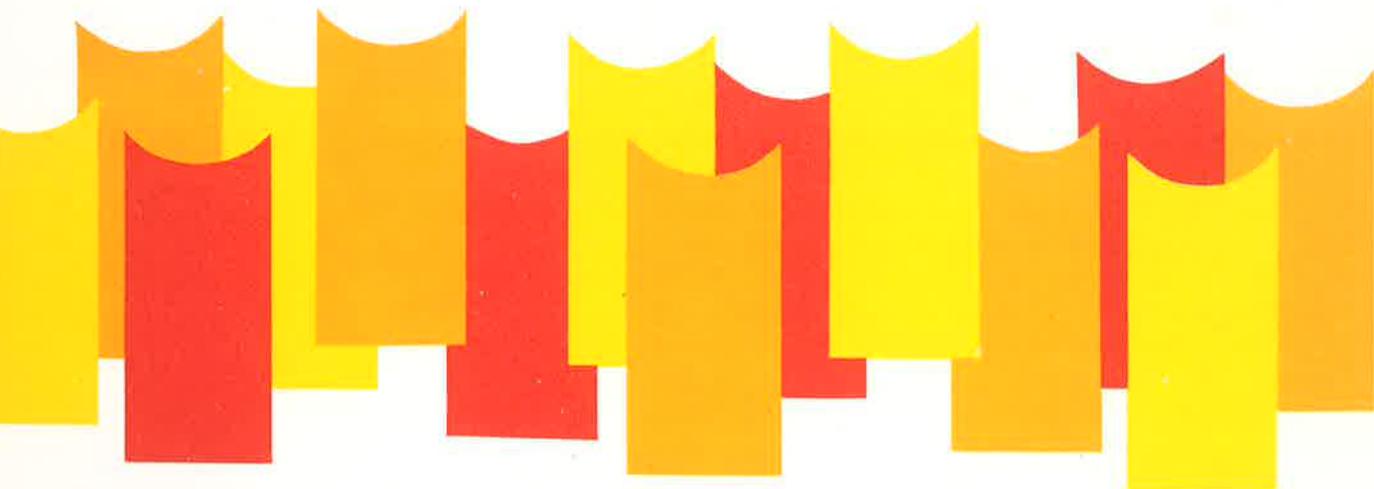


WATER & SOIL

MISCELLANEOUS PUBLICATION

No. 50

**Directory of Activities at the
Water and Soil Science Centres: 1983**



**NATIONAL WATER AND SOIL
CONSERVATION ORGANISATION**

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34. Water quality research in New Zealand, 1981. J. S. Gifford. (\$5)	1982
35. Liquid and waterborne wastes research in New Zealand, 1981. J. S. Gifford. (\$3)	1982
36. New Zealand river temperature regimes. M. P. Mosley. (\$8)	1982
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39. A guide to the common freshwater algae in New Zealand. (\$5)	1982
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WATER AND SOIL MISCELLANEOUS PUBLICATION No. 50

**Directory of Activities at the
Water and Soil Science Centres: 1983**

WELLINGTON 1983

Directory of Activities at the Water and Soil Science Centres: 1983

Water and Soil Miscellaneous Publication No. 50, 1983, 24p. 1ISSN 0110-4705

A directory to the work under way at the three water and soil science centres (at Hamilton, Aokautere and Christchurch) operated by the Ministry of Works and Development. Current work of each research group is discussed. Those at the Hamilton centre are chiefly concerned with studies of water quality and the effects on that of land use. At Aokautere is the national plant materials centre, and other work on erosion control and soil-related topics is undertaken. The Christchurch centre studies high country problems and undertakes water quantity research projects.

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INTRODUCTION

This is the second edition of a *Directory* first published in 1981.

The three science centres of the Water and Soil Division, Ministry of Works and Development, were set up as a result of recommendations contained in the Dunford Report, *Water and Soil Conservation Research in New Zealand*, 1973. The report recommended the establishment of research centres at Hamilton, Palmerston North and Christchurch. Suggested areas of study for these centres included the following:

(a) Hamilton

Studies of water quality and the effects of land use (including urbanisation) on water quality.

(b) Palmerston North (Aokautere)

Work on plants for erosion control. Studies of soils and soil erosion processes.

(c) Christchurch

Studies of high country problems, soil erosion processes, modelling of hydrological behaviour, tillage practices and irrigation. The centre would also co-ordinate the collection of hydrological data and be involved in water quality research.

Basically, the setting up of the three science centres has followed these suggestions, with the modification of these research topics as has been deemed appropriate. In addition to the suggested hydrological modelling studies to be undertaken at Christchurch, water quality modelling is carried out at Hamilton. The suggested high country studies to be done by the Christchurch centre now include research into alpine processes.

In line with the recommendations of the Dunford Report the Research Director, together with his technical supporting staff at Head Office, is responsible for "promotion, direction, and co-ordination of research in the division". The role of NWASCO (the National Water and Soil Conservation Organisation) in research is to "promote co-ordination of water and soil conservation research among all departments directly involved, including the Water and Soil Division".

In practice, this has meant that research projects, including those of the science centres are assessed at meetings of the Research and Survey Committee, and the Councils (the Soil Conservation and Rivers Control Council, and the Water Resources Council). Thus the overall direction of the work of the science centres is from the Head Office of the Water and Soil Division

and aims to meet identified problems in the NWASCO's fields of interest.

The research undertaken is basically applied research, directed towards solving problems associated with conservation and management of water and soil resources. In this problem-solving activity the needs of the catchment and regional water boards play a major part, since in large measure it is these organisations that actually carry out the conservation work in their respective districts.

In addition to their close association with the work and needs of the catchment authorities, the centres collaborate extensively with universities and other research organisations. This also includes assistance with, and assessment of, research projects carried out under contract.

The Dunford report recommended that research undertaken at the centres be "along problem lines rather than geographical lines", with district offices and staff remaining an integral part of the system. The District Water and Soil Officer would be "a key link between districts and research centres".

To assist those involved in the field with water and soil conservation work, it is essential that they be fully informed and kept up-to-date about the work of the science centres. It is towards this purpose that this *Directory* has been compiled.

WATER AND SOIL SCIENCE CENTRE, HAMILTON

Scientist in Charge: N M Burns, Ph.D

Group Leaders

I	Inland Waters	:	G B McBride, M.Sc
II	Catchments	:	R A Hoare, M.Sc, Ph.D
III	Scientific Services	:	J B Macaskill, M.Sc, Ph.D
IV	Coastal	:	B L Williams, B.Sc, M.E
V	District Hydrology	:	A L Singleton

The Water and Soil Science Centre, Hamilton, is located in the School of Science, University of Waikato, and in adjoining accommodation at Scotland Place. The centre is primarily concerned with water quality studies, so as to be a source of information and expertise in water quality management. The centre consists of three environmental studies groups - rivers, lakes and land use, and estuarine and coastal - together with three specialist groups - laboratory services, modelling and systems, and hydrology.

I INLAND WATERS GROUP

The main thrust of this group's work has been on projects aimed at increasing our understanding of the oxygen balance of a river subject to waste load inputs. This enable better predictions of the effects of future waste loads to be made. Specific projects on aquatic oxygen demand exertion, benthic oxygen demand exertion and reaeration are now well under way. A review of river dissolved oxygen modelling studies in New Zealand revealed that, while we have now developed sufficiently accurate analytical and numerical techniques to handle the advection and dispersion of river dissolved oxygen (DO) and biochemical oxygen demand (BOD), we still lack understanding of the respective roles of benthic and aquatic bacteria in the rates of exertion of BOD and removal of DO. Some rivers (e.g., Lower Manawatu, Tarawera) exhibit extremely high removal rates and the (mostly circumstantial) evidence to date suggests that this is attributable to the activity of benthic bacteria. It is also apparent that we lack precision in our ability to predict the important reaeration coefficient for New Zealand rivers.

An investigation of the efficiency of modelling techniques for river dissolved oxygen has been completed. This has resulted in the production of simple nomographs for the prediction of river assimilative capacity, these being based on the Streeter-Phelps model. More complex models and modelling techniques, including

the techniques for defining model parameters and boundary conditions, have been investigated. A *Handbook on Estimating Oxygen Depletion in Polluted Rivers* based on findings from studies to date, has been prepared for use by water managers.

The work on lakes is now of two main types - one dealing with the source of nutrients to streams which is being carried out by the Catchments Group and the other dealing with the effects of nutrients on lakes which is carried out by the Inland Waters Group.

A group of three projects deals with the relationships between nutrient load on a lake and the nutrient concentrations found in its water, the relationship between nutrient concentrations and algal growth, and the relationship between algal growth and the occurrence of anoxic bottom waters.

The intention is that, in addition to generating scientific reports, this research will be used in the writing of handbooks for water quality managers, in which advice can be given to those faced with lake management problems. Topics to be covered include ways of assessing and controlling nutrient exports from catchments, methods of assessing lake water quality, and methods for improving lake water quality.

New projects on investigations of methods of quantitative assessment of river and lake water appearance (especially colour) have been commenced. The public judge water clarity mainly by its appearance, yet colour and clarity are rarely measured. The Waikato River and local lakes are being used as a convenient test bed for the development of methodology and ideas about optical behaviour of waters.

The group is also called on from time to time to carry out studies aimed at providing a prediction of the effect of possible impoundments (e.g., Upper Clutha, Motu) on river water quality. The Clutha studies were designed to predict the likely quality of water retained behind and released from, the proposed dams at Luggate, Queensbury and Clyde. Longitudinal river surveys have been undertaken each month over a 14 month period by the Otago Catchment Board and local Ministry of Works and Development staff.

The group also participates in the UN GEMS (Global Environmental Monitoring System), project, for which it acts as the national coordinator.

II CATCHMENT GROUP

This group has for its overall aim, the study of management related aspects of materials entering water bodies. In the past the emphasis has been on sources of nitrogen and phosphorus as causes of eutrophication of lakes, and this is still of importance, but it is now becoming clear that work also needs to be done to evaluate the importance of sources of toxic substances in New Zealand streams.

The main effort in nutrient related studies in 1983 will be devoted to evaluating the effectiveness of stream bank vegetation for removal of nitrogen and phosphorus from overland flow. A pastoral catchment near Hamilton has been studied for several years now, and parts of the stream bank will be protected by electric fences from grazing stock in order to see what change in nutrient runoff is produced in those areas. Investigation of other management options will follow.

Toxic metals in urban runoff and in rural streams in mining areas have been measured for a year or more, and interpretation is proceeding. Some metals, particularly lead and zinc, are also potential industrial pollutants, for example, in oil refinery wastes, and the group has been involved in evaluating potential problems at the Marsden Point Oil Refinery. Toxic organic compounds are also found in urban runoff and refinery wastes, and some work has been undertaken to gain an appreciation of such problems.

In all environmental issues it is ultimately the biological effect of chemicals which determines the significance of a problem. For instance, sewage "fungus" is a complex growth consisting largely of bacteria, resulting from discharge of organic wastes to a river. The occurrence of this growth is being studied by the group to evaluate the consequences of organic containing discharges from a catchment. Bacteria can also affect the chemistry in a stream, and we have studied the way in which nitrogen in a stream is changed by bacteria from one form to another.

For both toxic materials and nutrients, point sources (e.g., factories and sewage works) and non-point sources (e.g., runoff from farms and old mine workings) exist, and it is important to establish the relative importance of different sources so that research and management activities can be concentrated on the biggest problems. Another general issue is the biological availability of the various chemical forms in which nutrients and toxic materials are found. These general issues will be behind the development of the research program of this group.

III SCIENTIFIC SERVICES GROUP

This group services the environmentally oriented groups in the centre and carries out some research of its own. The group consists of two sections: the Data Services Section which works at meeting the software and hardware requirements of the scientists; and the Laboratory Services Section which basically provides an analytical capability in chemistry and microbiology. The analytical techniques include atomic absorption spectrophotometry, automated colorimetry and gas chromatography.

An electronics specialist in the Data Services Section meets the instrument design requirements of all science centre projects and leads a project investigating the design and use of continuous water quality monitoring systems. The Laboratory Section also does analyses on occasion for regional water boards and Ministry

of Works and Development offices besides providing training programs in methods of water quality assessments.

IV COASTAL GROUP

This group is developing expertise in selected topics and endeavours to promote research in areas of need. Topics currently under study are:-

- (i) Estuarine hydrodynamics and mixing.
- (ii) Ocean outfall waste disposal systems.
- (iii) Coastal sediment budgets.

In conjunction with the Auckland Regional Authority the group has completed its contribution to a study of the Upper Waitemata Harbour to assess the likely effects of urban development on sedimentation and water quality. The project involved studies in estuarine hydrology and sedimentology - with subsequent development of mathematical models for predicting dispersion of pollutants entering estuarine systems. This work was undertaken in association with staff in other groups and the Department of Theoretical and Applied Mechanics, University of Auckland.

A handbook is being prepared on techniques for site investigations and design considerations for ocean outfalls, primarily from a water quality perspective. It will review the current state of knowledge for the investigation and design of ocean outfalls. Use of the handbook will assist with the determination of the pipeline length, design of the diffuser, and the effect of design variables on water quality.

A handbook which will deal with the techniques and applications of coastal surveys, is being prepared. Topographic surveying, aerial photography and sediment surveying will be detailed and applications to sand mining control, beach erosion assessment and hazard mapping discussed.

Other projects are being formulated on the response of plants and invertebrates to different types of waste loadings to estuaries.

V DISTRICT HYDROLOGY

This group maintains a local network of automatic raingauges and water level recorders, the recording sites being operated as part of the National Hydrological Network programme coordinated by Head Office.

The group has two field parties, one based in Hamilton, the other at Rotorua. The data obtained are edited and computer archived by the group on a centralised computer located in Wellington. Half of the data acquisition effort is directed toward gathering streamflow information for hydro-electric power station design and operation, while the remainder is primarily collected to investigate:

- (i) the effect of land use on hydrology,
- (ii) the concept of regionalised hydrologic response.

The group has been involved in the national pilot trial of a network of crest-stage stations as a low cost means of collecting stream flood peak data. This programme will provide a much larger data base of annual maximum stream discharges to supplement the data available from automatic water-level recorder stations. The data, presently collected in the Coromandel and Raglan areas, will be used in a flood frequency analysis designed to improve flood estimation procedures in use in New Zealand.

Specific research projects undertaken by the group include the investigation of changes in hydrological response and suspended sediment production of pumice catchments following the planting of pines into pasture. This is part of a national programme investigating the effect of land use on hydrology. The group has also been involved with water quantity aspects of the lakes and land use group's nutrient source projects.

WATER AND SOIL SCIENCE CENTRE, AOKAUTERE

Scientist in Charge: J G Hawley, B.E. (NZ), M.A, Ph.D
(Cantab), MIPENZ

Group Leaders

- | | | |
|----------------------|---|---|
| I Plant Materials | : | C W S Van Kraayenoord, IRAg (For)
(Wag), Dip ITC (Delft) |
| II Land Resources | : | G O Eyles, B.Sc, Dip, Ag.Sc |
| III Remote Sensing | : | P R Stephens, M.Ag.Sc (Hons) |
| IV Land Stability | : | P Luckman, B.Sc (Hons)
(Acting) |
| V District Hydrology | : | R D Henderson, B.E (Hons), M.Sc
(Acting) |

The Water and Soil Science Centre, Aokautere, (near Palmerston North) is the main centre for soil conservation research. It is concerned with the prevention and control of soil erosion by means of plants, and various mechanical techniques; the assessment of land resources and their capability for various uses; and, ultimately, the prediction and prevention of land instability.

I PLANT MATERIALS

This group develops and selects plant materials for soil conservation and river control and also carries out research into multiplication and establishment techniques. After extensive field testing, the plants are released to catchment authorities and commercial nurseries. The group produces advisory leaflets on the most appropriate use and management of soil conservation plants, and is preparing a comprehensive *Plant Materials Handbook* for publication.

(1) Poplar Breeding and Selection

The aim of this programme is to breed and select a range of improved poplar clones for soil conservation, protection from wind erosion, and for farm forestry. New clones have been imported and breeding work has continued with species and varieties showing resistance to poplar rusts and *Marssonina*. The breeding programme also is aimed at developing varieties having unpalatability to possums, drought and wind resistance, early development of rough bark, suitable crown form, increased length of growth period, and, for some clones, high suckering ability.

Poplar clones resulting from nursery selection are field tested to evaluate their use in erosion control plantings under various soil and climatic conditions occurring throughout New Zealand. New releases are described in advisory leaflets.

(2) Willow Breeding and Selection

The aims of this programme are similar to those for poplars. The complementary role of tree willows was emphasised after the arrival of the poplar rusts.

The development, selection and field testing of tree willows has continued to provide an improved range of fast growing willows for hillside stabilisation, river control and shelter. Lower growing non-seeding shrub and osier willows with more flexible branches have been developed for river bank protection to replace tree willows (especially crack willows) which tend to get uprooted in floods. Many of these clones can also be used for controlling debris movement in mountain lands, although specially adapted clones are being developed.

New species and clones of both poplars and willows are being introduced to increase the genetic variation in poplar and willow material for soil conservation and shelter planting to counter the effect of further accidental disease introductions.

(3) Alternative Species of Trees and Tall Shrubs

Most species in this programme are selections of trees and shrubs suitable for revegetation of dry, exposed and eroded sites and for shelter planting where poplars and willows are less suitable or even unsuitable. A range of *Eucalyptus* and *Acacia* species is being evaluated for such sites especially in summer drought-prone regions on the eastern side of both islands. Other species under test for soil conservation purposes are *Platanus*, *Alnus*, *Betula* and *Ulmus* to increase the range of plants which can be established on eroded sites.

(4) Low Shrubs, Legumes and Herbaceous Species

Several leguminous shrubs and plants are being evaluated for ground cover, soil improvement and as a nursecrop in erosion control. For example, *Hedysarum coronarium* (sulla) has proved very successful as a nurse crop for the revegetation of neutral to alkaline sites in Poverty Bay, where surface fretting had previously prevented plant establishment. On more acid sites, annual and perennial lupins are more suitable. The herb *Sanguisorba minor* (sheeps burnet) is being tested for erosion control on dry, sunny faces especially in the tussock grassland. Drought tolerant non-leguminous, nitrogen or non-nitrogen - fixing shrub species are being evaluated for revegetation of eroded, semi-arid country.

(5) Tissue Culture

A tissue culture laboratory has been established for the rapid propagation of newly selected plant materials; mainly poplars and willows but increasingly also other plants. The sterile culture of plant materials also provides a unique opportunity to import and export new selections of plants with minimal risk of disease transmission.

(6) Establishment and Protection Techniques

Investigations are continuing into improved techniques for nursery propagation and field establishment. Mechanical methods have been developed to protect rooted poles from damage by sheep and cattle; electrical methods are being evaluated at a range of sites.

(7) Plant Diseases

The incidence and pathogenicity of diseases in poplars, willows and other soil conservation plants continues to be monitored. New methods of control are being evaluated.

(8) Stabilisation of Roadsides and Disturbed Industrial Sites

Plant species (mainly grasses and legumes) are being selected, and establishment methods developed, for reclaiming and revegetating roadsides and sites disturbed by industry (e.g., by mining, quarrying and pipeline projects).

(9) River Bank Protection

River bank protection trials with willows and alders are being carried out in various areas to evaluate both the suitability of species or accessions and establishment techniques.

(10) Biomass Production

Studies at Aokautere have shown that high dry matter yields can be obtained from poplars and willows harvested on a short rotation coppicing system. Collaborative trials with the Ministry of Agriculture and Fisheries help to evaluate the potential biomass production of poplars and willows on a range of sites, including river berm lands.

(11) Farm Shelter

Windbreaks are essential in many areas in New Zealand for the prevention of soil loss due to wind erosion and for stock and crop protection. A range of shrub and tree species is being investigated in trials in co-operation with catchment authorities in Otago, Canterbury, Wairarapa and Hawkes Bay.

II LAND RESOURCES

The group collects all data relevant to land use resource planning on a national scale, and ensures national maintenance of consistent standards relating to erosion and land use capability assessment.

(1) New Zealand Land Resource Inventory Survey

To enable NWASCO to carry out its responsibilities for development of catchments and the promotion of wise land use, the group has carried out the New Zealand Land Resource Inventory Survey. The compilation of the worksheets for this survey has provided the staff with a fund of knowledge on the methodology of land resource assessment and on the analysis and interpretation of these resources. The survey method has included:

- (a) a review and collation of available data on soils, geomorphology, vegetation and climate;
- (b) photogrammetric interpretation and delineation of map units combined with:
 - (i) detailed, comprehensive field assessment;
 - (ii) a system of multiple checking involving staff other than the original surveyor;
 - (iii) systematic correlation within and between regions;
 - (iv) digitisation for input into the Vogel Computer Centre data base.

Bulletins are being prepared which will describe this procedure in more detail. They will also provide a guide to the systematic structure of the classifications used in the survey including the relationship between map unit categories.

The first bulletins will deal with rock type, erosion type and degree, and vegetation classifications. Later, regional bulletins are to be prepared which will explain the land use capability classifications used, and also will list salient physical data (e.g., rock types, soils, slope, erosion and vegetation cover) on a catchment, county or regional basis. Statistical information will be issued separately, at appropriate national, regional and local level.

A basic aim of these bulletins is to provide a guide to more specific use of the New Zealand Land Resource Inventory by water and soil agencies, planning authorities, consultants, and many other groups in the public and private sectors. The computer archive

("land dependent data", LADEDA) of the survey data is accessible through the Land Resource Liaison Group at Ministry of Works and Development, Head Office in Wellington, to provide this information to planning agencies and the public.

Two additional data collection programmes have been undertaken in co-operation with other departments to extend the scope of the survey. With advisors of the Ministry of Agriculture and Fisheries three levels of stock carrying capacity and fertiliser requirements to maintain pastures have been collated for each land use capability unit. With foresters of the NZ Forest Service the physical suitability of each LUC unit for *Pinus radiata* growth has been recorded by assessing the site index of typical areas in each unit.

Staff aim to provide a consistent overview of the country's present and potential erosion status with the completion in 1982 of the 1:250,000 Erosion Map Series. They are also responding to an urgent need for biological resource information by scientists and land planners through compilation, in collaboration with Botany Division, DSIR, of 1:1,000,000 national vegetative cover maps.

(2) Urban Land Resource Studies

A system of urban capability classification is being developed which will allow a consistent approach by catchment authorities and MWD to assess the physical suitability of areas for urban development. This project will conclude with the publication of a bulletin describing procedures and setting standards for use by catchment authority and MWD staff.

(3) Storm Damage Assessment

Storm damage assessment surveys will be undertaken on request in collaboration with the Remote Sensing Group. These aim to provide rapid assessment of storm damage by a combination of aerial photo interpretation and field work. This service is available to catchment authorities.

III REMOTE SENSING GROUP

This group evaluates the applications of remote sensing to water and soil conservation, and provides an aerial photographic service to other research and survey groups at the three science centres as well as the catchment authorities.

The group has developed an aerial photographic method for assessing the condition and trend of slip-prone hill country. This method has evolved into the use of aerial photographs to measure long term areal increases in eroded ground, and associated decreases in pasture production. The group is also eva-

luating the usefulness of different remote sensors for the detection of water and wind erosion in cultivated land. This work is expected to have significant applications in New Zealand, where these subtle erosion processes are often overlooked in comparison with the more spectacular forms of mass movement erosion in hill country. Computer programs have been developed for the calculation of positions, areas and volumes from photogrammetric measurements.

The group operates a 230 mm format Williamson aerial survey camera, four 70 mm Hasselblad cameras mounted on a common frame, and a single 70 mm Hasselblad. From hired aircraft, staff take large-format black-and-white coverage of storm damage and flooding with the Williamson; simultaneous black-and-white, colour, colour infra-red or multispectral coverage with the four Hasselblads for experimental purposes; and any type of small-format aerial photography with the single Hasselblad, as a service to catchment authorities. A well-equipped laboratory for processing and printing aerial photographic films is also maintained.

In addition to its own research, the group services the National Water and Soil Conservation Authority's requirements for aerial photography for the purposes of soil conservation research, water resources research, and the urgent survey of erosion and floods. Aerial photography for other purposes, e.g., routine surveying and mapping, is normally routed to the Government contractor, NZ Aerial Mapping Ltd, by Water and Soil Division's planning and operations staff. Since 1980, the group has offered advice and assistance to the catchment authorities. This ranges from technical advice to authorities undertaking their own photography, through the formulation of technical specifications for forwarding to commercial contractors on the authorities' behalf, to the provision of commercially unavailable small-format photographic and aerial film processing services.

IV LAND STABILITY

This group studies mass movement - particularly earthflows and soil slips.

In studies of mass movement, the overriding concern is to develop an understanding of how soil strength (and hence slope stability) varies with time and with soil conservation practices. The principal time variable as far as the soil is concerned is the weather. So the group is interested in how, and at what rates, slopes weaken during wet periods, and strengthen or weaken during dry periods, and how these effects accumulate over the seasons and decades to determine long term slope stability or instability.

Such basic understanding of soil behaviour, essentially under conditions of low natural stresses, has required establishment of two land stability laboratories at the science centre, a programme of (largely automated) field instrumentation, field trials of soil conservation techniques, and computer modelling of

hillslope hydraulic regimes and their dependence on weather and soil conservation works.

The land stability laboratories have been equipped to perform a wide range of soil mechanics and soil physics tests in addition to clay separations for mineralogical analysis. One particular apparatus being developed is a low stress computer-controlled triaxial apparatus. Using this apparatus it is possible to explore the role which creep plays in generating mass movements.

Weakening of mudstone regoliths by mechanical weathering resulting from seasonal desiccation and rewetting is also under investigation.

The group has an electronics section which is concerned with development of new laboratory and field instrumentation especially for automated data acquisition.

In the field, the group has long term land stability investigations at sites near Gisborne, Hunterville and Taumarunui. Sampling operations as part of the group's programme to characterise regoliths subject to in mass movement include sites from many areas, but especially the East Coast of the North Island.

V DISTRICT HYDROLOGY

Hydrological data are collected by this group as part of the Hydrological Network Programme. Local data are processed for storage on computer within the national hydrological bank (TIDEDA).

Formal projects in progress that use part of this data base are:

- (i) Taranaki Ring Plain Study
- (ii) Regional basin hydrology

The Taranaki Ring Plain Study concentrates on summarising water resources for management and planning purposes. A low flow map that depicts discharge by different colours in the stream channels has been prepared. This work is stimulated by the rapid development of the petrochemical industry in the area.

Data from the 10 regional basins in the Wanganui district are being analysed to test their representativeness and assess data extrapolation techniques for these regions.

The group provides help and advice to catchment board hydrology teams in the field and in processing and storage of data.

WATER AND SOIL SCIENCE CENTRE, CHRISTCHURCH

Scientist in Charge: S M Thompson, M.E, Ph.D

The centre is located in Cashel Street in the central city area.

Group Leaders

I	Environmental Hydrology	:	M P Mosley, M.A, Ph.D
II	Groundwater	:	H R Thorpe, B.Sc, M.E, Ph.D
III	Hydrology Network	:	A McKerchar, B.E, Ph.D
IV	Hydrosystems	:	R P Ibbitt, B.S, C.E, Ph.D
V	Instruments	:	D E Cottle, B.E, M.N.Z.I.E.
VI	Alpine Processes	:	Vacant
VII	Hydraulics	:	Vacant

The work of the centre is concerned with physical hydrology, including the "flow" in rivers and other water resources and the natural channels that convey that water. The work of the centre is carried out by seven groups mentioned above. There are also field parties located at the following 16 towns:

Whangarei, Auckland, Hamilton, Rotorua, New Plymouth, Turangi, Gisborne, Napier, Wanganui, Wellington, Nelson, Greymouth, Christchurch, Tekapo, Dunedin and Alexandra.

There are three groups of staff at the centre where programmes are technically affiliated to another science centre:

- A. Water Quality (to Hamilton)
- B. Land Resources (to Aokautere)
- C. Plant Materials (to Aokautere)

I ENVIRONMENTAL HYDROLOGY GROUP

The Environmental Hydrology Group studies the form and behaviour of river channels, particularly as they affect and are affected by man's activities. Thus, for example, the group has studied the possible impact of irrigation withdrawals upon the character of the Ahuriri River in North Otago, and has attempted to define the characteristics of the Motu River, Bay of Plenty, which make

it so attractive for recreational activities such as kayaking and rafting. The group has adopted a general approach to the study of rivers by considering the many different aspects of their appearance and behaviour. It develops its own field procedures and analysis techniques.

Recent work has focussed on the braided river environment, particularly with respect to the flow requirements of such "instream uses" as jet-boating and the salmon fishery.

(1) Passage depths in braided rivers

Water depth continually changes along the channels of braided rivers, because these rivers are made up of a regularly repeating sequence of deep pools and shall riffles. The latter represent potential restrictions on upstream migration of salmon or on passage by jet-boats and canoes; if water is removed from a river for irrigation, flow depths on riffles may become too shallow for easy passage. Using data collected in several Canterbury rivers, the group has established a relationship between discharge and the minimum depths on riffles; this allows prediction of the likely consequences of flow abstraction on ease of passage, or alternatively enables specification of the flow required to maintain some specified minimum depth.

(2) Water temperature in braided rivers

It appears that water temperature is one of the most critical controls on fish habitat, so that information on the detailed variation in water temperatures in braided rivers may prove of critical importance in water resource allocation.

Initial studies used diurnal water temperature curves for selected sites in a braided section of the Ashley River flowing at 1.5 cumecs on a clear, sunny day in February. Water temperatures at any one time during the day vary widely from site to site; the critical factor appears to be the amount of transfer between surface flow and flow through the gravels. Where flow in a braid is derived primarily from the gravels, the water has a much lower temperature than where flow is solely above ground; where water seeps into the gravels and then reappears, it loses heat because the gravel behaves as a heat sink.

(3) River Characterisation and Classification

A field procedure has been developed to measure objectively, as far as possible, the characteristics of rivers as they relate to scenic, recreational, and aesthetic values. Field parties throughout the country are gathering data for this study. These data will be used to develop a classification of New Zealand rivers, and to assess the characteristics of rivers which members of the public find particularly attractive.

(4) Impact of River Control Works

Analysis of the effect of river control work on the Waimakariri River is under study; information on changes in land use along the river and changing river morphology (width, cross-sectional area, etc), has been collated and data on expenditure completes the picture. An interesting implication of the river control work is the potential for reducing groundwater recharge rates by reducing the area of floodway. Flow losses from the river have declined from about 20% of total flow before 1972 to about 5% after 1972; this may be related to changing channel patterns in the vicinity of Halkett Groyne - Crossbank.

(5) Rakaia River Fish Habitat Survey

Because large irrigation schemes are proposed for the Rakaia River, a study was conducted to show the effect of reduced flows on fish habitats there.

Combined teams from MWD, Ministry of Agriculture and Fisheries (MAF), and North Canterbury Catchment Board, measured depths and velocities in the river at a number of discharges ranging from the lowest recorded flow to the median flow. Fisheries Research Division Staff of MAF did surveys to find the depth and velocity preferences of various native species.

The data from both surveys was combined to show that there was no significant change in fish habitat over the range of flows surveyed. This is because as the flows reduce in a braided river, the areas that have become too shallow or slow for the fish are replaced by areas that previously were too deep or swift, so that the total area of usable habitat stayed about constant over the range of flows studied.

II GROUNDWATER GROUP

The Groundwater Group's function is to provide specialist services to regional water boards in investigating ground water resources. Two emphases within the group are numerical modelling of aquifer systems and geophysical investigation methods.

(1) Ashburton-Rakaia Groundwater Resource

The proposed Lower Rakaia Irrigation Scheme will use water from both surface sources and groundwater. The study, which is now completed, has quantified the various inputs to the aquifer system and their variability. Present consumptive uses of groundwater have also been determined.

A numerical model of the groundwater system has been developed which has enabled the response of the system to several different irrigation proposals to be evaluated. Water requirements for each irrigation strategy were deter-

mined from 30 years of meteorological records. Results have been presented in the form of depth to watertable exceeded less than 10% of the time, and as changes in piezometric level from a defined equilibrium level.

(2) Numerical Model of the Waimea Plains, Nelson

The aquifer system of the Waimea Plains consists of three aquifers, one unconfined and two confined. Water demand during the irrigation season exceeds the recharge and severe aquifer depletion occurs. The Nelson Regional Water Board has to make difficult decisions in managing this limited resource. Development of a numerical model (from a general USGS model) should assist in management decisions relating to use of this water resource.

(3) Geophysical Investigation of Groundwater Systems

Resistivity and downhole logging equipment are used by the group to help catchment boards understand the structure of aquifer systems. This equipment has been successfully used in the Auckland, Hauraki, Manawatu and Wairarapa areas. A handbook on the use of the resistivity equipment is being prepared and eventually equipment will be available for board staff to do their own surveys.

(4) Groundwater Data Archive

A data archive for storage and retrieval of site data has been developed and its practical application is being evaluated by the Waikato Valley Authority. The archive will store physical and lithologic data for each well. Retrieval is primarily on the basis of well location but can also be done for other parameters such as depth, yield, and static water level.

III HYDROLOGICAL NETWORK

The Network Group's concern is to establish and promulgate field and office procedures that will ensure that river flow records are to appropriate technical standards. It does this by preparing manuals of standard procedures, by running short courses for hydrological technical staff, by examining data gathered, and by providing an inspection service and advice on field installations. These services are available to both MWD and catchment authority hydrological survey staff.

Floppy disc data loggers are being installed at the locations of all 16 MWD hydrological field parties, as part of the forthcoming telemetry installations, to log and process incoming data (see section on the Instruments Group below). The Network Group is responsible for installation and proper utilisation of this equipment.

Data from the loggers are sent to the group at two weekly intervals on floppy discs. The group checks the validity of the data

as they are entered to the national archive held in the Vogel Computer Centre.

IV HYDROSYSTEMS GROUP

This group develops analytic techniques for the interpretation of hydrological information for use in management decisions. While analysis work is largely statistical, interpretation requires a knowledge of how hydrological systems behave. From such knowledge simulation models are postulated which are tested against measured data. If validated they are used to study changes to the systems. Recent activity has included; preparation of hydrological data processing, software for data loggers, simulation of a spatially distributed network of recorders, flood forecasting, cumulative mass curves, and study of the relationship between low flow and basin geology.

(1) Preparation of Software for Data Loggers

Much effort has gone to implementing the TIDEDA set of computer programs on floppy disc data loggers, part of the work being contracted out. The package being developed is expected to lead to innovations in field party work. New data processing conventions and procedures are being established in anticipation of the introduction of radio telemetry commencing in 1983.

(2) Flood Forecasting

Flood forecasting conveniently divides into two sub-problems. The first is to route a known upstream hydrograph down a main river channel to give a forecast downstream hydrograph. The second problem is to forecast runoff, given the storm rainfalls.

A general computer program developed for implementation on micro-computers has been set up for forecasting flood levels in the Ruamahunga River in the Wairarapa, and on the Mataura River in Southland.

(3) Low Flows as a Function of Basin Geology

Basin geology influences low flow behaviour. Systematic estimation of low flow as a function of geology is possible using a Base Flow Index (BFI). The BFI is the ratio of sub-surface flow, derived using a simple and objective procedure, to the total flow in a river. It shows spatial variation similar to the predominant rock type of an area.

BFI values have been calculated for 230 flow stations in the North Island. High values (0.7-1.0) predominate on the volcanic plateau while low values (0-0.3) are characteristics of the east coast. Anomalous values can be detected. In general terms the conclusion that BFI is a measure of basin geology is supported and work is proceeding on refining ways to derive BFI values for ungauged catch-

ments. Further work will define relationships between BFI and other low flow parameters.

V INSTRUMENTS GROUP

This group is responsible for the servicing of hydrological instruments, for the evaluation and purchase of instruments, and for the development of new instruments and measurement techniques.

(1) The Instrument Service Centre

The centre at Kainga, about 14 km north-east of Christchurch, includes a store for purchasing and storage of equipment and spares, a rating tank for calibration of current meters and comprehensive facilities for servicing of all types of instruments both mechanical and electronic. Instrument service work is done for MWD, New Zealand Forest Service, catchment authorities, local bodies and the Royal New Zealand Navy.

Recent major activity has been to equip the centre with test instruments needed to service the data logging and telemetry equipment which is currently being installed (see (3) below).

Future work will be oriented towards the evaluation, installation and commissioning of the data logging and telemetry system, the servicing of this equipment and the interfacing of different types of sensors to the system.

(2) Instrument Development Laboratory

This section, at Cashel Street, develops new instruments and measurement techniques when the requirements cannot be satisfied by commercially available equipment. The major project currently being undertaken is the development of a pressure transducer based water-level recorder. Future projects are likely to include an investigation of ultrasonic methods for water-level sensing and the development of improved gauging equipment.

(3) Data Logging and Telemetry

MWD is installing a data logging and telemetry system for hydrological data collection. The ultimate objective of this system is to replace the existing network of water-level recorders and raingauges with an electronic system which telemeters the data over the existing departmental VHF radio telephone network and provides a flood warning facility.

The initial purpose is to telemeter about 400 sites to 16 regional centres. Setting up the 16 regional data logging facilities is well under way. Installation of telemetering equipment for the initial 400 sites is expected to be completed during 1988.

(4) Pressure-Transducer Based Water-Level Recorder

Electric pressure-transducers will enable water level recording without the need for stilling well and associated costly civil works. At present commercially available pressure-transducer based equipment does not provide the required accuracy. This problem has been overcome by sensing the transducer temperature and applying a correction. One prototype has been successfully tested, and further prototypes are being built for a comprehensive field evaluation programme.

(5) Automatic Dilution Gauging

Dilution gauging is used to measure flows in mountain torrents where the cross-section is too ill defined for current meter measurement. Because it is difficult to get to these streams in time to measure flood flows, a stage triggered automatic (unattended) constant rate injection (salt) dilution gauging system has been developed and tested for flows up to 5 cumecs.

VI ALPINE PROCESSES

The group measures and describes earth surface processes affecting man's abilities to live with and wisely use New Zealand's mountain lands to enable proposed or unintended impacts of man to be assessed in the context of natural events.

Studies of selected small and large drainage basins provide opportunities to develop and test new techniques for erosion assessment, and to understand the functions of various erosion processes in maintaining catchment condition. On the Shotover River, the effects of storms on a few major sediment sources, and the hydraulics of sediment transport in the stream channel appear to determine the sediment yield. At Cropp River, in the superhumid western Southern Alps, estimates of flood flow and sediment yield bring into question the adequacy of engineering design standards for rivers draining that region.

Measurements of rainfall, runoff, sediment sources and sediment yield along a transect across the Southern Alps in the vicinity of the Rakaia River, establish storm-induced flood runoff as a dominant influence, along with geomorphic history, on variation in erosion rates from basin to basin within the Southern Alps. Normal rates from 200 to 20,000 $t.km^{-2}.a^{-1}$ are apparent for rainfalls from 500 to 12,000 mm/a east to west across the chain. At the scale of the individual basin, however, variations in geological structure and rock type, and proximity to the stream channel are the important influences. Detailed surveys of the soil landscape show the relative influences of natural events, and Polynesian and European fires, and the important role of soil erosion processes in maintaining soil fertility over geological time.

In the dry eastern South Island high country slow rates of erosion lead infertile old soils to persist, inhibiting a complete

plant cover. This contrasts with the wet western Southern Alps where exceptionally vigorous erosion processes provide natural tillage and rapidly form new and fertile soil.

Locally, basin sediment yields are dominated by catastrophe, such as major storm-induced debris flows, whose frequency and widespread occurrence form a significant hazard to development of mountainlands, or through rarer rock avalanches. The latter may create long-lasting sediment-retaining lakes such as Waikaremoana and Lochnager, or they may create major point sources of sediment, supplying as much as 50,000 m³/a for thousands of years.

Over a surveyed 12,000 km² of the Southern Alps, rock avalanches of more than 10⁶ m³ have occurred with a frequency of about two per century, not coincidentally approximately the expected frequency of major earthquakes, with the most recent being the Falling Mountain rock avalanche in the 1929 Arthurs Pass earthquake.

Weathering rind thickness and rock surface colour are used in dating rock avalanches, scree surfaces, and other areas of bare greywacke rock. Variation in scree-surface age provides information on the frequency of scree forming processes, and on the relative stability of screes for process research and for possible future use in planning catchment rehabilitation work.

Analysis of historical and modern photo-pairs, and marked vegetation plots show the equivocal influence of more than a century of European management of the eastern Southern Alps, with areas of increase, decrease, and no change in vegetation cover being apparent in the same or adjacent high country scenes. Vegetation plots also give information on long-term changes in plant species composition with time over the last 30 years, while the photo-pairs reveal the dominating impact of historic storms on the erosion scene of the last century, and the markedly faster tempo of erosion and recovery in the wetter regions of the Southern Alps.

An inventory of New Zealand glaciers based on annual aerial surveys of the end of summer snowline corrects the extent of permanent snow and ice shown on existing maps, updating this unit of the New Zealand Land Resource Survey, and providing information for use in summer low-flow models of alpine drainage basins.

The group also participates in studies of Southern Hemisphere climate change through measurements of glacier fluctuations and river flow in the Dry Valleys of Antarctica, through annual surveys of the New Zealand snow line, and through studies of present and recent past fluctuations of New Zealand glaciers.

VII HYDRAULICS GROUP

(1) Ohau River Scour

During the Upper Waitaki power construction the Ohau River has received sustained controlled flows up to 500 cumecs equivalent to floods in the natural channel with return

period in excess of 100 years. These controlled flows provided an excellent opportunity to study scour in a full size outdoor flume.

The main conclusion is that for flow approach depth $y > 1.0$ m, the depth of scour $d = 0.4 y$, a useful result for engineering design. Compared with laboratory results, the Ohau River data suggests that, in a live bed condition with strongly graded sediments, scour is inhibited compared to uniform sediment results, but may be greater than suggested by laboratory results for graded sediments.

(2) Ohau River Gravel Transport

The rate at which a 2 km³ delta has formed in Lake Benmore during three years of large flows before the Ohau C Power Station commissioning, has been surveyed. Concurrent detailed measurement of the depths and velocities in the river just upstream of the delta have been used to calibrate at prototype scale gravel transport formulae previously derived for laboratory data.

A. WATER QUALITY GROUP

The group is concerned primarily with groundwater quality research, but one staff member is presently allocated to surface water biological studies. The group operates its own chemistry/microbiology laboratory to service the research programme.

The groundwater programme primarily involves the development of chemical and microbial tracing techniques and research into the effects of sewage disposal (surface and subsurface) and fresh-water irrigation on groundwater quality. The role of macroinvertebrates in the purification of sewage-polluted groundwater has been briefly examined. The surface water biology programme involves the investigation of periphyton ("slime" growths) in rivers.

B. LAND RESOURCES GROUP

The group complements the work undertaken by the Land Resources Group at the Science Centre at Aokautere.

Its major functions has ben to compile South Island map coverage for the New Zealand Land Resource Inventory and related data, and to develop a computer program to handle spatial data. The group is studying relationships between geology and erosion, vegetation cover trends in hill and mountain terrain rates of soil erosion and applications of remote sensing to land resource evaluation.

C. PLANT MATERIALS GROUP

Work from Christchurch which is part of the programme of the Plant Materials Group, Aokautere, is largely oriented towards evaluation of plants which have a potential for erosion control

in drought-prone areas of the eastern South Island. Specific fields of investigation include:

- (a) testing grasses, legumes and other herbs (e.g., *Hedysarum*, *Sanguisorba*) which have a potential to revegetate depleted droughty hillslides;
- (b) selection of trees and shrubs suitable for:
 - (i) erosion control on droughty eroded or eroding hillslides (especially species of *Acacia* and *Eucalyptus*);
 - (ii) windbreaks, particularly on irrigated land or on drier, droughty parts of the Plains (including species of poplar, willow, *Acacia* and *Eucalyptus*);
- (c) testing pre-release poplars and willows over a range of sites including irrigated and non-irrigated land as well as river berm lands.

WATER AND SOIL TECHNICAL PUBLICATIONS

1. Liquid and waterborne wastes research in New Zealand. Sally Davis (\$1)	1977
2. Sampling of surface waters. M. Kingsford, J. S. Nielsen, A. D. Pritchard, C. D. Stevenson (\$1)	1977
3. Water quality research in New Zealand 1976. Sally Davis (\$1)	1977
4. Shotover River catchment. Report on sediment sources survey and feasibility of control. 1975 (out of stock)	1978
5. Late Quaternary sedimentary processes at Ohiwa Harbour, eastern Bay of Plenty with special reference to property loss on Ohiwa. J. G. Gibb (\$1)	1978
6. Recorded channel changes of the Upper Waipawa River, Ruahine Range, New Zealand. P. J. Grant (out of stock)	1978
7. Effects of domestic wastewater disposal by land irrigation on groundwater quality of the central Canterbury Plains. G. N. Martin and M. J. Noonan (\$1)	1978
8. Magnitude and frequency of floods in the Northland-Auckland region and their application to urban flood design. J. R. Waugh (\$1)	1978
9. Research and Survey annual review 1977. (out of stock)	1978
10. The problem of coastal erosion along the "Gold Coast", western Wellington, New Zealand. J. G. Gibb (out of stock)	1978
11. The Waikato River: A water resources study. (\$12)	1979
12. A review of the habitat requirements of fish in New Zealand rivers. Compiled by D. F. Church, S. F. Davis, and M. E. U. Taylor (\$3)	1979
13. The Ruahine Range: A situation review and proposals for integrated management of the Ruahine Range and the rivers affected by it. A. Cunningham and P. W. Stribling (\$5)	1978
14. A Survey of New Zealand peat resources. A. Davoren (\$10)	1978
15. Effects of urban land use on water quantity and quality: an annotated bibliography. I. Simmers (\$5)	1980
16. Research and Survey annual review 1978. (free)	1979
17. Investigations into the use of the bacterial species <i>Bacillus stearothermophilus</i> and <i>Escherichia coli</i> (H ₂ S positive) as tracers of groundwater movement. L. W. Sinton (\$1.50)	1980
18. A review of some biological methods for the assessment of water quality with special reference to New Zealand. Part 1. (\$3)	1979
19. The frequency of high intensity rainfalls in New Zealand, Part I. A. I. Tomlinson (free)	1980
20. Regional flood estimation in New Zealand. M. E. Beable and A. I. McKerchar (\$8)	1982
21. Coastal hazard mapping as a planning technique for Waiapu County, East Coast, North Island, New Zealand. J. G. Gibb (\$5)	1981
22. A review of some biological methods for the assessment of water quality with special reference to New Zealand. Part 2. (\$4)	1981
23. Hydrology of the catchments draining to the Pauatahanui Inlet. R. J. Curry (\$3)	1981
24. Potential for contamination of the Heretaunga Plains aquifers (\$10)	1982

WATER AND SOIL MANAGEMENT PUBLICATIONS

1. Regional planning and development. (\$1)	1975
2. Wetlands. (\$1)	1975
5. Forest operations guideline. (\$2)	1978
6. A guideline for the construction of access tracks and firebreaks. (\$2)	1980
7. A guideline to skifield development. (\$2)	1980
8. A wetlands guideline. (\$5)	1982