

# BLACKWOOD CATCHMENT

## FEASIBILITY STUDY INTRODUCTION

A preliminary prefeasibility assessment on the Blackwood Salinity and Hydroelectric project, carried out in early 2000, made two significant statements;

“Based on this review a number of technical and commercial risks have been identified and evaluated to confirm that, subject to a detailed review that can only be undertaken during the pilot study, the project is viable.”

“It is concluded that the project is technically viable and the scheme may be commercially viable without factoring in the social and environmental benefits.”

One of the major issues confronting the project concerned the economic consequences of such a large and audacious project. Simply put, there can be little justification for spending \$2000 per hectare on land worth \$1000 per hectare.

In March 2001 an Economic Audit was carried out on the Blackwood Catchment (see report two in the main book).

The major finding supported the two earlier quotes from the prefeasibility assessment in saying;

“It is concluded from the preliminary benefit-cost assessment presented in this report that the further refinement of all aspects of the strategy of groundwater pumping, drainage and canal disposal to the ocean organisational, technical, social, environmental and economic - is well warranted.”

Based on the net cost alone over 30 years the strategy should be supported as a matter of priority by the Commonwealth and Western Australian Governments.

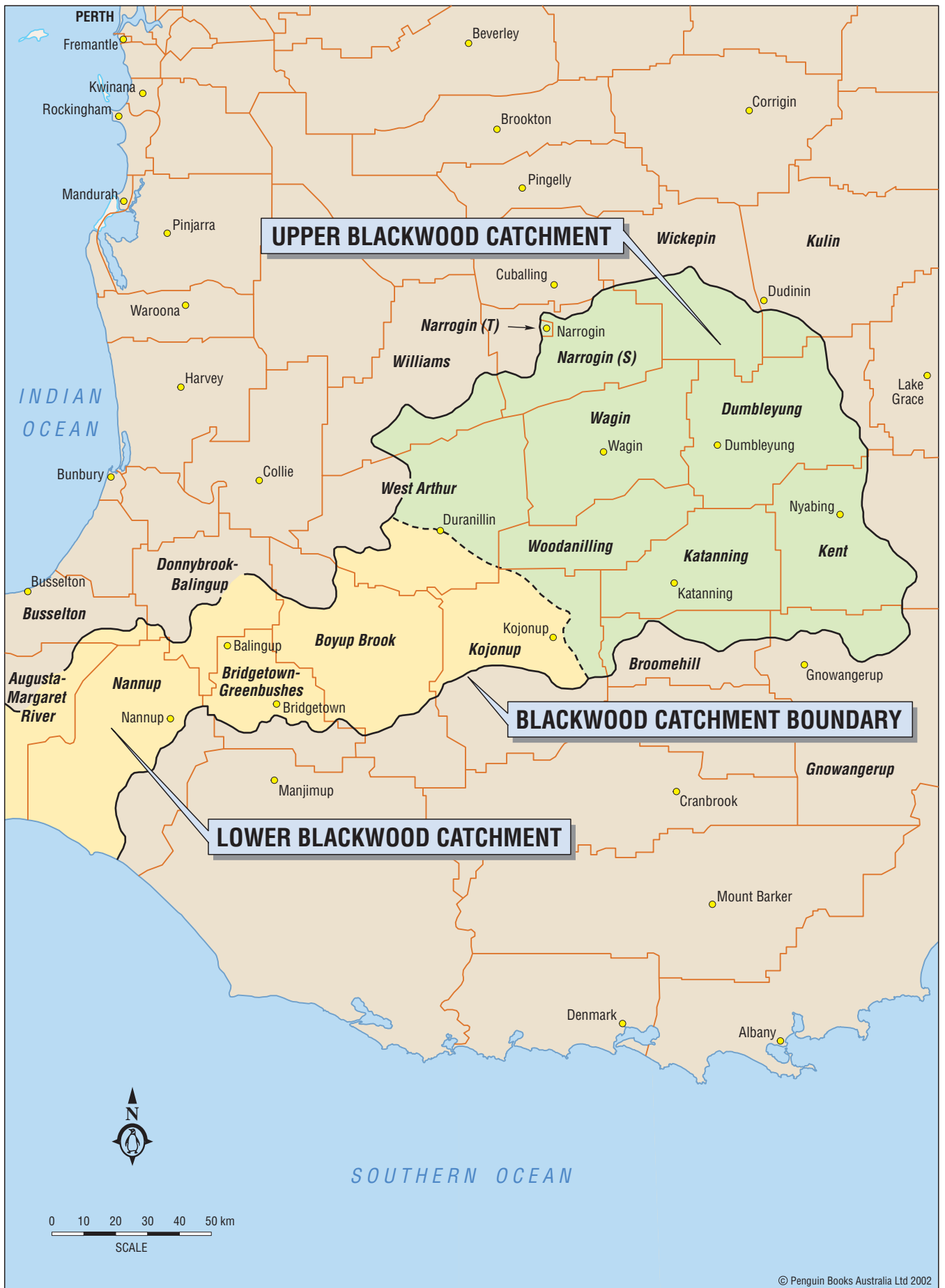
The overwhelming majority of scientists, engineers and academics who have had the benefit of a detailed presentation of the project, have all expressed the view that the project is exciting, innovative and visionary and is deserving of a detailed feasibility study.

The Salinity Crisis Action Team listed in this insert is a combination of all the skills and expertise required to carry out a comprehensive investigation into a project of this magnitude.

Necessarily the major engineering components of civil, geotechnical, environmental and construction have been separated to ensure a totally objective and committed implementation team all at “arms length” from each other, to ensure an absence of bias and prejudice which has so often retarded progress in the salinity debate.

**Peter Coyne**





**Map 1**



**Upper and Lower Blackwood  
Catchment showing  
Shire Boundaries**



Penguin  
Books  
Australia  
Ltd  
2002

## PILOT STUDY TASK OVERVIEW

### GEOTECHNICAL AND GROUNDWATER SCOPE

Coffey Geosciences Pty Ltd (Coffey) will be responsible for Upper Blackwood Catchment geotechnical and groundwater investigation and design studies, overall direction of construction of Pilot Study works (drains, pumping bores, and monitoring works), and the analysis of geotechnical and groundwater monitoring results. Coffey will provide expert advice to Worley on geotechnical route assessments for the transfer canals and other proposed infrastructure between Duranillin and discharge to the Coast. A detailed scope follows:

#### PLANNING

- Scoping studies and project design;
- Search existing published and other data sources. Collate cadastral, topographic, geological and hydrogeological maps; aerial photography and Landsat imagery; Water and Rivers Commission hydrogeological records; published reports;
- Site selection for drain and preliminary test work. Excavation of test pits, geotechnical logging, photography, insitu geotechnical testing, sampling for laboratory testing;
- Water level and salinity observations in existing water bores as appropriate;
- Coordinate preliminary level survey, and aerial geophysical mapping to locate paleodrainage system and to provide the base line soil condition;
- Select pilot study drain alignments;
- Design drains, and provide conceptual design of pumping bores and monitoring borefield;
- Design monitoring programme

#### PILOT STUDY IMPLEMENTATION

- Hydrogeological investigatory drilling, pumping bore construction and testing monitoring bore construction;
- Bore equipping (pumping; monitoring);
- Drain design documentation;
- Direct the construction of Pilot Study drains;
- Manage the monitoring of groundwater and of the performance of the drains
- Geotechnical walk over/drive over route assessment of transfer canal options (Note: No drilling or other testing other than geotechnical mapping is proposed in this study).

#### ANALYSIS AND REPORTING

- Analyse results of groundwater monitoring; and geotechnical performance of drains. Present hydrogeological and geotechnical interpretation and recommendations arising from Pilot study;
- Results of Transfer canal route assessment to be conveyed to Worley as work is completed;
- Provide recommendations on Pilot Study closure:
- Interact with Study Consultants in writing of Study Report, and closure of Environmental Impact Assessment Process.

#### STUDY MANAGEMENT

- Attend meetings; liaison with community, project team, Statutory Authorities and other as required

## PILOT STUDY TASK OVERVIEW

<b>TECHNICAL INVESTIGATIONS</b>	<b>Comments</b>	<b>Leader</b>
<b>Study Planning</b>	Pilot study planning by the project team. A clear strategy for project execution, definition of project goals and how to quantify the results is required. Project planning and timelines are also required. A Pilot Study manager could be appointed whose primary role is to focus on the Pilot and ensuring the outcomes are achieved.	<b>C,ALL</b>
<b>Site Selection</b>		
<b>Geotechnical Assessment</b>	Review of paleodrainage conditions and geotechnical selection of preferable locations for both drainage channels and bores.	<b>C,D</b>
<b>Access Issues</b>	Consideration of access issues, including liaison with landowners and leaseholders. Refinement of possible sites based on these issues.	<b>A,B</b>
<b>Prelim Environmental Survey</b>	Initiate liaison and information sourcing regarding the proposed and preferred pilot study sites. Identification of no-go areas.	<b>B</b>
<b>Prelim Route Selection</b>	Based on existing survey information and preferred sites, identify drainage routes.	<b>W</b>
<b>Borefield Design</b>	Design of pumping and measurement borefields.	<b>C</b>
<b>Approvals</b>	Environmental, ownership, heritage etc issues relating to the pilot study. Obtaining approval to proceed for the relevant government agencies	<b>B</b>
<b>Survey</b>	Detailed survey of Pilot Study area, including proposed drainage routes.	<b>F</b>
<b>Route Optimisation</b>	With input from detailed survey, refine the drainage routes.	<b>W</b>
<b>Geotechnical Investigations</b>	Necessary geotechnical investigations for drainage channels and borefields.	<b>C</b>
<b>Drainage Design</b>	Based on input on design flow rates, optimised route and geotech provide a stable and adequate channel design.	<b>W,C</b>
<b>Baseline Monitoring</b>	Measurement of existing conditions in the Pilot Study area for baseline purposes.	<b>C,D,B</b>
<b>Ongoing Measurement</b>	Required measurements during Pilot Study duration (12 months) to demonstrate scheme performance and viability.	<b>C,D,B</b>
<b>Abandonment Planning</b>	Preparation of an abandonment plan should things go wrong.	<b>ALL</b>

# Coffey

Coffey Geosciences Pty Ltd is a consulting and project management company that has provided a high level of satisfaction to clients since 1959. With core skills in engineering, management and a range of sciences, Coffey undertakes a wide variety of project types. Projects have included major infrastructure and land development, mine development and operation, environmental studies and designs, water resource evaluations and a range of international developments in the water, health, education and environment sectors.

Our core purpose is to help our clients contribute to the economic and social well being of society by solving challenging problems innovatively., Our values are focused on outstanding customer service, integrity and ethics, our people, and advancement of the knowledge in our industry.

Coffey has offices throughout Australia and Asia, and has also undertaken major projects in the Pacific, Africa, the Middle East and the USA. Our people are adept at working in remote and difficult conditions, and enjoy solving the most challenging problems. Our clients represent a wide segment of the private and public sectors in Australia and Asia, and also include a large number of multinationals. We have a high frequency of repeat business and a number of clients with whom we have worked for over 20 years.

The holding company of the Coffey Group, Coffey International limited, is listed on the Australian Stock Exchange. This is a reflection of the financial strength of the Group. Consulting activities are conducted through the various subsidiary companies. The Group has five key operating areas that focus on particular client markets, and many projects involve more than one of these technical areas. Our key service areas are:

**GEOTECHNICAL** which includes investigation, design and construction services for foundation systems, excavations, dams, roads, railways, buried services, ports, pavements, landslides, tunnels, retaining walls, embankments, slopes, shafts.

**PROJECT MANAGEMENT SERVICES** with extensive experience in international development projects, including water supply, waste water and sanitation, land management, roads, railways, community health, environmental management, agriculture, animal studies, economic assessment.

**RESOURCES** which includes specialised services to the mining industry including dewatering, water supply, surface and ground water hydrology and modelling, mine planning, underground support systems, open pit design, waste management, environmental studies, rehabilitation, geophysical studies.

**TECHNICAL** which includes NATA registered construction testing and inspection services, concrete and asphalt mix designs, quarry studies, soil and rock testing, specialised field testing, instrumentation.

**ENVIRONMENTAL** which includes planning assessment, engineering and management services relating to land, water, air, waste and operational facilities. The Environment Division provides services to customers across the civil, industrial and mining sectors.

**MIKE HILLMAN** Principal Engineer  
BE MEngSc MIEAust

Michael Hillman joined the Coffey Group in 1981 and established its Perth Office, managing that office from 1981 to 1994. He has worked in the related fields of groundwater engineering, geotechnical engineering and mine geotechnics most of his professional life. He has broad experience in geotechnical projects including major industrial plant, structures on soft soils, marina developments and town site developments. He has carried out engineering studies on some 40 mine developments, providing design advice on water supply and dewatering, tailings management, water management, and mine geotechnics. He has worked throughout Western Australia and overseas.

**DR LEN DRURY** Senior Principal Hydrogeology  
BSc PhD Dip Hydrology

Dr Drury has worked for 17 years with the Coffey Group and more than 25 years as a groundwater specialist, mining and industrial consultant in Australia and overseas, with extensive experience in regional water resources management, mine rehabilitation and dewatering, pollution recovery and prevention, aquifer injection, salt water intrusion and subsidence prevention, insitu mining, town and irrigation water supply investigations, expert witness, groundwater and soil pollution investigation and remediation, and project management.

As a consultant to the water supply, civil engineering, mining and environmental industries following 13 years with Government water authorities, he has worked throughout Australia and in 23 other countries, especially concentrating in South East Asia and Indian sub-continent.

He has been a Director, Senior Principal and International Manager of the Resources Division (groundwater, mine geotechnics, geophysics, tailings dams) for Coffey Geosciences. Dr Drury has worked as Project Manager and Team Leader on many large water supply projects in Australia, The Pacific, South East Asia, Africa and the Indian sub-continent as well as having supplied consulting services on over 140 mining projects,

**DR BOB WHITELEY** Senior Principal Geophysics

Dr. Whiteley has been a geophysical consultant since 1974. In 1991 he joined Coffey on a full-time basis as Principal Geophysicist and Manager of Coffey Geophysics. He is now Senior Principal Geophysicist. Dr. Whiteley commenced his career in Engineering Geophysics with the Bureau of Mineral Resources (now AGSO) and also worked in the mineral industry as a general manager and senior exploration geophysicist/geologist. In 1972 he joined the academic staff of School of Applied Geology, University of New South Wales. While at UNSW Dr. Whiteley established and directed two consulting and contracting companies specialising in engineering, marine and groundwater geophysics. From 1984 to 1986 he was Associate Professor in the Division of Geotechnical Engineering, Asian Institute of Technology, Bangkok and Senior Lecturer at the University of New South Wales until 1988. Dr. Whiteley has an extensive consulting and research background in engineering, groundwater and environmental geophysics with over 80 published scientific articles and one book. Dr. Whiteley has worked on projects throughout Australia and in Bangladesh, China, Hong Kong, India, Indonesia, Malaysia, Netherlands, New Caledonia, New Zealand, Philippines, PNG, Singapore, Solomon Islands, Thailand, Vietnam and USA.

**BOB SIMPSON** Senior Principal Natural Resources  
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Prior to joining Water Studies in 2001, Mr Simpson was Deputy Director General in the NSW Department of Land and Water Conservation. In this position, he led fundamental reform programs for NSW's natural resources. The six divisions reporting to Mr Simpson developed systems and programs for land, water, soil and coastal resources; developed and implemented programs for community collaboration and targeted investment in landscape management, managed an action program to implement the major reforms of the new Act; administered a statewide program to improve the access and efficiency of non metropolitan water and sewerage services; and developed and implemented a program to develop water conservation initiatives. Mr Simpson held the following ex-officio positions: Soil Conservation Commissioner of New South Wales; Chair, Crown Land Revenue Review Committee; Chair, New South Wales Water Reform Implementation Management Committee.

## ENVIRONMENTAL ISSUES

Bowman Bishaw Gorham will assess the environmental, social and heritage impacts of the project. This will include the impacts on the biodiversity of receiving environments such as lakes, wetlands, rivers, streams and the ocean and the corridor through which the canals will traverse. The assessment will be undertaken in accordance with current government sustainable development objectives.

### LAND OWNERSHIP

- Obtain cadastral maps from shires
- Search crown reserve index
- Search land titles
- Identify current owners
- Create database and draft letters detailing proposal and seeking agreement for land access in conjunction with project team

### ABORIGINAL HERITAGE

- Assess all ethnological and archaeological issues

### EUROPEAN HERITAGE

- Assess all ethnological and archaeological issues

### SOCIAL IMPACTS

- Assess social impacts including:
  - Towns, infrastructure and farmers
  - Potential for tourism

### REGULATORY CONSTRAINTS

**Liaise, consult and obtain approvals from Western Australian State and Local Government Agencies including:**

- Local Authorities
- Department of Agriculture
- Department of Environment Water and Catchment Protection
- Conservation and Land Management
- Conservation Commission
- State Salinity Council
- Department of Indigenous Affairs
- Water Corporation
- Fisheries Western Australia

**Liaise and/or consult with Federal Government Agencies including:**

- Environment Australia
- Murray Darling Basin Commission

#### **Environmental Assessment Process**

- Determine and list regulatory requirements
- Undertake environmental assessment
- Prepare associated environmental management plans
- Submit to relevant authorities and obtain public submissions
- Respond to submissions
- Obtain Approvals
- Implement management plans

### ENVIRONMENTAL ISSUES

**To satisfy regulatory requirements Bowman Bishaw Gorham will undertake the following steps for each task listed below:**

- Set objectives
- Determine the scope of work
- Assess the existing environment
- Assess the potential environmental impacts
- Develop Environmental Management Plans

#### **Biological Factors**

- Overall Biodiversity
- Sustainable development
- Terrestrial Flora - Vegetation

- Vegetation types
- Threatened Ecological Communities
- Significant, Declared Rare and Priority Flora
- Disease
- Weeds

### Fauna

- Community types
- Threatened Ecological Communities
- Significant, Declared Rare and Priority Fauna
- Wetland, lake, stream and soil fauna
- Wildlife Corridors and Links
- Disease

### Wetlands and Lakes

- Wetland flora and fauna
- Types
- Threatened Ecological Communities
- Significance
- Recreation
- Wetting and drying cycles
- Nutrients and algal blooms etc

### Rivers and Streams

- Flow contribution and quality
- Riparian Ecology and Vegetation
- Stream ecology and significance
- Recreation
- Wetting and drying cycles
- Nutrients and algal blooms etc

### Marine

- Volume and quality of discharge to ocean
- Type of outfall
- Impacts on ocean biota
- Impacts on benthic biota
- Mixing and flushing (liaise with Worley)
- Impact of contaminants/nutrients/agricultural chemicals

## PHYSICAL FACTORS

### Surface Water Quality

- Potential for Acid Drainage (secondary acidification)
- Salt loads
- Potential to mobilise heavy metals/agricultural chemicals/nutrients

### Groundwater Water Quality

- Potential for Acid Drainage (secondary acidification)
- Salt loads
- Identification of fresh groundwater
- Potential to mobilise heavy metals/agricultural chemicals/nutrients

### Soils

- Soil survey
- Salt loads
- Soil structure
- Soil acidity
- Saline seepage
- Waterlogging
- Erosion control

### Noise impacts

### Dust impacts

### Visual Amenity



## **BOWMAN BISHAW GORHAM**

### **ENVIRONMENTAL MANAGEMENT CONSULTANTS**

**Bowman Bishaw Gorham** is a Western Australian based consulting practice offering specialist services in environmental management. The firm was established in 1986, and has an established reputation for the provision of pragmatic environmental advice and technical expertise to a diversity of industrial, resource and land development projects. Bowman Bishaw Gorham is now one of the largest specialist environmental consultancies in Western Australia.

**Bowman Bishaw Gorham's** prime objective is to provide its clients with the highest standards of professional service. The firm has a reputation for technical quality, and an excellent record of meeting project schedules and budgetary commitments.

All members of Bowman Bishaw Gorham, both professional and administrative staff, are committed to the implementation of the firm's Quality Management System to AS9002.

**Bowman Bishaw Gorham's** technical and scientific skills to perform authoritative investigations and analysis of complex environmental management issues derive from specialist skills in the following administrative and applied science disciplines:

- biogeography and ecology of the Western Australian environment;
- geology, geomorphology, groundwater hydrology and hydrochemistry of the settled and developing areas of WA;
- vegetation, flora and fauna of the south-west of the state;
- estuarine environments and wetlands of the south-west;
- marine ecology of Western Australian coastal waters;
- groundwater hydrology and hydrochemistry and the effect of land use change;
- sustainability strategies and techniques for land development and industry;
- pollution control, water and wastewater treatment and atmospheric emissions;
- contaminant fate and transport modelling;
- environmental chemistry, toxicology and eco-toxicology;
- human health and environmental risk assessment techniques;
- soil and groundwater remediation technology;
- effluent treatment and disposal strategies and technologies;
- state, national and international environmental quality criteria;
- administrative procedures for environmental assessment and project approvals under the Environmental Protection Act 1986, the Commonwealth Environmental Protection and Biodiversity Act 2000 and associated legislation;

**MARTIN PAUL BOWMAN**

Director

**Qualifications**

Bachelor of Environmental Science (1st Class Honours), Murdoch University .

**Industry Experience**

**1986 to Date:** Founding Director, Bowman Bishaw Gorham. Responsible for project coordination and technical input to land development, environmentally sustainable development, water and wastewater management, environmental planning, industrial, resource and pollution control projects. Extensive experience in strategic environmental planning and land use management to enable development in environmentally sensitive areas to proceed whilst meeting Local, State and Commonwealth government objectives for the environment.

**Key areas of expertise**

- Environmental impact assessment,
- Expert testimony: TPAT, Supreme Court,
- Environmental approvals, Section 16, 38, 46, 48,
- Stormwater and effluent management,
- Environmentally sustainable development,
- Effluent treatment and disposal strategies,
- Environmental planning and constraints analysis,
- Constructed wetland design and management,
- Interpretation of environmental policies and guidelines.
- Ecological recovery plans,
- Coastal and waterside resorts and developments.
- Groundwater studies and impact analysis,
- Appeals preparation,
- Newtown and new urbanist projects,

**RICHARD GORHAM**

Director

**Qualifications**

M. Sc. (Resource Management Science), University of British Columbia. 1985

B. Sc. (Zoology), University of British Columbia. 1979.

LL.B., University of Western Australia. 1974

**Principal**, Bowman Bishaw Gorham.

**Manager of the firm's Marine Studies Group.**

Typical projects have related to the following.

- |                                    |  |
|------------------------------------|--|
| ● Offshore oil exploration         | ● Coastal land developments            |
| ● Industrial wastewater discharges | ● Port developments                    |
| ● Marina developments              | ● Marine fouling control               |
| ● Environmental contamination      | ● Fisheries management and aquaculture |
| ● Urban wastewater disposal        | ● Canal estate developments            |

**Expertise** in defining and interpreting environmental management responsibilities consistent with legislative and regulatory requirements. Specialist capabilities in studies to assess the fate and ecological consequences of wastes and leachates from industry, agriculture and urban areas, with emphasis on aquatic environments. Has directed the preparation of more than two hundred environmental impact studies in Western Australia. Has also provided expert testimony to Government Ministerial Tribunals and has participated in both Government Committees and Government-Industry Working Groups.

**1986-1988:** Senior Scientist with Kinhill Engineers, foundation scientist to their Environmental Studies Group in W.A. Projects included the preparation of the Peel Inlet and Harvey Estuary Management Strategy ERMP, studies for industrial wastewater outfalls (CSBP and Farmers, SCM Chemicals, and the W.A. Meat Commission); assessments of the fate and environmental effects of priority contaminants (PCB's, lindane, pesticides), and numerous environmental monitoring studies.

**BLACKWOOD FEASIBILITY STUDY**

## ENVIRONMENTAL MANAGEMENT

### DR PHILIP LEON BOURGAULT

Associate

#### Qualifications

B.Sc. (Hons) Environmental Science, Murdoch University, 1989

Ph.D, Murdoch University, 1996

#### Associate

**Responsible for supervising** site contamination assessments, groundwater investigations, landfill management plans and undertaking groundwater flow and contaminant transport modelling.

**1991-1996:** Ph.D Student Murdoch University. Thesis involved the study of the rainfall induced solute transport in saline agricultural soil in the Wheat belt of W.A. A combination of a field and laboratory experiments were used to investigate the role of soil structure, macroporosity and cultivation practices on chloride leaching. Modelling of water and solute transport through macroporous soils was undertaken to predict the effective leaching time.

**1987-1988:** Honours project (Murdoch University). Investigated soil properties and water/nutrient management options for turf wickets at the Western Australia Cricket Association.

#### Specific Expertise

Site contamination assessment and management, groundwater flow and contaminant transport modelling, salinity management, land capability and pesticide management.

#### Publications

Bourgault P.L., Williamson D.R., and W.D Scott (1997) Prediction of chloride leaching from a non-irrigated, de-watered saline soil using the MACRO model, Hydrology and Earth System Sciences, 4, 845-851. Bourgault P.L., S.A. Smith, and P.L. Cock, (1999) Risk Assessment of Marina Development on Contaminated Land - Exposure Pathway Modelling, Contaminated Site Remediation: Challenges Posed by Urban and Industrial Contaminants, Proceedings of the 1999 Contaminated Site Remediation Conference, Centre for Groundwater Studies, CSIRO Land and Water, Wembley, Australia, 797-804.

### STUART ALLEN SMITH

Director

#### Qualifications

B.Env.Sc. Environmental Science, Murdoch University, 1988

#### Experience

**Principal and Director** Responsible for the conduct of environmental audits, site contamination assessment and management, risk assessment, waste management and pollution control studies throughout Western Australia.

**Risk Assessment (RA)** projects have included human health and/or ecological RA of trace metals, pesticides, PAH, MAH, HAH, and/or hydrocarbons in soil and/or groundwater. Example projects include horticultural sites (Yangebup, Wanneroo, Gwelup, Mullalyup) and industrial sites (Fremantle, North Lake, Exmouth).

**Environmental Officer**, Environmental Protection Authority. Responsible for the environmental assessment of industrial development and waste management proposals. Contributed to the development of standards for chemical storage facilities. Reviewed proposed Federal Legislation on the transport of hazardous wastes. Involved in Government inquiry into a toxic chemical spill from a train derailment.

**1988-1989:** Research Scholar, Technology and Industry Development Authority. Conducted laboratory studies on metals removal using waste soils.

**1988:** Contractor, Health Department and Water Authority of WA. Principle researcher and author of Environmental Management Guidelines for the Metal Finishing Industry in Western Australia.

#### Specific Expertise

Management of environmentally hazardous substances, environmental auditing, site contamination assessment and management, risk assessment, waste management and pollution control.



**WORLEY** is a leading wholly Australian owned engineering consultancy that encapsulates a broad spectrum of technologies and project expertise that are delivered through discrete business units operating in a common management system. It offers a vast depth of multi-disciplined experience to the maritime, civil, structural, offshore, energy and mineral processing industries. Offices of the member companies are located throughout Australia, New Zealand, South East Asia, and in Ireland, the Middle East and the USA. Total payroll is now in excess of four thousand employees.

**WORLEY BUSINESS UNITS** work closely together to ensure optimum response to client needs and effective deployment of engineering staff and expertise. The Infrastructure Business Unit traces its history back to 1986. Worley Infrastructure has completed projects in Australia, Malaysia, Brunei, Indonesia, India, Myanmar, Vanuatu and the Philippines.

**THE COMPANY** undertakes all aspects of project design and implementation, from feasibility studies and conceptual ideas through to detailed design, preparation of tender documents, contract award, construction supervision and final hand over to client, followed if required by ongoing involvement in operation and maintenance of the facility. It specialises in practical, innovative concepts tempered by solid engineering experience to ensure that the facility meets the required technical, aesthetic and environmental specifications.

**WORLEY INFRASTRUCTURE** specialises in a range of engineering disciplines including:

Civil Infrastructure, including drainage design, earthworks and site preparation design, roads, subdivision and residential developments, siting studies, sewerage and service corridors.

**STRUCTURAL ENGINEERING**, including industrial buildings, commercial buildings and highrise developments, marine structures, stack design, bridges and foundation design.

**MARINE AND COASTAL ENGINEERING**, including coastal protection, marinas, canal estates, port infrastructure and logistics, coastal and environmental modelling, design criteria assessment and design of ocean outfall systems.

**WORLEY'S ENGINEERS** are experienced with working with multi-disciplinary teams on civil, structural, marine and environmental projects.

## CIVIL ENGINEERING MANAGEMENT

### JOHN SCHEPIS

BE (Hons) Dip HE (Delft) MIE Aust CPEng  
General Manager Infrastructure

John Schepis is the General Manager for Worley Infrastructure in Perth. He graduated from the University of Western Australia in 1982 with First Class Honours in Civil Engineering. He was a participant of the International Institute for Hydraulic and Environmental Engineering (Delft, The Netherlands) in 1986/87. Graduated with Distinctions in Coastal, Offshore and Port Engineering. John's experience spans some 20 years and includes Port Harbour Consultants, Department of Marine and Harbours, Western Australia (WA) and the Public Works Department of WA. Duties were diversified and covered most aspects of marine, coastal, port and offshore engineering. John has successfully completed a large number of civil and maritime projects and feasibility studies in a wide range of environments within Australia and overseas.

### RICHARD BARON-HAY

BE (Hons)  
Senior Civil Engineer

Richard holds a Bachelor of Civil and Environmental Engineering and has over ten years' engineering experience in the civil, industrial, mining and commercial construction industries, both in the government and private sectors. Richard has been responsible for the design and contract management of roads, drainage, effluent containment, earthworks and services for residential, industrial and mining projects.

Richard was a member of the engineering team that undertook the frontend engineering design for the development of a Pressure Acid Leach operation for the Ravensthorpe Nickel Project. He coordinated civil, marine and geotechnical works to manage the civil design activities associated with the development. His scope included the supervision of a geotechnical investigation and bathymetric survey, seawater inlet and brine return structure, seawater pumping station, plant site preparation, site access roads, weighbridges, construction water facilities and waste water facilities.

### MURRAY BURLING

BE (Hons), MEngSc, MIEAust  
Senior Coastal Engineer

Murray Burling is a Senior Coastal Engineer and manages Worley's coastal and environmental modelling group. Murray has a Master's degree in Coastal Oceanography, with particular application to the modelling of complex hydrodynamic systems. Since joining Worley in 1997, Murray has completed many assignments, including feasibility studies, detailed design of coastal protection systems and many modelling studies.

Murray has recently been responsible for the technical application of a circulation model to Cockburn Sound, and has been involved with a team from the DEP in the assessment of the impacts of industrial discharges, including thermal and brine outfalls. Murray also led Worley's work on the Burrup Desalination plant intake and outfall investigations. Murray was also a key member of the Oakajee Port feasibility team, which included the preliminary design of river training works.

### DAVID TODD

BEng MBA MIEAust CPEng  
Operations Manager - Infrastructure

David has more than 15 years of experience in infrastructure and marine projects, including project management and detailed feasibility studies, through to detailed design, documentation and construction supervision. These projects have included greenfields industrial infrastructure projects in Australia and Southeast Asia, including port and onshore civil works, hydraulic investigations for coastal projects and infrastructure requirements for ocean outfall systems. David has performed work for a range of private and government organizations within Australia and overseas and was a recent Chairman of the Coastal and Ocean Panel of the Institution of Engineers WA.

Recently, David has been a key team member of the Aluminium Pechiney Siting Study, a major new infrastructure project in the Northern Territory with significant strategic importance to the NT Government. David's work included corridor assessment, conceptual design of port layouts and integration of all the logistical components of the project.



## UNIVERSITY OF WESTERN AUSTRALIA CENTRE FOR WATER RESEARCH



The Centre for Water Research was created in 1981 as a result of a joint University and State Government initiative. It has now grown to encompass nine academic units, which comprise the Department of Environmental Engineering, three commercial services groups - the Technology Transfer Facility, the Contract Research Group and Field Operations Group. Together these units offer an environmental engineering service to the water industry locally, nationally and internationally, and undertake fundamental research in the following areas:

### **LAKES, WETLANDS, RIVERS AND ESTUARIES**

CWR has considerable expertise and accumulated experience in the investigation of hydrodynamic and biogeochemical processes in wetlands, lakes, rivers and estuaries which include: eutrophication alleviation in lakes, wetlands, rivers and estuaries, physical modelling of hydraulic phenomena, integrated catchment management, cycling of chemicals in natural systems

### **ESTUARIES AND COASTAL SEAS**

The Centre offers services in sediment dynamics, geomorphology and coastal stabilisation, circulation and dispersion which include: numerical simulation of sediment and tracer transport in coastal seas, design and implementation of hydrodynamic and biological data collection programmes, design of ocean outfalls

### **CATCHMENTS**

The Centre has expertise in environmental impact studies for river basin development to predict the effect of land use changes on water yield and water quality which include: integrated catchment management studies, numerical simulation of catchment hydrology, water resource development in tropical environments, solute transport in saturated and unsaturated groundwater systems

### **PROF. JORG IMBERGER**

Jorg Imberger is Professor of Environmental Engineering and Chair of the Centre for Water Research at the University of Western Australia. His main research interest is in the motion of stratified fluids in the context of environmental fluid dynamics. Specifically, this research includes the study of the motion and quality of water in estuaries, reservoirs and lakes. The interaction of the biological system and the water motion is also a primary focus. Prof. Imberger has also held various visiting, and academic positions at the University of Padova, University of California (Berkeley), Stanford University, Caltech, University of Karlsruhe and the University of Western Australia.

Jorg has been the recipient of numerous local, national and international awards. In 1995 he was awarded the Onassis Prize for the Environment for his contribution to environmental issues. In 1996 he was awarded the Stockholm Water Prize for his outstanding contribution to the water industry. In 1999, he was awarded an Honorary Doctorate from the Democritus University of Thrace of Greece. Jorg is one of a handful of people in Australia to be elected to both the Australian Academy of Science and the Australian Academy of Technological Sciences and Engineering.

Prof. Imberger is currently the Walter Bean Scholar at the University of Waterloo in Canada, and is also a Fellow of the Sackler Institute of Advanced Studies in Israel. He is also current Chair of the Western Australian Estuarine Research Foundation, and was formerly Scientific Advisor to Earthwatch and a member of the United Nations High Level Advisory Board on "Sustainable Development". Jörg has published 4 books, 16 book chapters, 109 refereed journal papers, 71 conference papers and 99 research reports.



**CENTRE FOR WATER RESEARCH**

**PROF. MURUGESU SIVAPALAN**

Murugesu Sivapalan is currently Professor of Environmental Engineering at the Centre for Water Research, University of Western Australia. He leads an active research programme in Surface Hydrology, with a particular focus on prediction of ungauged catchments. He has made outstanding contributions to catchment hydrology in the areas of spatial variability and scale, flood frequency, and hydrologic modelling. He is the lead developer of LASCAM, the large-scale catchment model, aimed at predicting the long-term effects of climatic, soil and vegetation changes on both water quantity and quality (salinity, sediments, nutrients and heavy metals).

Siva is the author of over 100 peer-refereed publications, including 65 in international journals. He has been lead organiser of over a dozen international conferences, and keynote or plenary speaker in a number of these. He currently serves as Associate Editor of four international journals and an encyclopaedia. He has held research and teaching positions at the Asian Institute of Technology (Thailand), Princeton University, Technical University of Vienna, Technical University of Delft, and the University of Western Australia. Over the past 13 years he has supervised the work of over 12 PhD and 4 Masters students.

Siva has been the recipient of a number of awards. He was awarded the Lise Meitner Fellow of the Austrian Academy of Sciences in 1996. In 2000 he was elected a Life Member of the International Water Academy, located in Oslo, Norway. In 2001 he was awarded the Biennial Medal of the Modelling and Simulation Society of Australia and New Zealand, and elected a Fellow. Also in 2001, he was inducted as a Fellow of the Australian Academy of Technological Sciences and Engineering.

**ASSOC. PROF. KEITH SMETTEM**

Keith Smettem is a sub-program leader in the CRC for Plant-Based Management of Dryland Salinity. He leads active research programs concerned with the theory and measurement of water and chemical movement through soils and landscapes. He has made significant contributions to developing methods for field measurement of soil hydraulic properties and analysis of preferential flow processes in field hydrology. He has been a keynote speaker at many International Conferences and is a former President of the Australian Society of Soil Science. Keith has also received a British Royal Society/Australian Academy of Science scientific exchange award and was co-author of a paper that won the Institute of Engineers, Australia G.N. Alexander medal for the best paper in hydrology and/or water resources.

Keith is the author of over 80 peer-refereed publications. He has held research and teaching positions at the University of Sydney, CSIRO, and the University of Western Australia, and over the past 7 years has supervised 10 PhD and 5 Masters students.

Keith has also sat on many state and federal scientific advisory committees and is a regular reviewer for the American National Science Foundation.

**DR. DAVID HORN**

David Horn is the Manager of the Contract Research Group at the Centre for Water Research at the University of Western Australia. He is a chartered professional engineer with over fifteen years experience in civil engineering and the water industry. He holds a PhD in environmental fluid dynamics and his main research interest is the management of water quality in lakes and reservoirs.

David currently leads the Contract Research group at CWR. The group undertakes applied research projects around the world and valued at over \$1 million annually, including major projects for the Sydney Catchment Authority, the Israeli Water Commission and Idaho Power. The Contract Research Group also manages the development and distribution of the internationally acknowledged suite of CWR software, which includes the hydrodynamic model DYRESM, which is currently used in over 40 countries around the world.

Current and previous research projects investigating salt and salinity related issues include the development of a computer model of solar salt production and a project investigating the commercial use of Western Australian salt lake biota in aquaculture.



**DM CIVIL** is one of the largest privately owned civil works contractors in Western Australia. Its civil undertakings include large-scale drainage, earthwork and pipeline projects in urban and rural areas throughout Western Australia. Recent projects completed include the Stirling, Harvey to Perth pipeline and the Woodman Point Environmental Enhancement Project.

**DM CIVIL** has invested in new techniques and are at the forefront of their industry in drainage, excavation and pipeline construction. The training developments of the necessary skills in its workforce are of the highest priority. Consistency with its training and **DM CIVIL'S** safe site policy has produced a LTI frequency rate that is 70% less than industry average.

As a rural and remote locations operator **DM CIVIL** is an environmentally conscious contractor and employs the highest standards of environmental care. In acknowledgment of these high standards, **DM CIVIL** has been significantly recognised by winning major environmental awards throughout Australia including:

<p><b>Engineering Excellence Award 2000</b> For Environment</p>		<p><b>Western Australian Case Earth Award</b> For Environmental Best Practice</p>
<p><b>Engineering Excellence Award 2000</b> For Management of Engineering</p>		<p><b>National Case Earth Award</b> For Environmental Best Practice</p>

**REG TOOHEY**  
Managing Director

Reg has been the Managing Director of DM Civil for 25 years. Reg offers considerable experience in project management, organisation, constructability reviews and costing. He would be a valuable team member and has had extensive experience at board management levels on various projects. Reg is currently the immediate past National President for the Civil Contractors Federation (CCF) and is a past president of the Western Australian Branch. Reg is also a member of the Urban Development Advisory Committee for the Water Corporation of Western Australia and also represents the Civil Contractors Federation on the Water Corporation's Technical Committee. Reg has considerable standing in the pipeline industry not only in Western Australia but is also well recognised by his peers throughout Australia. Reg also has significant skills in cost estimating of pipeline and drainage projects from deep, wet difficult main sewer projects in the Perth CBD, to remote mining water supply pipelines.

**TONY SPANJERS**  
Managing Director

Tony has been the Managing Director of DM Civil for 25 years. Prior to this Tony spent his formative years working in his father and uncle's business, Hercules Construction, which undertook dam construction, pile driving and concrete construction. Tony then set up a civil construction company with his brother Eric and did numerous contracts including subcontract work to Leighton Contractors before forming a partnership with Reg Toohy to incorporate DM Civil (previously DM Drainage). Tony undertook the excavation of the Yanchep Sun City Marina subcontracted to John Holland. He also was the Project Manager on the \$8M Araluen Golf Course and subdivision project, which was constructed in 1992 and 1993 and the \$27M Mandurah Quay Project in 1994. Tony has been instrumental in introducing many new practices, procedures and development of new technologies in this field of work such as hydraulic excavators, steel trenching boxes, automatic pipe lifters and horizontal earth boring equipment. Many of these are taken for granted in today's construction environment, however Tony was responsible for pioneering the introduction and use of this equipment in Western Australia.

**BLACKWOOD FEASIBILITY STUDY**



## CIVIL CONTRACTOR

### **BRUCE SHAW**

Qualifications: BEng (Civil/Hydraulics), 1978; M.I.E. Aust. C.P. Eng  
Senior Contracts Manager

Bruce is a chartered professional engineer with 24 years of experience working in private enterprise in the irrigation, water supply and civil construction industry and has been working at **DM CIVIL** for the last 14 years.

Bruce has worked in a variety of organisations associated with manufacturing and construction undertaking a range of work including design, estimating, procurement and project management. Bruce's duties in **DM CIVIL** involve quantifying and costing for the construction of bulk earthworks projects including general fill, drainage catchment dams, pond embankments and marinas etc.

Pipelines are Bruce's area of expertise having worked for Southern Cross Machinery (Pump & Irrigation Equipment Manufacturer), James Hardie & Coy Pty Ltd (Pipe Manufacturer) and now **DM CIVIL** (Specialising in Pipeline Construction). He has extensive experience in the design, costing and construction of water supply, drainage, sewerage, irrigation and ocean intake pipeline systems.

Bruce undertook the pipeline cost estimation of the recently completed \$32M DN1400 Harvey - Perth Trunk Water Main, **CONSTRUCTED BY DM CIVIL**.

### **MARTIN HICKS**

Qualifications: 25 years experience in the construction industry  
Projects Manager

Martin has been in the civil contracting industry for 25 years. His experience has been gained from a "grass-roots" level having started in the industry as a labourer and working his way to his present position as Projects Manager. His position of Projects Manager with **DM CIVIL** encompasses the organising and administration of contracts, planning strategies for larger contracts, coordinating men and machinery through all of **DM CIVIL**'s contracts, advising the tender team on construction methods and assisting DM's supervisors.

Martin has experience in earthworks and drainage through his involvement with many past projects, including Coolgardie Wastewater Treatment Plant, Mandurah Quay Marina and several large subdivisions. Martin in his previous capacity of supervisor had extensive experience with large precast and insitu concrete contracts through his involvement with the UWA underpass and quarry industries batching plant, the later involving the forming and pouring of over 1,000m<sup>3</sup> of concrete.

**JONATHAN THOMAS**

M.A. (Oxon)

Economics Consultant

He has over twenty year's experience as a resource and environmental economist in Australia. He was trained as an economist and statistician at Oxford University, where he holds Bachelor and Masters degrees; and later as a management consultant at the Sundridge Park Management Centre. He was Assistant Chief of the **CSIRO DIVISION OF WATER RESOURCES** between 1988 and 1997.

**JONATHAN WAS AN AUTHOR OF** *On Rational grounds: Systems Analysis and Catchment Land Use Planning* (Bennett and Thomas, 1982), which considered the problems of salinity in the WA Murray River Catchment, and concluded that vegetative approaches to salinity management were not economic in that catchment. He was also responsible for the economic analysis of national salinity issues in Consultancy Report No 8 to the Water 2000 Study (Peck, Thomas and Williamson, 1983)

**AS DIRECTOR OF THE RESOURCE ECONOMICS UNIT**, Perth, he is a consultant to the National Land and Water Resources Audit on the non-agricultural costs of natural resource degradation, the National Dryland Salinity Program on options for productive use of saline lands, the Western Australian Rural Towns Program on costs of salinity to infrastructure, and the Western Australian Water and Rivers Commission on water futures. He also was engaged in the Mid-term Review of the Natural Heritage Trust, Inland Waterways Theme.

Jonathan has a total of 99 publications, including 3 books, 14 journal papers, 28 conference papers and 54 consultancy reports.

**DAVID WILLIAMSON**

BSc Agr(Syd) MSc(Agric)(WA)

Soil Scientist

His academic qualifications are in soil physics and agricultural hydrology from Sydney University and the University of Western Australia. Recently he retired from his position as a principal research scientist with **CSIRO LAND AND WATER**, a career which spanned some thirty-six years, during which he was concerned primarily with catchment water balance and salinity studies in Australia and particularly in Western Australia.

**HE WAS A LEADING MEMBER** of the team which conducted the paired catchment studies in the Collie Catchment between 1970 and 1985, and recently contributed to the need for greater emphasis on pumping approaches to salinity abatement in the Western Australian wheat belt. He has been a consultant on salinity management to state governments throughout Australia. He worked with Jonathan Thomas on the National Water 2000 Study Salinity impacts study (Peck, Thomas and Williamson, 1983). He later prepared a major review of salinity trends in the Murray-Darling Basin for the Murray-Darling Basin Commission.

**DAVID HAS CONTRIBUTED TO THE CURRENT INTEREST IN DRAINAGE APPROACHES FOR SALINITY MANAGEMENT**, through publication of the report *Salinity Crisis Needs Bold Action* (Coyne, Williamson and Giudici, 1999). He also presented papers on the subject of integrated salinity management at the 1999 UWA Winter School and the AGCON 2000 conference.

He has published 26 journal papers; 37 published conference, seminar and workshop papers, 12 consultancy reports and 25 technical reports, and lectured on salinity at Australian Groundwater Schools since 1981 and in Thailand and China in the 1990s.

## PILOT STUDY TASK OVERVIEW

### BLACKWOOD SALINITY REDUCTION AND HYDRO-ELECTRIC PROJECT

#### PROJECT DESIGN

Version: 24 April 2002

ITEM	DESCRIPTION	LEADER	NOTES
<b>O.</b>	<b>Overall Project Management</b>	A	
<b>A PRELIMINARY WORKS</b>			
<b>A. 1 UPPER BLACKWOOD CATCHMENT STUDIES</b>			
<b>A.1.1</b>	<b>On Farm Studies - Desk Review</b>		
	Collate existing research	D	
	Advise on baseline conditions	D	
	Advise on rate of salinization	D	
	Scientific liaison with agencies, universities	D	
	Identify appropriate drainage methods	C	surface and deep aquifers
	Pumping systems required	C	effects of pH, salt, oxygen
	Design generic drainage systems	C	energy requirements
	Drainage system modelling studies	CWR/C	prediction of lateral effect
	Local Government and Farmer site acceptance	All	farmland, lakes
	Confirm alignments for Pilot Study	C	
<b>A.1.2</b>	<b>Off Farm Studies - Desk Review</b>		
	Collate existing research	C	
	Identify known boundaries of palaeodrainage	C	
	Identify links palaeodrainage & saprolitic aquifers	C	
	Identify aquifer types and characteristics	C	alluvial, palaeo, saprolite
	Palaeodrainage aquifer quality & yield data	C	
	Saprolitic aquifer quality & yield data	C	
	Commence Site Access Studies:		
	<i>Land Ownership</i>	B	
	<i>Aboriginal Heritage</i>	B	
	<i>European Heritage</i>	B	
	<i>Social Impacts</i>	B	
	<i>Regulatory Constraints</i>	B	
	<i>Environmental Issues</i>	B	
	Catchment analyses - surface water hydrology	CWR	
	Flood management design	CWR	
	Provision for 'natural' surface runoff flows in drain	C	
<b>A.1.3</b>	<b>Off Farm Studies - Preliminary Site Assessment</b>		
	Palaeodrainage geophysics	G	aerial geophysics proposed
	Canal Route Alignment and Level Survey	C	level accuracy 0.1m required
	Geotechnical Assessment	C	
	Provision for 'natural' streamflow in rivers/creeks	G	include in engineering design
	Environmental Assessment (acid drainage, biodata, etc) for discharge disposal to lakes	B	
	Deep open drain design	C	include in engineering design
	Pumping systems required	C	surface drains, aquifer pumping
	Palaeodrainage de-pressurising bore design	C	effects of pH, salt, oxygen
	Monitoring Bore Design	C	
<b>A. 1.4</b>	<b>Implementation Planning</b>		
	Pilot study implementation	All	
	Pilot study abandonment plans	All	
	Pilot study risk and risk management	All	

## PILOT STUDY TASK OVERVIEW

ITEM	DESCRIPTION	LEADER	NOTES
<b>A.2</b>	<b>TRANSFER CANAL - DURANILLIN TO OCEAN</b>		
<b>A.2.1</b>	<b>Desk Review - Duranillin to Power Station</b>		
	Available Survey	W	
	Available Geotechnical Data	C	
	Aerial Photography/ Landsat	G	
	Canal type and construction method	W	
	Alignment Options - North and South Route		
	<i>Power Station Site</i>	W	
	<i>Lengths of alignment</i>	W	
	<i>Structures (syphons, tunnels, dams aqueducts, lining, culverts, bridges)</i>	W	
	Planning Site Access Studies:		
	<i>Land Ownership</i>	B	
	<i>Aboriginal Heritage</i>	B	
	<i>European Heritage</i>	B	
	<i>Social Impacts</i>	B	
	<i>Regulatory Constraints</i>	B	
	<i>Environmental Issues</i>	B	
	<i>Identification of No Go areas</i>	B	
	Surface water/flood management	W	flow into canal, flow in stream
<b>A.2.2</b>	<b>Desk Review - Power Station Assessment</b>	H	HEC to advise
<b>A.2.3</b>	<b>Desk Review - Outlet to Ocean Discharge</b>		
	Available Survey	G	
	Available Geotechnical Data	C	
	Aerial Photography/ Landsat	G	
	Canal type and construction method	W	
	Alignment Options - North or South Route		
	<i>Options for Discharge to Coast</i>	W	
	<i>Lengths of alignment</i>	W	
	<i>Structures (syphons, tunnels, dams aqueducts, lining, culverts, bridges)</i>	W	
	Planning Site Access Studies:		
	<i>Land Ownership</i>	B	
	<i>Aboriginal Heritage</i>	B	
	<i>European Heritage</i>	B	
	<i>Regulatory Constraints</i>	B	
	<i>Environmental Issues</i>	B	
	<i>Identification of No Go areas</i>	B	
	Ocean outfall environmental issues	W	
	Surface water/flood management	W	flow into canal, flow in stream

## PILOT STUDY TASK OVERVIEW

ITEM	DESCRIPTION	LEADER	NOTES
<b>B PILOT STUDY IMPLEMENTATION</b>			
<b>B.1 UPPER BLACKWOOD CATCHMENT STUDIES</b>			
<b>B.1.1</b>	<b>On Farm Studies - Field Investigations</b>		
	Questionnaire: Requirement by land owners for off farm disposal of excess water	D	
	Extend Review Studies.	D	
	Scientific liaison with agencies, universities	D	
<b>B.1.2</b>	<b>Off Farm Studies - Field and Laboratory Testing</b>		
	Geophysical Traversing	G	
	Topographical Survey	G	
	Shallow aquifer monitoring bore construction	C	Note: Monitoring to address salt balance as well as water balance issues.
	Palaeodrainage Investigation	C	
	Palaeodrainage de-pressurising bore construction	C	
	Palaeodrainage deep aquifer monitoring	C	
	Drain Excavation	C	
	Drain flow monitoring structures	C	
<b>B.1.3</b>	<b>Upper Blackwood Catchment Monitoring</b>		
	Full seasonal sequence groundwater and surface water flow and quality monitoring	LA,CWR	include WRC gauging stations
	Continuous Pumping - Maintenance/Security	LA	involves land owners
<b>B.2 TRANSFER CANAL - FIELD AND LABORATORY TEST PROGRAMME</b>			
<b>B. 2.1</b>	<b>Duranillin to Ocean</b>		
	Implementing Site Access Studies:		
	<i>Land Ownership</i>	B	
	<i>Aboriginal Heritage</i>	B	
	<i>European Heritage</i>	B	
	<i>Social Impacts</i>	B	
	<i>Regulatory Constraints</i>	B	
	<i>Environmental Issues</i>	B	
	Detailed Survey	G	
	Geotechnical Route Assessment	C	
	Route Optimisation	W	
	Centre for Water Research		
<b>B. 2.2</b>	<b>Power Station Site</b>		
	Project details to be provided by HEC	H	HEC to advise
<b>B. 2.3</b>	<b>Power Station Penstock Outlet to Coastal Discharge</b>		
	Implementing Site Access Studies:		
	<i>Land Ownership</i>	B	
	<i>Aboriginal Heritage</i>	B	
	<i>European Heritage</i>	B	
	<i>Social Impacts</i>	B	
	<i>Regulatory Constraints</i>	B	
	<i>Environmental Issues</i>	B	
	Detailed Survey	G	
	Geotechnical Route Assessment	C	
	Route Optimisation	W	
	Offshore discharge site selection	W	

## PILOT STUDY TASK OVERVIEW

ITEM	DESCRIPTION	LEADER	NOTES
<b>C ANALYSIS OF PILOT STUDY AND REPORTING</b>			
	Presents results of desk studies, field and laboratory testing; Interpretations of site conditions:	D, C	
<b>C.1</b>	<b>UPPER BLACKWOOD STUDIES</b>		
	Catchment Hydrology	CWR	
	Catchment Hydrogeology	C	
	Geotechnical Design Issues	C	
	Collector/Transfer Canal Layout Design	C, W	
	Drainage design and hydrology	C	
	Land/Community/Environmental/Heritage issues	B	
	Design Optimisation and Costing	W, C	
<b>C.2</b>	<b>TRANSFER CANAL DESIGN</b>		
<b>C. 2.1</b>	<b>Duranillin to Power Station</b>		
	Prefeasibility Level Design		
	Optimised route	W	
	Structures	W	
	Cost Estimate	W	
	Land/Community/Environmental/Heritage issues	B	
<b>C. 2.2</b>	<b>Power Station to Coastal Discharge</b>		
	Prefeasibility Level Design		
	Optimised route	W	
	Structures	W	
	Offshore Discharge Location/ Design	W	
	Cost Estimate	W	
	Land/Community/Environmental/Heritage issues	B	
<b>C. 3</b>	<b>POWER STATION SITE</b>		
	Prefeasibility Level Design and costing	H	HEC to advice
<b>C.4</b>	<b>ECONOMIC REVIEW</b>	E	
<b>C.5</b>	<b>PROJECT RISK ASSESSMENT</b>	All	
	Pilot Study Abandonment Planning		
<b>D ENVIRONMENTAL IMPACT ASSESSMENT, COMMUNITY CONSULTATION</b>			
<b>D.1</b>	<b>ENVIRONMENTAL IMPACT ASSESSMENT</b>	All	
	To be run concurrently with Pilot Study		
<b>C.2</b>	<b>Community Liaison Group</b>		
	<i>Communication with farming community</i>	All	Reference group meeting periodically for advice/feedback
	<i>Liaison with Blackwood Basin Group</i>	A, D	
<b>DESIGN TEAM INDEX</b>			
<b>A</b>	Agritech Hydropower Pty Ltd	<b>H</b>	Hydro Electric Commission
<b>D</b>	David Williamson Consulting	<b>E</b>	Economic Resource Unit
<b>C</b>	Coffey Geosciences	<b>All</b>	All Consultants
<b>B</b>	Bowman Bishaw and Gorham	<b>LA</b>	Local Government Authorities
<b>W</b>	Worley	<b>CWR</b>	Centre for Water Research
<b>G</b>	Aerial Geophysical Specialist		

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*Trend in Area of Salt Affected Land for Different Land Management Systems in the Upper Blackwood River Basin, Western Australia*

