIWA's capabilities in designing land-based abalone farming systems are attracting world-wide interest. Proposals have been provided for technical designs for abalone farms in Ireland, Malaysia, Oman, and Iran. The proposals would utilise NIWA-developed abalone rearing technology and adapt it to the species and diets available in each country. Farm scales vary from 10 tonnes to 30 tonnes of abalone production per annum.

Over 100 000 abalone (paua) juveniles have been harvested from our V-tank production system at Mahanga Bay and are currently being sold to commercial ongrowers.

The production of yellowbelly flounder at our Bream Bay Aquaculture Park has been a great success, with several thousand weaned juveniles produced and ready for ongrowing. Similar success has been achieved in the rearing of kingfish. Fingerling sales began in December and are anticipated to reach 100 000 by mid February. We are now forecasting the sale of 210 000 kingfish fingerlings to commercial ongrowers in 2005–06.

More than 588 000 juvenile salmon have been reared this year at our Silverstream hatchery. Deliveries to commercial ongrowers were completed by the end of November, which is 2–3 weeks earlier than normal.

Glass eels collected from the Waikato River several months ago, and relocated to our Bream Bay hatchery, are going from strength to strength. After coming into the hatchery at 0.15 g in September, they were graded in November. The average weight of the small grade was over 1.0g, with the large grade averaging 1.5 g. Weaning success has been very high and mortalities low which is a great success for this stage of culture for glass eels.

NIWA researchers have successfully seeded the large brown seaweed *Lessonia variegata* on to strings in the laboratory. The *Lessonia* life cycle was completed on the strings, resulting in a luxuriant growth of small sporelings. The sporelings have recently been transferred, in collaboration with industry, to mussel farms in the Marlborough Sounds, where growth will be monitored and assessed over the next few months. This is the first time this seaweed species has been cultivated on a pilot scale in New Zealand.

Fisheries
A stock assessment for the most valuable New Zealand fishery, hoki, has now been completed. The assessment, using our novel CASAL programme, has demonstrated that continued fishing at current Total Allowable Commercial Catch levels is likely to be sustainable and allow for increasing biomass unless recruitment is poor. There is now some evidence that fish are spawning at a younger age in the eastern stock.

An assessment of the snapper stock on the west coast of the North Island has shown that stock levels are significantly below preferred levels, and that it might take 15 to 30 years to recover to an appropriate stock size.

The first stock assessment of Antarctic toothfish for the Ross Sea (sub-area 88.1) was presented at the 2005 meeting of the Convention for the Conservation of Antarctic Marine Living Resources. The assessment suggests a long-term yield of almost 3000 tonnes from the Ross Sea region, with a further 300–400 tonnes from an adjacent region (sub-area 88.2). These estimates are slightly lower than the current Total Allowable Catch for these two exploratory fisheries.

Studies on catch per unit effort standardisation for albacore tuna and swordfish in the New Zealand Exclusive Economic Zone have been completed. A key feature of this work was the inclusion of remote sensed sea surface temperature data in the models. This is the first time that these data have been used in this way. Standardisation allows annual variation in catch per unit effort for the commercial fishery to be adjusted to allow for changes in local environmental conditions from year to year. The resulting estimates more accurately reflect long-term changes in abundance. The new models are a considerable improvement over those developed in previous years, with albacore tuna (in particular) showing a very well defined preference for sea surface temperatures of 19 °C.

NIWA's developing relationship with research organisations in Chile has been extended with a request for NIWA reviews of assessments of key hoki and orange roughy fisheries in Chile.

Aquatic Biosecurity

Experiments using controlled temperature tanks have assessed growth and flowering/fruiting performance of aquatic weeds under a range of climatic conditions to predict their invasiveness within New Zealand. The weed invasiveness potential of the emergent plant gypsywort (*Lycopus europaeus*) was assessed for the Auckland region, where it is has recently naturalised. Here, gypsywort is likely to be at least as successful under warmer conditions as it has been in the Waikato. Gypsywort can form dense patches which exclude native rushes, spread by long stolons, and set considerable quantities of water dispersed seed. This finding has provided support for pre-emptive action by the Auckland Regional Council. Information was also used to update the weed risk rating of gypsywort from 36 to 53, putting the species on a similar score to the problematic purple loosestrife, *Lythrum salicaria*.

Alligator weed (*Alternanthera philoxeroides*) and parrot's feather (*Myriophyllum aquaticum*) are troublesome invasive weeds of drainage and river systems in New Zealand. Field tests conducted by NIWA confirm that the herbicide triclopyr amine is far more effective in controlling these pests than other herbicides already registered here. Currently, triclopyr amine is not registered for use in New Zealand, but NIWA research results have prompted an application to the Environmental Risk Management Authority. NIWA has been asked to provide technical support to assist in registration. The registration of additional herbicides for new targets or environments provides biosecurity managers with better weaponry against pest plants.

The finding of the invasive diatom *Didymosphenia geminata* in the Buller River by NIWA attracted major media and public attention. Within days further incursions were reported in four other rivers by NIWA and Fish & Game. This generated a major response by Biosecurity

New Zealand, who commissioned NIWA to run a nationwide survey of 'most likely' *Didymosphenia* habitats. The survey was organised and commenced within three days. It involved major logistics, including multiple teams throughout the country of up to 10 field staff (including staff from regional councils, Fish & Game, and the Department of Conservation) and setting up field laboratories to carry out immediate sample analysis. Under considerable pressure for results, and public accusations of Biosecurity New Zealand neglecting its responsibilities, long hours were put in to complete the work within 3 weeks. Only one new incursion was found from 475 sites surveyed. No *Didymosphenia* was found in the North Island. This event triggered large political concern, and Cabinet approved funding for research into culture, detection, and control methods. NIWA is continuing to be the key science advisor to Biosecurity New Zealand for *Didymosphenia.*

Almost synchronously with the *Didymosphenia* incursion, the invasive seasquirt, *Styela clava,* was discovered in the Viaduct Basin. This caused a major response from the aquaculture industry because *Styela* has caused many millions of dollars of fouling problems in marine farms overseas. NIWA was contracted for the initial *Styela* delimitation survey and to identify potential spread to other areas. *Styela* was widely distributed in the Viaduct Basin and Freeman's Bay, but at moderate to low densities. The scope of the original project was modified almost daily with notifications of new occurrences elsewhere in New Zealand. As a result, NIWA was requested to survey a total of 26 locations nationwide in 4 weeks. An enlarged survey team was trained and deployed, and most surveys have been completed, with three new incursions being found.

Aquatic Biodiversity

NIWA biodiversity researchers, in collaboration with La Trobe University in Australia, have published an identification guide to common crustose coralline algae of central New Zealand. This guide has been described by experts as a 'world first', and makes coralline algal identification possible for a range of users, from professional phycologists to ecologists, students, and the interested amateur. It is the key output and showcase product resulting from a 2.5 year project funded by the Ministry of Fisheries.

Polychaete assemblages have now been described from samples collected at 151 stations on the Ross Sea shelf between Cape Adare and Cape Hallett. This is the first description of the polychaete assemblages, an important and often dominant aspect of benthic communities, in this area of the Ross Sea Dependency. Some 3146 polychaetes were identified to 113 putative species in 29 families with at least 2 species being new to science. Preliminary results indicate that one of the main, but indirect, driving forces for polychaete assemblage composition is primary production in the surface waters, which affects the assemblages via the phytodetritus that sinks to the seabed. Another important factor influencing polychaete assemblages is disturbance caused by iceberg scouring.

Collaborative research with Oslo University has led to the development of a model that links biodiversity to habitat diversity and allows for the effect of habitat diversity when predicting species richness. The model, the first of its kind, can be used to predict the effects of habitat removal on the species richness of specific areas. Research will further develop the model to predict the role that habitat generalists play in maintaining biodiversity and the effects of habitat removal on diversity.

NIWA research on seagrass biology, ecology, and conservation shows that seagrass meadows are important habitats for invertebrates and the growth of young fish in New Zealand coastal environments. Recent studies have found higher genetic diversity, and more rapid recovery following physical disturbances, than expected. This suggests that seeds play a more important role in the establishment and persistence of seagrass habitats than previously suspected, based on concepts of vegetative reproduction. This research helps define the need to carefully manage seagrass meadows for the benefit of the ecosystems and sustainable fish communities. A review article has been published that summarises the findings of new research on the dispersal and recruitment strategies of seagrasses, and the potential role of seeds in seagrass restoration projects.

The New Zealand Marine Macroalgal e-Flora project has been launched (in New Zealand in October and at the Asia Pacific Phycology Forum in Bangkok in November). The goal is to provide up-to-date, fully illustrated accounts of species, genera, families, and orders, supported by a flora framework that will include an overview of the flora, maps, and an illustrated glossary. The e-flora will operate at several levels to include plain language accounts aimed at a wide readership using minimal technical language and detailed scholarly treatments aimed at professional phycologists. Within the phycological community the New Zealand macroalgal e-flora is a world-first and the launch has been well-received. This approach has been adopted so that taxonomic treatments will be published quickly as data become available, thus making knowledge more readily accessible. Collaborations on New Zealand taxa have been initiated with researchers in Australia, USA, Japan, Korea, Taiwan, Eire, Canada, and New Caledonia.

A large-scale revision of the marine isopod family Aegidae (micro-predators of fishes) nears completion for publication in the *NIWA* Biodiversity Memoir series. The New Zealand fauna now stands at 44 species in three genera, with three species of the four previously known species removed from the New Zealand fauna. The number of genera will increase, pending results of a phylogenetic analysis. In the course of this study 25 new species will have been described. (In 2001 there were 211 known aquatic isopods recorded for the New Zealand fauna. Today there are some 330 species, including known undescribed species. In that period 22 new species and one new genus have been described).

Freshwater

There is extensive concern that forest harvesting dramatically increases suspended sediment loads to lakes and the sea. Six years of sediment data collected by Environment Waikato from the Opitonui River in the Coromandel Peninsula were analysed to determine the effects of forest harvesting activities. Surprisingly, weather events produced more variability in the river's sediment load than forest harvesting. The annual average sediment yield was within the range experienced from other exotic forests under harvest and may be a product of good harvesting practices and protection of the riparian zone. This study will be useful for developing operational harvesting guidelines.

The need for refugia in rivers to allow for the protection of biota from catastrophic events, such as floods, has become an important issue in river and river restoration ecology. Medium- to large-scale features such as oxbow lakes, backwaters, and boulder bars are now widely promoted as important features to protect as refugia for invertebrates and fish. Studies recently completed by NIWA show that the surface texture of stones, representing different rock geologies, is an important factor determining refuge availability for attached algae.

Rocks such as pumice afford a large degree of protection, whereas well-worn greywacke affords little protection. This work suggests that primary production and associated ecosystem recovery rates are likely to be much faster following catastrophic events in rivers containing stones with rough surfaces than those with smooth surfaces, and provides an important mechanism to help explain large differences in ecosystem resilience observed among rivers following disturbance.

NIWA has completed the development of NPLAS, a new web-based computer model for the prediction of nitrogen and phosphorus losses from single properties in the Rotorua Lakes area. NPLAS will be used for land use consenting under the Environment Bay of Plenty's Land and Water Plan. The website will be opened to the public soon. The model has been demonstrated to the Ministry of Agriculture & Forestry and the New Zealand Fertiliser Manufacturer's Association. There is potential to extend this system to other locations around New Zealand, such as the Manawatu.

Freshwater crayfish (or koura) are an important mahinga kai resource for Māori and are a vital component of healthy natural freshwater ecosystems. To better understand this resource, NIWA scientists have studied koura habitat preferences in almost 800 locations in 30 rivers and streams. The resulting research produced models that correctly predicted the presence/absence of koura at 75% of locations, using habitat variables such as water velocity and the presence of different types of instream cover. The research will assist in stream management for the enhancement of koura for mahinga kai purposes, in stream protection, and especially in restoration programmes on degraded streams.

Water harvesting from rivers provides a solution to restricted agricultural development in water-short areas. One of the environmental 'costs' of water harvesting is the subsequent development of woody vegetation in former stream channels that affects channel shape, sediment transport, and river ecology. NIWA researchers have developed a computer model that links channel vegetation with river conditions and enables the effects of water harvesting on river flow and sediment movement to be determined. NIWA is now using the model to run future development scenarios for water-short regions.

Stocks of endemic longfin eels have seriously declined in recent years due to overfishing, dam construction, habitat modification, and water abstraction. NIWA research has shown that eels require relatively high minimum residual flows at night for feeding. During the day, large eels shelter and rest in pools beneath bank and instream cover and require little water. At dusk they move into fast flowing shallow waters to feed, and therefore require similar amounts of water to trout. This is the first evidence to show that flow recommendations designed to maintain and enhance eel stocks need to take into account the higher night-time flow requirements of eels.

The process of river bed and bank erosion during floods is important for engineering designs, biodiversity maintenance, and sediment transport. NIWA has developed cutting edge technology to measure pressure fluctuations and the movement of gravel particles in rivers in flood. The new technology includes a specially designed and made turbulence sensor and stones tagged with radio transmitters. The physical processes that cause upward lift of gravel particles were shown to provide the major forces in riverbed erosion. This information will be used by river engineers, regional councils, and by hydropower companies who release flows from dams to rivers.

Coasts and Oceans

NIWA achieved a major milestone for marine and coastal science in New Zealand with the formal release by the Minister for the Environment of NIWA's Marine Environment Classification System. This new tool will be used extensively in the development and management of coastal fisheries and aquaculture farms.

The transport of the larval stages of coastal shellfish by marine currents is crucial to the sustainability of these coastal resources. NIWA's numerical modelling studies of the transport of larval paua on the Gisborne open coast have shown that the recruitment of larvae is from a combination of outside sources and from self-recruitment. Our results show that an ideal management system would place marine reserve areas at spacings of 15–40 km along the coast to ensure larval supply to areas between reserves. These results provide much needed quantitative information on marine reserve area designations.

The Firth of Thames supports the largest single mussel farm in New Zealand, and this farming area may triple in size under pending applications. It is therefore crucial for regional councils to assess and predict the environmental effects of aquaculture. Of particular importance is the amount of plankton removed from the waters of the Firth by the farms due to mussel feeding. NIWA research and modelling has shown that at maximum projected development the farms would remove 1.6% of the annual plankton production. This is less than the defined Limits of Acceptable Change for plankton removal imposed on the Aquaculture Management Area and shows that the farms will have a minor impact on this aspect of the Firth's marine ecosystem.

There has been considerable public concern over perceived erosion of Pauanui Beach in the Coromandel. Three years of images taken by NIWA's Cam-Era instrument at Pauanui Beach have been analysed to detect shoreline trends and variability. Despite the public concern, the data show that erosion is not occurring. A large interannual variability (up to 30 metres) is clearly observed with the cross-shore extent of the beach, but no overall trend can be established. Pauanui Beach is characterised by a strong seasonal pattern, with erosion occurring during the first 6 months of the year and beach build-up primarily occurring during the last 6 months of each year.

Heavy metal pollution of urban estuaries is a major issue for larger coastal cities. Recent research has determined that the addition of uncontaminated sediments in harbours and estuaries can reduce the toxic effects of heavy metals already present. The results may have significant implications for how regional councils manage urban catchments as sediments and heavy metal inflows to these estuaries will need to be managed jointly. Discussions are currently underway with the Auckland Regional Council to investigate the feasibility of joint management of sediment and heavy metals.

A recently completed survey of Cook Strait by RV *Tangaroa* has revealed the faulted and unstable nature of the seabed at an unprecedented level of resolution. The voyage was the fifth in a series designed to image the entire depths of the Strait. The data reveal massive current scours across the narrows region, a deep canyon system associated with hundreds of landslides, and active fault traces, including the 1855 Wellington earthquake rupture. The new data set will enable much improved assessments of earthquake and tsunami sources, better understanding of plate boundary processes and evolution of canyon systems in

seismically active regions, more informed planning for power and telecommunication cable installations, and it provides important information for fisheries and studies of biodiversity.

Oceanic mixed layer nutrient concentrations are an important factor controlling phytoplankton growth and primary production. Measurements made in situ, while precise, often cannot be used to infer estimates of primary production on large spatial scales. Models to predict mixed-layer nitrate concentrations from measurements of temperature and chlorophyll concentration have been derived for the open ocean of the New Zealand Exclusive Economic Zone. These models have been validated using unique NIWA data sets which resolve the seasonal variation in nitrate concentrations in the Chatham Rise region. Ultimately, the combination of these models and satellite data will give the spatial and temporal sampling frequency needed to study seasonal and inter-annual variability in primary production in our Exclusive Economic Zone.

The Hokitika and Cook Canyons and their associated channel complexes have been mapped for the first time over distances more than 650 km from the coast. These canyons are key spawning areas for hoki and hake.

Significant fluxes of methane were detected in the water column above cold seep sites on the Wairarapa coast during a recent voyage of *Tangaroa*, which successfully recovered and redeployed two biophysical moorings in subtropical waters. There has been significant interest from Crown agencies regarding the methane seeps as a potential energy resource.

Māori Development

New Zealand lakes and ponds often have large populations of koura or freshwater crayfish. These are an important traditional food source for Māori, particularly for Te Arawa and Ngati Tuwharetoa of the central North Island. There is anecdotal evidence that changes in lake conditions (e.g., spread of exotic weeds, reduced bottom water dissolved oxygen due to eutrophication, exotic fish introductions) over the last 50 years have reduced koura abundance in many lakes. However, the lack of quantitative information on trends in koura abundance makes it difficult for iwi and government agencies to formulate plans for managing this taonga species. A key obstacle is the lack of sampling methods for monitoring koura populations. Several methods have been investigated. Tau koura appears to be a particularly useful method for monitoring long-term patterns in catch per unit effort and koura population structure, particularly where the lake bed is relatively free of tall-growing aquatic plants. A preliminary protocol for use of the Te Arawa tau koura method as a monitoring tool has been developed in collaboration with Ngati Pikiao.

An interactive/educational CD Rom (Kaitiaki Toolz) has been designed to assist iwi resource managers through the resource consent process and help to produce submissions based on scientific facts. The program provides information about the effects of various land-use changes and industry discharges on freshwater mahinga kai species and recommends appropriate mitigation actions.

A Foundation for Research, Science & Technology funded research partnership with Ngai Tahu Seafood was established to add value to fish waste and bycatch by identifying products for use in the cosmetic industry. NIWA have recently developed a new UV-stress functional assay which is a reliable model of the effects of the sun's radiation. The assay identifies extracts which decrease or stop UVA and UVB damage in cells, and thereby have potential

for inclusion in sun-block creams and cosmetics. Use of the new assay system has already highlighted several promising extracts in fish waste and bycatch species.

In 2001, NIWA were granted funds to examine the relationship between the matauranga hauora (i.e., health knowledge) of indigenous communities and the coastal marine environment in New Zealand. NIWA and our subcontractor Crop & Food Research found that there was no significant difference between the frequency of fish consumed by hapu members living in a 'non-traditional', more urbanised setting and those living in a 'traditional' setting. However, the pattern of consumption differed between groups. Non-traditional hapu members consumed tinned tuna more often, but consumed shellfish and other seafood less often than those living in a traditional setting. These differences were consistent with a greater reliance on processed foods, and may reflect the relative availability of processed foods compared with fresh fish in non-traditional or more urbanised settings.

Energy

Sewage treatment plants produce methane gas as a by-product of the treatment process. This gas can be recycled as a fuel for the operation of the treatment plants. NIWA and Hamilton City Council are collaborating in a research investigation into the feasibility of capturing methane gas from sewage treatment ponds. A series of large experimental anaerobic digesters has been constructed at Hamilton's Pukete Wastewater Treatment Plant. The project will measure the amount of methane that can be collected for use in energy production and the enhancements in waste treatment that can be subsequently achieved.

Forecasts of daily temperature, rainfall, wind, and solar radiation are now produced by NIWA out to 14 days ahead at up to about 50 sites. The forecasts are derived from ensembles of 2-week weather predictions made by the U.S. National Oceanographic & Atmospheric Administration. These 2-week forecasts have also been shown to lead to 1-month temperature predictions that are an improvement on previous estimates by NIWA. These forecasts will also be incorporated into the hydro-storage lake inflow predictions. There are significant economic gains to the energy industry from this research.

Natural Hazards

Recent studies, in collaboration with the University of Waikato, have shown that there are examples of 'large' tsunamis (10–50 m high) along the New Zealand coast during the last 800 years of human occupation, but no evidence of 'mega-tsunamis' (> 50 m). Causes of the large tsunamis include submarine volcanic activity, continental shelf earthquakes, submarine landslides, and debris avalanches. The large tsunamis may have resulted in major changes in the nature of Māori coastal settlements.

A project to develop a Geographic Information System (GIS) based flood risk model of five countries in Eastern Europe for use by the insurance industry has been completed. NIWA developed and applied a flood model that predicted water extent and depth at high spatial detail for over 1500 flood scenarios, including cases of flooding from failure of flood defences, in Austria, Hungary, Poland, Slovakia, and the Czech Republic. The development of this model merged very large GIS databases (including satellite-derived topography) with pragmatic water routing routines. Other members of the project team used the flood model results to calculate 'damage functions' for different lines of business, with the final results mapping loss estimates by postcode areas on a probabilistic basis and for specific events. The

project results will be made available to the European insurance industry in 2006. The leading-edge GIS work done by NIWA was critical to the project's success. A similar, but larger, contract to map the catchment and coastal flooding hazard of Norway and Sweden has recently been secured. NIWA's contribution to this new project is currently being negotiated.

Two technical reports have been prepared for the Tokelau Government to assist in the future reduction of coastal hazard risks, particularly those associated with cyclonic storm surge and wave overtopping and inundation. The first report provides an assessment of historic cyclones and associated coastal hazards, including wave set-up and inundation. The second report focuses on mitigating coastal hazards for the main atoll groups. The work is part of a more detailed strategic framework that aims to develop a set of guiding principles for consideration by the Tokelau administration for long-term reduction of cyclonic storm surge risk.

A new web-based tool has been developed to display coastal information relevant to coastal hazard assessment and management. This tool, called 'NZCoast', provides a 'live' GIS platform for displaying features such as basic shoreline morphology, (e.g., beach, dune field, cliff, hapua), beach sediment type, and hinterland character, along with context layers (such as topography, river network, etc.). It is planned to include numerical information on coastal forcing functions (e.g., wave climate, tidal range) as well as interpretive indices such as vulnerability to inundation by tsunami, coastal storm flooding, and coastal erosion. The site is currently viewable only within NIWA, but will be made public after evaluation (http://chimera.chch.niwa.co.nz/coast/map.phtml).

A new model for detailing the wind hazard in New Zealand has been applied to Wellington City and used to quantify the large variations between shelter and exposure that result from Wellington's characteristic hills and city skyline. This work is complemented by the development of a 'virtual wind tunnel' using the Computational Fluid Dynamics code Gerris. In comparisons the simulations are at least as good as other Computational Fluid Dynamics methods and within 3% of observed results and real wind-tunnel tests. The system will eventually provide engineers with a cheaper and more versatile alternative to wind tunnel methods to calculate pressure loadings and pedestrian level wind modifications.

Atmosphere

An analysis of the NIWA Climate Database usage over the last financial year has shown remarkably high interest, with more than 20 million rows of data accessed via the web interface, CliFlo, during the last financial year from nearly 142 900 separate transactions. For users who obtain data from the Climate Database via a telnet session, there is no comparable usage information available; however, we know 92 users accessed the database for more than 14 600 hours.

New studies have confirmed that summer UV intensities in New Zealand are much greater (by almost 30%) than in corresponding latitudes in the USA. The differences are slightly smaller than between New Zealand and Europe. They are due to differences in Sun-Earth separation, ozone, and aerosols. The findings verify that New Zealanders are at much greater risk of skin cancer from sunburn.

An important NIWA study determining the oxidising power of the atmosphere, using Baring Head and Scott Base measurements, was recently published in the prestigious journal *Nature*. The study determined that, over the last 13 years, the average concentration of the critical

atmospheric 'detergent', the hydroxyl radical OH, had not changed significantly despite increasing pollution. However, for the first time, short-term decreases of up to 20% in the OH concentration were identified, and it was deduced they were caused by the Mt Pinatubo eruption in 1991 and the Kalimantan fires in 1997.

A simple method has been used to identify areas with similar climate, soil, and topography to those at existing grapegrowing locations in eight major viticulture regions in New Zealand. Indices of 'similarity' were derived for each region and maps of this index are available on CD. The maps show areas that are potentially suitable for growing the same grapes as those grown in the established vineyards. This approach demonstrated the power of GIS techniques, and the project featured in an article for the October issue of *The Climate Update*.

Although the size of the Antarctic ozone hole has been decreasing recently, the question remains as to whether this is the recovery expected as the emissions of ozone destroying substances are reduced. NIWA's research has considered the chemical and dynamical conditions for the reduced ozone hole, and concluded that the active chlorine concentrations have not decreased, and the increased ozone concentrations are due to increased stratospheric temperatures. Hence, the recovery in ozone that would come from reduced emissions has not yet been observed. This important result demonstrates that as well as monitoring the ozone concentrations, a good understanding of the science is needed for the correct interpretation.

NIWA's coupled atmospheric chemistry model has been used as part of an international effort to investigate the relationship between climate change and changes in atmospheric chemistry. The model will also be used for the upcoming World Meteorological Organization/United Nations Environment Programme global ozone assessment. Because of the significant computing resources required for this type of modelling, NIWA is one of only a few institutes in the world able to participate in this work. The ozone assessment results will be of considerable significance to managing human health risks from UVB overexposure in New Zealand and internationally.

Two significant advances have been made in statistical prediction of New Zealand rainfall. Realistic synthetic rainfall time series are now being produced. It has been shown that seasonal changes can be attributed entirely to the frequency of rainfall events and not to their intensity, and also that rainfall 'seasons' do not align with the standard meteorological seasons. Another prediction scheme for New Zealand seasonal-average rainfall has been developed in collaboration with the Australian Bureau of Meteorology Research Centre. Prediction skill is substantially higher than achieved previously.

Recent NIWA research has shown how El Niño-Southern Oscillation variations in the tropical Pacific can influence sea-ice concentrations around Antarctica, further linking the coupled systems. These sea ice variations also have a significant effect on climate through changing the amount of reflected solar radiation and energy fluxes between the atmosphere and oceans. The publication of this significant work was recently recognised by the award of the Royal Society's Kidson medal to Dr Jim Renwick.

National Centres

The commercial consulting services of NIWA are marketed through seven National Centres – Climate, Aquatic Biodiversity & Biosecurity, Water Resources, Coasts & Oceans, Natural Hazards, Climate-Energy Solutions, and Fisheries & Aquaculture. The Centres have helped to

improve the quality and scope of our services, better target client needs, and enhance access to our skills. Each Centre routinely produces a newsletter that is sent to existing and potential clients. The look, content, and distribution of these newsletters have recently been revised to improve our market image, brand, and reach. Each newsletter is now produced every 2 months (previously quarterly), with the exception of *The Climate Update*, which is monthly.

NIWA Vessels Management Ltd

Both RV *Tangaroa* and RV *Kaharoa* will spend more time at sea this financial year than budgeted for in our 2005–06 Business Plan. The likely number of sea days for *Tangaroa* is 299 (cf. 271 budgeted). The likely number of sea days for *Kaharoa* is 221 (cf. 216 days budgeted).

NIWA Natural Solutions Ltd

In the first quarter of 2005–06, NIWA's Intellectual Property Management Committee evaluated nine concept documents under the stage-gate commercialisation process and approved two of these for 'proof of concept' research. A natural bio-herbicide for control of invasive plants has progressed through the first 'gate' and transferred into the NIWA Natural Solutions portfolio as a Horizon 3 opportunity.

Ensid Technologies, jointly owned with a private investor and formed to sell our unique electronic identification tags, is now marketing directly to customers and to solutions providers in the identification and product tracking market sectors. Although the technology was initially developed for the tagging of fish for the research and aquaculture markets, it is apparent that the greatest opportunities lie in the tracking of products in the food and beverage industries and in animal identification. Partnering agreements are well-advanced with significant global companies in these sectors.

NIWA in the USA

Appropriate management and governance structures are being maintained to allow access to US research funds and facilitate interactions with key collaborators. Sufficient research grants have already been obtained to exceed the 2005–06 revenue target for our US subsidiaries.

NIWA Australia Pty Ltd

Partnering arrangements with two Australian companies have led to successful tenders for studies on stormwater management in Singapore and monitoring flows for hydroelectric power development in Vietnam. Further joint tenders have been submitted for work in Malaysia and the Philippines.

A trial of a novel system for treating wastewaters from prawn farming activities has been designed jointly with researchers from the Department of Primary Industry and will be carried out at their Bribie Island Aquaculture Research Centre in South-East Queensland during the prawn season (November to March). Pollution from prawn farm wastewaters is limiting expansion of the industry, both in Australia and Asia.

Marketing of our highly differentiated service package on vehicle emissions testing and analysis has led to the securing of an initial contract in Brisbane, where poor urban air quality

has been recognised as a potential health concern. This study is serving as a 'pilot' for studies in other Australian cities.

EcoConnect Ltd

EcoConnect Ltd is scheduled to start delivering real-time environmental forecasts in July 2006. Good progress has been made to date in establishing the web-based delivery infrastructure, bringing environmental models up to operational capability, and in assessing market demand.

Unidata Pty Ltd

Good progress has been made on incremental upgrades to key Unidata products. An upgraded water level measuring instrument is ready for production and final testing, and release to production of other flagship products is scheduled for the end of January.

Joint Unidata/NIWA development of a new integrated system for real-time data collection, transfer, and reporting is progressing well with the fundamental structure of the server framework now well advanced. A web-based output is now available for demonstration through a NIWA server.

Sue Suckling
Chair

Rick Pridmore
Chief Executive

February 2006

National Institute of Water & Atmospheric Research Ltd and Group
Statement of Financial Performance (Unaudited)
For the 6 Months Ended 31 December 2005

	Note	6 mths to Dec 05 ($000s)	6 mths to Dec 04 ($000s)	12 mths to Jun 05 ($000s)
Revenue		42,190	40,419	91,137
Operating surplus/(loss) before taxation	*2*	**1,460**	**2,282**	**9,654**
Taxation (expense)/refund		(836)	(753)	(3,220)
Net surplus		**624**	**1,529**	**6,434**
Net surplus comprises:				
Parent interest		651	1,550	6,437
Minority interest		(27)	(21)	(3)
		624	**1,529**	**6,434**

The accompanying 'Notes to the Financial Statements' are an integral part of, and should be read in conjunction with, this 'Statement of Financial Performance'.

National Institute of Water & Atmospheric Research Ltd and Group
Statement of Movements in Equity (Unaudited)
For the 6 Months Ended 31 December 2005

	Note	6 mths to Dec 05 ($000s)	6 mths to Dec 04 ($000s)	12 mths to Jun 05 ($000s)
Net surplus				
Parent		651	1,550	6,437
Minority interests		(27)	(21)	(3)
Foreign currency translation reserve movement		553	539	312
Total recognised revenues and expenses		**1,177**	**2,068**	**6,746**
Distributions to owners				
Dividends		–	–	(15,000)
Movements in equity for the year		**1,177**	**2,068**	**(8,254)**
Equity at the beginning of the year		43,690	51,944	51,944
Equity at the end of the year		**44,867**	**54,012**	**43,690**

The accompanying 'Notes to the Financial Statements' are an integral part of, and should be read in conjunction with, this 'Statement of Movements in Equity'.

National Institute of Water & Atmospheric Research Ltd and Group
Statement of Financial Position (Unaudited)
As at 31 December 2005

	Note	6 mths to Dec 05 ($000s)	6 mths to Dec 04 ($000s)	12 mths to Jun 05 ($000s)
Equity				
Share capital		24,799	24,799	24,799
Retained earnings	3	19,417	28,879	18,766
Foreign currency translation reserve		617	289	64
Shareholders' interest		44,833	53,967	43,629
Minority shareholders' interest		34	45	61
Total equity		**44,867**	**54,012**	**43,690**
Non-current liabilities				
Unsecured loans		409	400	403
Employee entitlements		1,627	1,708	1,598
Total non-current liabilities		**2,036**	**2,108**	**2,001**
Current liabilities				
Payables and accruals		22,399	16,661	13,163
Tax Payable		–	–	18
Short-term advance facility		–	–	1,700
Employee entitlements		4,478	4,004	6,278
Total current liabilities		**26,877**	**20,665**	**21,159**
Total equity and liabilities		**73,780**	**76,785**	**66,850**
Non-current assets				
Property, plant, & equipment		42,634	43,475	43,295
Identifiable intangibles		142	92	59
Investments		98	–	47
Future income taxation benefit		1,446	979	1,460
Receivables and prepayments		366	547	208
Total non-current assets		**44,686**	**45,093**	**45,069**
Current assets				
Cash and short-term deposits		5,667	7,317	1,357
Receivables and prepayments		13,434	13,167	15,721
Taxation receivable		454	1,038	109
Inventory and Contract work in progress		9,539	10,168	4,594
Total current assets		**29,094**	**31,692**	**21,781**
Total assets		**73,780**	**76,785**	**66,850**

The accompanying 'Notes to the Financial Statements' are an integral part of, and should be read in conjunction with, this 'Statement of Financial Position'.

National Institute of Water & Atmospheric Research Ltd and Group
Statement of Cash Flows (Unaudited)
For the 6 Months Ended 31 December 2005

	Note	6 mths to Dec 05 ($000s)	6 mths to Dec 04 ($000s)	12 mths to Jun 05 ($000s)
Cash flows from operating activities				
Cash was provided from:				
Receipts from customers		55,167	46,377	90,442
Interest received		176	222	355
Cash was disbursed to:				
Payments to employees and suppliers		(44,298)	(40,959)	(71,048)
Interest paid		(1)	–	(1)
Taxation expense paid		(1,187)	(1,000)	(3,000)
Net cash inflow from operating activities	*4*	**9,857**	**4,640**	**16,748**
Cash flows from investing activities				
Cash was provided from/(applied to):				
Sale of property, plant, & equipment		–	38	169
Purchase of property, plant, & equipment		(3,758)	(2,531)	(7,348)
Investment in associates		(95)	–	(107)
Net cash outflow from investing activities		**(3,853)**	**(2,493)**	**(7,286)**
Cash flows from financing activities				
Cash was provided from/(applied to):				
Dividends paid to shareholders		–	–	(15,000)
Unsecured loan received/(repaid)		6	(24)	–
Short-term advance facility received/(Repayment)		(1,700)	–	1,700
Net cash outflow from financing activities		**(1,694)**	**(24)**	**(13,300)**
Net increase/(decrease) in cash held		**4,310**	**2,123**	**(3,838)**
Opening cash balance		1,357	5,195	5,195
Closing cash balance		**5,667**	**7,318**	**1,357**

The accompanying 'Notes to the Financial Statements' are an integral part of, and should be read in conjunction with, this 'Statement of Cash Flows'.

National Institute of Water & Atmospheric Research Ltd and Group
Notes to the Financial Statements

1. Statement of accounting policies

There have been no changes to the accounting policies stated in the 2005 annual report. These policies have been consistently applied during the 6 months ended 31 December 2005.

These interim financial statements have been prepared under the requirements of FRS-24: Interim Financial Statements. They should be read in conjunction with the 2005 annual report.

(a) Basis of consolidation

The financial statements are for the NIWA Group only. This comprises the Parent company (the National Institute of Water & Atmospheric Research Ltd) and its subsidiaries (NIWA Vessel Management Ltd, NIWA Australia Pty Ltd, NIWA Environmental Research Institute, NIWA (USA) Inc., NIWA Natural Solutions Ltd, and Unidata Pty Ltd.) and the Group's interest in associates (Ensid Technologies Ltd and Ensid Investments Ltd). The NIWA Group financial statements are accounted for using the purchase method, except for the associates, which are accounted using the equity method. The Group recognises its share of the associates' net surplus or deficit for the year as operating revenue in its statement of financial performance. The Group recognises its share of other post-acquisition movements in reserves in its statement of movements in equity. All significant intercompany transactions are eliminated on consolidation.

(b) Comparatives

The financial statements for the 6 months ended 31 December 2005 and for the comparative 6 month period to 31 December 2004 are unaudited. The comparative figures for the year ended 30 June 2005 are extracted from the audited financial statements at that date.

(c) Implementation of New Zealand equivalents to International Financial Reporting Standards

NIWA has commenced reviewing its accounting policies and financial reporting to comply with the New Zealand equivalents of International Financial Reporting Standards ('NZ IFRS'). NIWA intends to adopt NZ IFRS for the year ending 30 June 2008, and accordingly the first report using NZ IFRS will be for the half year ended 31 December 2007. The transitional rules for the first time adoption of NZ IFRS require NIWA to restate our comparative financial statements using NZ IFRS. The majority of the adjustments required on transition will be made to opening retained earnings in the opening NZ IFRS balance sheet as at 1 July 2006. The company has allocated internal resources and may engage external consultants to conduct impact assessments to isolate key areas that will be impacted by the transition to NZ IFRS.

Set out below are the key areas where accounting policies may change and have an impact on the financial reports of NIWA. It should be noted that at this stage NIWA is not able to reliably quantify the impacts of the new standards. NIWA will be required to restate the Statement of Financial Position of the comparative period financial statements in accordance with the version of NZ IFRS applicable at the first NZ IFRS reporting date. Changes continue to be made to NZ IFRS, and therefore there may be further changes to the information disclosed.

(i) NZ IAS 12 – Income taxes

A 'balance sheet' approach will be adopted, replacing the 'income statement' approach under NZ GAAP. This method recognises deferred tax on most temporary differences between the carrying value of an asset or liability and its tax base. This change may lead to larger deferred tax balances being carried. Any initial impact will be on retained earnings as at 1 July 2006, but it is not expected to impact significantly on the tax expense reported in subsequent periods.

(ii) NZ IAS 36 – Impairment of Assets

An asset is impaired if its carrying value exceeds its recoverable amount, being the higher of the asset's fair value less costs to sell or 'value in use' to NIWA. Fixed assets must be reviewed each year to determine whether there are any indications that they may be impaired. Any impairment identified should be recognised immediately in the Statement of Financial Performance.

(iii) NZ IAS 39 – Financial Instruments: Recognition and Measurement

NZ IFRS requires NIWA to recognise the derivatives used by the Group to hedge exposures to foreign currencies and interest rates on the balance sheet at fair value. Gains or losses on such contracts, even if unrealised on unsettled transactions, will be reported in the statement of financial performance in each period, except in those cases where effectiveness tests are met and hedge accounting can be used. If a derivative instrument does qualify for hedge accounting, any change in fair value will be recognised directly within the Statement of Movements in Equity, then released to the Statement of Financial Performance in the same period as the hedged item is recognised in the Statement of Financial Performance. Any ineffectiveness is recognised in the Statement of Financial Performance immediately. Given the current level of hedging and short-term nature of most hedges, no significant impact is anticipated. Higher volatility of earnings from period to period may result as the reported impact of a hedging instrument may now fall in a different reporting period to the impact of the underlying risk.

A number of other items related to financial reporting are also under consideration in conjunction with the transition to NZ IFRS.

2. Operating surplus before taxation

	6 mths to Dec 05 ($000s)	6 mths to Dec 04 ($000s)	12 mths to Jun 05 ($000s)
The operating surplus before taxation is stated after charging/(crediting):			
Interest revenue	(176)	(222)	(355)
Interest expense	1	–	1
Depreciation	4,380	4,294	9,204
Directors' fees	143	130	260
Renting and operating lease costs	501	527	1,093
Remuneration of auditor:			
Deloitte – audit fees	21	19	104
Deloitte – other services	–	–	15

3. Retained earnings

	6 mths to Dec 05 ($000s)	6 mths to Dec 04 ($000s)	12 mths to Jun 05 ($000s)
Balance at beginning of the year	18,766	27,329	27,329
Add net surplus	651	1,550	6,437
Less dividend paid	–	–	(15,000)
Balance at end of the year	**19,417**	**28,879**	**18,766**

4. Reconciliation of net surplus to net cash inflow from operating activities

	6 mths to Dec 05 ($000s)	6 mths to Dec 04 ($000s)	12 mths to Jun 05 ($000s)
Net surplus	624	1,529	6,434
Add/(less) items classified as investing activities			
Net gain/(loss)on disposal of property, plant, & equipment	(89)	50	(147)
Add/(less) non-cash items			
Share of Associate's deficit for the year	44	–	60
Depreciation	4,380	4,294	9,204
Amortisation of identifiable intangibles	2	17	9
(Gain)/Loss on foreign currency loan	6	–	(21)
Unrealised changes in the value of subsidiaries	553	346	313
Increase/(decrease) in employee entitlements	29	(44)	(154)
Increase/(decrease) in provisions	–	–	–
(Increase)/decrease in future income taxation benefit	14	–	(481)
	5,028	4,613	8,930
Add/(less) movements in working capital items			
Increase/(decrease) in payables and accruals	9,236	3,322	(176)
Increase/(decrease) in employee entitlements	(1,800)	(821)	1,453
(Increase)/decrease in receivables and prepayments	2,129	1,855	(360)
(Increase)/decrease in inventory and contract WIP	(4,944)	(5,661)	(86)
(Increase)/decrease in taxation receivable	(327)	(247)	700
	4,294	(1,552)	1,531
Net cash inflow from operating activities	**9,857**	**4,640**	**16,748**

5. Commitments

5a Operating lease obligations

	6 mths to Dec 05 ($000s)	6 mths to Dec 04 ($000s)	12 mths to Jun 05 ($000s)
Obligations payable after balance date on non-cancellable operating leases:			
Within 1 year	944	744	938
Between 1 and 2 years	804	678	786
Between 2 and 5 years	1,953	1,831	2,175
Over 5 years	3,718	3,136	4,271
	7,419	**6,389**	**8,170**

5b Capital commitments

Commitments for future capital expenditure:			
Approved, but not contracted for	3,444	2,656	–
Contracted, but not provided for	778	809	119
	4,222	**3,465**	**119**

6. Contingent liabilities

The New Zealand companies have a contingent liability in respect of the Accident Compensation Commission's residual claims levy. The levy will be payable annually from May 1999 for up to 15 years. Each Company's future liability depends upon ACC's unfunded liability for past claims and future payments to employees by these companies. There are no other significant contingent liabilities that require disclosure in the financial statements.

7. Subsequent events

The Board of Directors declared a dividend of $6.5 million on 14 December 2005. The payment of the $6.5 million was made on 9 January 2006.

National Institute of Water & Atmospheric Research Limited
Directory

BOARD OF DIRECTORS

Sue Suckling, *Chair*

John Spencer, *Deputy Chair*

Dr Carolyn Burns

Miranda Cassidy

John Hercus

Dr Graham Hill

Ed Johnson

Troy Newton

David Sharp

EXECUTIVE MANAGEMENT

Dr Rick Pridmore, *Chief Executive Officer*

Dr Bryce Cooper, *Director, Strategic Development*

Dr Mark James, *Director, Operations*

Dr Rob Murdoch, *Director, Research*

Kate Thomson, *Chief Financial Officer & Company Secretary*

Dr Andrew Jeffs, *General Manager, Aquaculture & Marine Natural Products*

Dr Clive Howard-Williams, *General Manager, Freshwater & Coasts*

Dr John McKoy, *General Manager, Fisheries*

Dr Murray Poulter, *General Manager, Atmosphere, Natural Hazards, & Energy*

Dr Don Robertson, *General Manager, Aquatic Biodiversity & Biosecurity*

Dr Charlotte Severne, *General Manager, Māori Development & Oceans*

Solicitors

Bell Gully Buddle Weir
Kaimai Law

Auditors

Deloitte on behalf of the Auditor-General

Bankers

The ANZ National Bank of New Zealand Limited

Insurance Broker

Marsh Limited

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