SWAN-CANNING CLEANUP PROGRAM

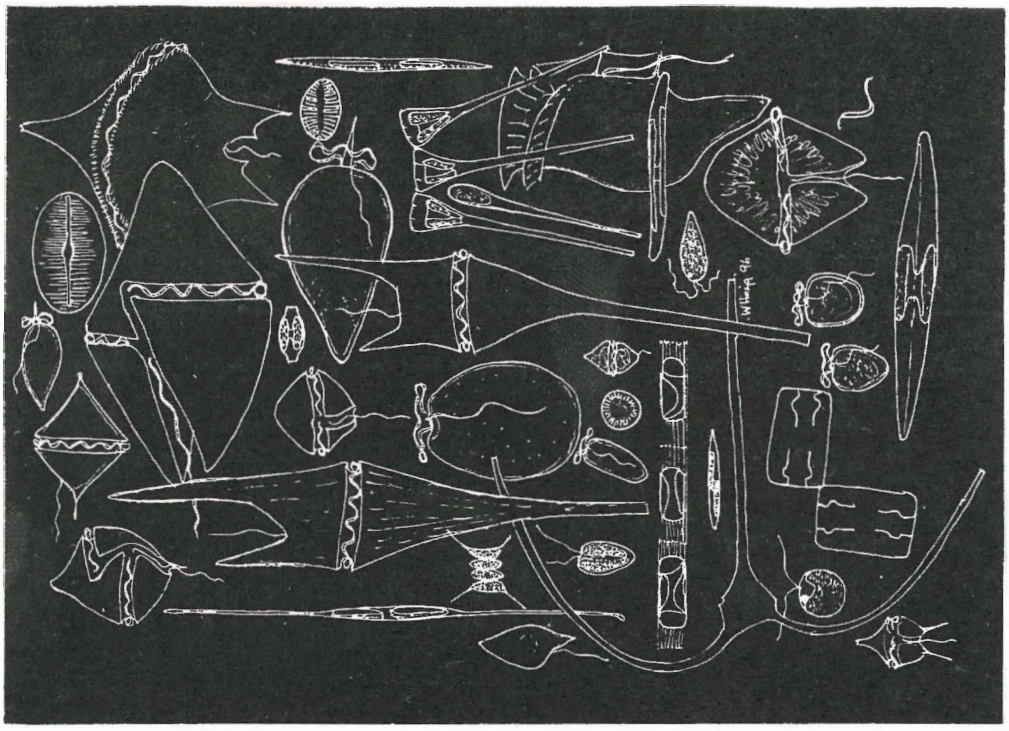
and the

WA ESTUARINE RESEARCH FOUNDATION

forum on the

HEALTH OF THE SWAN ESTUARY

12 April 1996, CSIRO auditorium, Floreat, Perth, WA



Incorporating research and management projects contributing to the health of the Swan Estuary including projects from the Swan River Trust, the Water and Rivers Commission, Agriculture WA, Water Corporation, Department of Environmental Protection, Ministry for Planning, local government, WA universities, CSIRO, and the Swan-Avon Integrated Catchment Management Program.

SWAN RIVER TRUST

List of abbreviations

ARMA	Avon River Management Authority
AWA	Agriculture WA
AWMA	Albany Waterways Management Authority
BICM	Bayswater Integrated Catchment Management
CALM	Department of Conservation and Land Management
CSIRO	Commonwealth Scientific & Industrial Research Organisation
CU	Curtin University
CWR	Centre for Water Research
ECU	Edith Cowan University
ICM	Integrated Catchment Management
ILAP	Integrated Local Area Planning
LIMA	Leschenault Inlet Management Authority
MFP	Ministry for Planning
MU	Murdoch University
OCM	Office of Catchment Management (now catchment management branch of DEP)
PIMA	Peel Inlet Management Authority
ROB	Ribbons of Blue
SAICM	Swan-Avon Integrated Catchment Management Program
SCCP	Swan-Canning Cleanup Program
SRT	Swan River Trust
UWA	University of Western Australia
WAERF	Western Australian Estuarine Research Foundation
WAWA	Water Authority of WA (now Water Corporation)
WIMA	Wilson Inlet and Mangement Authority
WRC	Water and Rivers Commission
WWC	Waterways Commission (now part of the Water & Rivers Commission)

Editor's note: This document was produced from the submissions of its many authors. The production process was coordinated by John Jones, Tim Larcombe and Rita Sputore-Keller. Copies can be obtained by contacting the Swan River Trust, 3rd Floor, Hyatt Centre, 87 Adelaide Terrace, East Perth WA 6004. Telephone: (09) 278 0400, Fax: (09) 278 0401.

INDEX

INDEX

APPENDIX

List of SCCP-Net Contributors

FOREWORD

Following serious algal blooms in the Swan and Canning Rivers and increasing public concern over the health of our waterways, the Premier Richard Court launched the Swan-Canning Cleanup Program (SCCP) in May 1994.

The program provides funding for:

* research into the causes of algal blooms
* in-river trials to determine ways to prevent built-up nutrients in the river sediment being released into the water column
* improved catchment management to reduce the amount of nutrients entering the river
* increased community awareness of river issues and involvement in river restoration projects and catchment management.

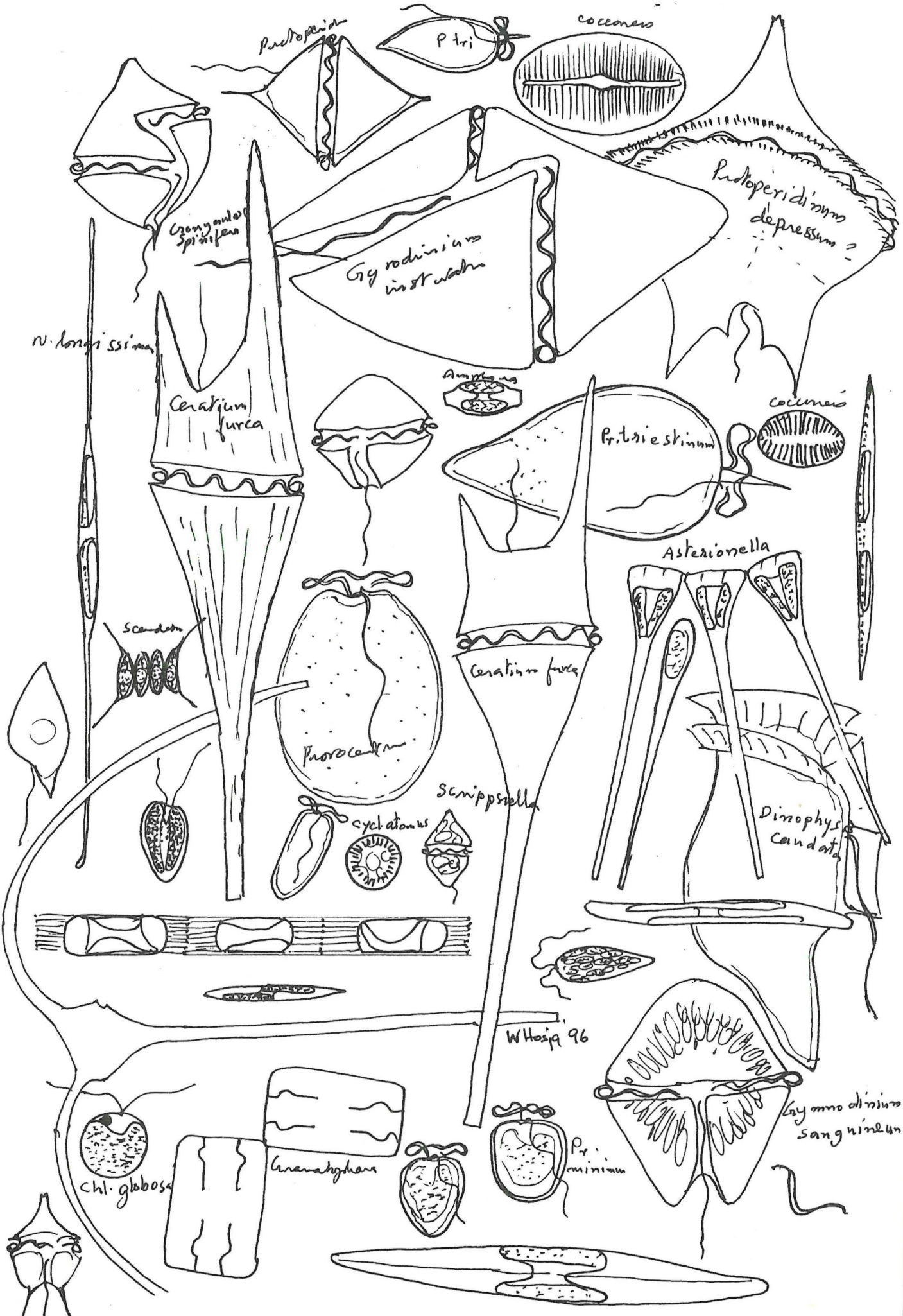
In 1994 the Government also established the Western Australian Estuarine Research Foundation to fund research into ways of improving estuarine systems in Western Australia. The Foundation has funded three projects for the Swan estuary, the main project being the integrated ecological model of catchment hydrology and water quality which brings together research expertise from Western Australian universities and the CSIRO. It consists of 12 projects, each of which is designed to investigate a particular component of the physics, chemistry or biology of the Swan and Canning Rivers in order to construct a predictive model of the ecology of the system.

In August 1995 the Swan-Canning Cleanup Program Task Force was established, bringing together representatives from State agencies and local government, the universities and research institutions to direct the management of the Cleanup Program. The main role of the Task Force is to develop an action plan from the recommendations and results of in-river trails, research and catchment management projects.

It is nearly two years since the Cleanup Program was announced and the Swan River Trust, as lead agency for the program, has organised this forum to bring together those people involved in SCCP projects and projects from outside the Cleanup Program that contribute to the program's ultimate objective – the improved health of the Swan-Canning River system.

One of the main achievements of the Cleanup Program to date has been the improved coordination and communication between those involved in caring for our waterways. The program's emphasis on community involvement has improved communication between researchers and community groups and local government and State agencies. The Cleanup Program operates in partnership with the Swan-Avon Integrated Catchment Management Program and many of the submissions to the forum found in this document are from SAICM projects whose success contribute directly to the success of the Cleanup Program.

The forum is an opportunity for people involved in rivercare projects to deliver their results and to discuss directions for ongoing research and management to reduce the risk of further serious algal blooms in the Swan and Canning Rivers. The emphasis is on devising practical ways of improving the health of our waterways. The Swan River Trust would like to thank all the participants for their ongoing contribution to the Swan-Canning Cleanup Program.



Some of the microalgae that occur in the Swan River estuary.
Illustration by Was Hosja

GROUP 1

WA Estuarine Research Foundation and other university projects

1 PID 54 WA Estuarine Research Foundation
Project Leader: Prof. Jorg Imberger

funding source	State Government Vid SCCP	+ w = weeks ahead or - w = weeks behind	
expected total cost	$2M over 3 years	name of organisation doing the project	WA Estuarine Research Foundation
date of project start	1 June 1994	which projects depend on this one ?	WEARF currently funds four projects
proposed date of project completion		on which projects does this one depend	-----
is this project on schedule ?	-----		

Review

WESTERN AUSTRALIAN ESTUARINE RESEARCH FOUNDATION

Project objective

The Western Australian Estuarine Research Foundation (WAERF) was formed in 1994 by the State Government of Western Australia to fund research into ways of improving estuarine systems in Western Australia. The applied and fundamental research funded by the WAERF is aimed at further understanding of estuarine ecosystems, with immediate focus on the Swan-Canning River system.

Review of project in respect of meeting its objectives

The dissemination of research funds was carried out along guidelines of a peer review funding scheme. A call for proposals was carried out in November 1994 under two broad categories:

- fundamental projects aimed at understanding the ecological processes in the catchment and the estuary which lead to nuisance algal blooms with emphasis on the Swan-Canning system, and
- applied projects which would lead immediately to management alleviation measures.

Following peer review, four projects have been funded by the WAERF. The projects are:

- An integrated ecological model of catchment hydrology and water quality for the Swan and Canning Rivers. This project brings together research expertise from UWA, CSIRO and Murdoch, Edith Cowan and Curtin universities. It consists of 12 projects, each of which is designed to investigate a particular component of the physics, chemistry or biology of the Swan and Canning Rivers in order to construct a predictive model of the ecology of the system.
- Soil and water nutrient dynamics in the rooting zone of turf grasses in relation to nutrient leaching. This project aims to determine best turf management practices to minimise nutrient loss from turf grasses grown on the sandy soils of the Swan Coastal Plain. The project is being carried out by Professor G. Aylmore (Soil Science, UWA) and Dr J. Yeates (AGC Woodward-Clyde).
- Economic valuation of the Swan-Canning Estuary, including the economic benefits, evaluation of the costs and benefits of estuary management and alternative mechanisms to fund estuary management. This project is run by Mr I. Briggs and Dr G. Hertzler (Agricultural and Resource Economics, UWA).
- One further project is funded by the WAERF on the effects of the Dawesville Channel on crustaceans and fish.

The small number of proposals for applied research projects were only considered as letters of interest and were accompanied by little documentation. The WAERF is making a serious effort to obtain matching funding from industry. To date only two expressions of interest from industry-related groups have been received.

1 PID 66 Integrated ecological model
Project Leader: Dr. David Hamilton

funding source	WAERF	+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	UWA, ECU, MU, CU, CSIRO wr, CSIRO df
date of project start	April 1995	which projects depend on this one ?	-----
proposed date of project completion	April 1998	on which projects does this one depend	67,68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 84
is this project on schedule ?	yes		

Review

AN INTEGRATED ECOLOGICAL MODEL OF CATCHMENT HYDROLOGY AND WATER QUALITY FOR THE SWAN AND CANNING RIVERS

Project objective

The basis of this project is to bring together a group of researchers who, through their co-operative research and interaction, will achieve a greater level of understanding of the functioning and behaviour of the Swan and Canning Rivers than the sum of their research contributions in isolation. The integrating tool is two ecological models; a two-dimensional model applied to the upper reaches of the river and a three-dimensional model applied over the entire length of the river. The models will combine physical, chemical and biological input and validation data derived from eleven component studies, to simulate the inputs to the Swan River, its hydrodynamics and water quality.

Review of project in respect of meeting its objectives

The underlying philosophy of the study is that the important ecological processes in the Swan River can be modelled through an integrated, multi-disciplinary framework which combines a model of the catchment hydrology and sediment yield with water quality models which captures the major physical, chemical and biological processes that occur within the estuary. The final success of the project will be judged on the ability of the two ecological models to successfully simulate the water quality and hydrodynamics of the Swan River. The project therefore relies of each of the component projects to deliver the relevant input and validation data according to a defined schedule, enabling proper model validation and the relevant water quality interactions to be fully explored. To date, each of the field projects is on track with monitoring or parameter validation. Five of the projects are Ph.D. studies and considerable effort has been made to ensure that suitable Ph.D. applicants were canvassed and that they could readily adjust to the prescribed project schedule. The main problem relating to the project schedule has been in finding suitable modelling personnel. This aspect is currently being addressed and we expect to rectify any delays in this area in the next six months.

Prior to achieving our modelling goals, there are many intermediate milestones. Swan River meetings have been initiated and now take place every 5-6 weeks. These meetings are an important forum for presentation of results and for discussion amongst researchers, students and personnel from the Swan River Trust, Water and Rivers Commission and many other groups. They have promoted awareness of research and management taking place on the river and encourage interaction and cooperation amongst the various groups. A close link has been established between the researchers and the Water and Rivers Commission and Swan River Trust.

The funding from the W.A. Estuarine Research Foundation has been useful in a number of instances in allowing researchers to supplement their projects with research from additional postgraduate or undergraduate students and to successfully compete for further external funding. The final research outcome of the projects has therefore been significantly enhanced upon what was proposed to the Estuarine Research Foundation. In several cases additional projects have been set up to validate specific components of the ecological model.

A "List Server" has been established to enable electronic transfer of data between the various research groups, in addition to electronic mail links. The List Server is still in its infancy but is expected to be fully operational when the Water and Rivers Commission obtain a regular electronic mail link and as researchers compile their data. The List Server will eventually form a valuable link allowing for rapid response and monitoring of specific events, e.g., an algal bloom.

1 PID 67 Catchment model
Project Leader: Dr. M Sivapalan

funding source	WAERF	+ w = weeks ahead or - w = weeks behind	
expected total cost	$209,138	name of organisation doing the project	Centre for Water Research, University of WA
date of project start	1 Sep 1995	which projects depend on this one ?	66
proposed date of project completion	31 Aug 1998	on which projects does this one depend	
is this project on schedule ?	yes		

Review

CATCHMENT MODELLING PROJECT

Objectives

A study of the dynamics and water quality of the Swan River Estuary cannot be complete without a concurrent investigation of the inputs of water, salt, sediment and nutrients to the estuary from the upstream catchment area. In particular, the effects of human activity in the catchment (e.g., farming practices, urbanization and other land use changes) have a significant impact on the health of the estuary. Furthermore, we need to be able to predict the impact of proposed remedial actions in the catchment. Currently there are no operational models available that are capable of predicting the inputs of water, salt, sediment and nutrients from the upstream catchment area subject to different land use practices. The aims of this project are:

to extend an existing large scale catchment water and salt balance model, LASCAM, to the entire Swan/Avon River catchment;

to develop ahnd implement conceptual sediment generation and transport algorithms, and incorporate them into LASCAM;

to develop and implement conceptual models of nutrient generation and transport and to enable identification of the sources of nutrients within the catchment;

to validate the the resulting LASCAM-WQ model with measurements of salt, sediment and nutrient transport at different locations in the catchment; and

to simulate the inputs of water, salt, sediment and nutrients to the estuary under different scenarios of land use and climate.

Progress

Research commenced in September 1995. Much of the research work to date has focussed on the first of the objectives listed above. The Avon catchment includes several attributes and characteristics that are not present in any of the catchments to which LASCAM has previously been applied. These may present considerable challenges for water balance modelling.

The most obvious difference is that the notional Avon basin (120,000 km^2) is much larger than any catchment encountered previously. It is nearly two orders of magnitude larger than the previous largest Western Australian catchment (Collie, 2500 km^2). Secondly, the catchment size, together with its relative aridity, ensures that transmission losses are much greater than in catchments in the Darling Ranges for which LASCAM was originally developed. A re-infiltration parameter and a more comprehensive stream evaporation algorithm have been incorporated into LASCAM to account for transmission losses.

The presence of expansive playa lakes and swamps also provides a significant challenge for LASCAM. In non-extreme events streamflow is detained in these lakes sufficiently long to be completely evaporated. Evaporation from these wide, shallow surfaces is greater than was originally modelled in LASCAM using the assumption of V-shaped channel cross-sections. Consequently, a simple reservoir detention algorithm has been incorporated into LASCAM and applied at selected locations near the downstream end of the lake networks.

The model is now almost ready for calibration. A notional channel network (130 subcatchments) has been defined, and a large amount of rainfall, streamflow and land cover information has been collected and is presently being prepared for use in LASCAM. It is anticipated that model calibration will be completed by the end of April 1996.

1 PID 68 Water quality & hydrodynamics
Project Leader: Dr. David Hamilton

funding source	WAERF	+ w = weeks ahead or - w = weeks behind	-12
expected total cost	$255,504	name of organisation doing the project	Cenre for Water Research University of WA
date of project start	June 1995	which projects depend on this one ?	66
proposed date of project completion	June 1998	on which projects does this one depend	-----
is this project on schedule ?	no		

Review

WATER QUALITY MODELLING AND HYDRODYNAMIC FIELD VALIDATION FOR THE SWAN AND CANNING RIVERS

Project objective

The complex nature of the ecological processes and their interactions in the Swan-Canning River system means that the only effective way of devising and testing management strategies is by means of numerical models. Two numerical models will be used to predict water quality in the river-estuarine system. One is a full three-dimensional hydrodynamic model which will simulate the physics of the entire estuary and will generate transport fields for use in a separate ecological module. The other is a two dimensional, fully coupled hydrodynamic-water quality model which will simulate the upper estuary, where the Swan River is relatively narrow but where the most severe water quality problems are generally encountered. A field data collection program has also been undertaken to provide a comprehensive data set on water levels, currents and temperature/salinity distributions for the initial conditions, forcing data and the validation required for the hydrodynamic models, and to provide background physical data for intensive studies of biological and chemical processes undertaken by other investigators.

Review of project in respect of meeting its objectives

Eight tide gages were deployed in the estuary at the following locations: Fremantle Police Jetty; East Fremantle Yacht Club, Freshwater Bay Yacht Club, South Perth Yacht Club, Royal Perth Yacht Club, Mount Henry Bridge, Maylands Yacht Club and Ashfield Yacht Club. Of these, the gauges at Mount Henry Bridge and Maylands Yacht Club were vandalised and only a limited data set is available. The tide gauges were deployed in September 1995 and the remaining six gauges are still operational. Tidal data from Barrack Street Jetty and Fremantle Fishing boat harbour have also been acquired. All the data have been analysed for long-term water level fluctuations and tidal constituents.

The HAMburg Shelf Ocean Model (HAMSOM) has been successfully applied to the Estuary. The model is three-dimensional with horizontal resolution 100x100m and 7 vertical layers. The model domain extends from Fremantle Harbour to the Ellen Brook-Avon River confluence. The model is able to reproduce the observed tidal regime in the River as well the salinity distribution over each tidal cycle. Further validation tests are in progress to compare model output with tidal elevations, tidal currents and salinity/temperature distributions within the estuary.

The two dimensional water quality model for the upper reaches of the Swan River will be based on the existing laterally averaged estuary model TISAT. The model is to be applied over the domain from the Narrows Bridge to the Ellen Brook-Avon River confluence. To date the model has successfuly simulated the observed salinity distribution over 700 hours and work is currently in progress to obtain the observed temperature distribution. The model is about to be coupled with the various ecological components. Discussions have taken place between all of the component groups contributing to the model, in order to derive suitable component models for all of the ecological processes.

The main problem relating to the project schedule has been in finding suitable modelling personnel. This aspect is currently being addressed and any delays in the project are expected to be rectified in the next six months. A final decision on a suitable 3-D modeller is about to be made, having gone through several iterations and readvertisments for the position. We expect to make up for lost time in thie project by employing this person full time for the first year instead of the proposed half time for the first two years.

1 PID 69 Groundwater & saline water
Project Leader: Dr. Jeffrey Turner

funding source	WAERF	+ w = weeks ahead or - w = weeks behind	
expected total cost	$88,575	name of organisation doing the project	CSIRO, dwr
date of project start	July 1995	which projects depend on this one ?	PID 66,11
proposed date of project completion		on which projects does this one depend	PID 11,7
is this project on schedule ?	yes		

Review

INTERACTION BETWEEN SHALLOW GROUNDWATER AND SALINE SURFACE WATER IN A SEASONAL ESTUARY: THE SWAN RIVER SYSTEM

Jeffrey Turner, William Linderfelt and Lloyd Townley, CSIRO Division of Water Resources, Floreat Park, WA.

Deliverables

- The following are anticipated results of our research:
- To understand the dynamics of groundwater-surface water interaction in the Swan-Canning Estuary, with reference to the seasonal dynamics of the brackish water-fresh water interface in the Swan River.
- To evaluate the important hydrogeochemical processes operating in the sediments underlying the estuary in response to the seasonal migration of brackish water up the river, and to assess the role of groundwater as a mechanism for nutrient loading to the Swan river.
- To determine the significant fluxes of water and contaminants to and from the shallow groundwater system surrounding the Swan-Canning Estuary.

Progress

Significant progress has been made in all of the areas listed above. Multilevel samplers were developed and installed in the sediments underlying the Swan river at the Ron Courtney site and the Tonkin Overpass site in October and November, 1995. Nested piezometers were installed in the shallow aquifers adjacent to the river at these two sights in November and early December, 1995. Water samples were collected from the multilevel samplers underlying the river starting in early November, approximately one week before the brackish water migrated up-river past these locations. Water level measurements were taken from the multilevel samplers and the nested piezometers, and water samples were collected from the nested piezometers, starting in December. Collection of water samples and water level measurements has continued to present.

Electrical conductivity (EC) measurements taken from the multilevel samplers before and after the seasonal up-river migration of brackish water indicate a fairly rapid intrusion of this higher density water to a depth of approximately one-half metre into the sediment. This is a significant volume of sediment which may undergo chemical changes and facilitate nutrient release into the pore water. Our measurements of nitrogen in the sediment pore water below the river reveals that it is primarily in the form of ammonium, with remarkably high concentrations ranging from 0 to 50 mg/L, but commonly in the 1 to 10 mg/L range. This is a potentially significant nitrogen source to the water column. Using a heat-pulse seepage metre, groundwater fluxes into the river at one location are estimated at 16 cm/day indicating that groundwater may be contributing significant amounts of nitrogen to the river. Nitrogen in the aquifer adjacent to the river occurs as nitrate with concentrations typically much lower than ammonia levels in the river sediment suggesting that the nitrogen in the sediment does not originate entirely in the groundwater.

At a broader scale, EC data collected from several bores installed within the shallow aquifer adjacent to the Swan River indicate spatially varying groundwater salinities. Given that EC is a gross indication for former brackish/saline river water, high ECs found in groundwater adjacent to the river are a useful tracer of former river water. It is conjectured that this spatial variability reflects zones of groundwater discharge to and recharge from the river. By combining geologic data, soil-type information and measured ECs of water collected from springs, drains, bores and groundwater samplers along the river, the discharge and recharge zones along the river can be delineated. In general, the emerging pattern is one of lower EC water along the outside of river meanders where groundwater is discharging to the river, while higher EC water is seen along the inside of river meanders where river water may be flowing into the aquifers, especially during the summer months when river salinities are high.

Incorporating additional information about the hydrogeochemistry of groundwater is helping to construct a map of locations and magnitudes of contaminants entering the Swan River system.

1 PID 70 Phytopolankton ecology (algal triggers)
Project Leader: Dr. Peter Thompson

funding source	CSIRO, WAERF, SRT	+ w = weeks ahead or - w = weeks behind	-----
expected total cost	unknown	name of organisation doing the project	CSIRO
date of project start	June 1993	which projects depend on this one ?	unknown
proposed date of project completion	April 1998	on which projects does this one depend	unknown
is this project on schedule ?	yes		

Review

Macro

THE EFFECTS OF NUTRIENTS AND MICRONUTRIENTS ON THE GROWTH OF ALGAE IN A STRATIFIED ESTUARINE ECOSYSTEM: THE SWAN/CANNING SYSTEM

Original CSIRO Objective

"To identify trigger mechanisms for algal blooms in the estuary by examining the temporal relationship between "in-stream" availability of nutrients and micronutrients and incidents of algal growth".

Laboratory work

1. ***Anabaena***
   - the influence of environmental factors on the growth and toxicity of *Anabaena*. Conclusions: growth in the Canning River can be controlled by allowing salt water intrusion, light and salinity both influence toxicity.
2. ***Humics***
   - the effects of humics on the growth of some phytoplankton species. Conclusions: high humic concentrations produced modest and some times variable reductions in the growth of *Nodularia spumigena*.
3. ***Nutrients***
   - the role of silica, nitrogen phosphate, light and temperature on competition between seven species of phytoplankton; ongoing work.

Field work

1. 1993-94 at 1 site, describing the annual cycles:
   - ◊ physical cycles
     - temperature
     - salinity
     - rainfall
     - tributary flow
     - light regime
   - ◊ chemical cycles
     - dissolved inorganic nitrogen
     - dissolved inorganic phosphate
   - ◊ biology
     - phytoplankton biomass (chlorophyll *a*)
     - phytoplankton species
     - bioassays for limiting nutrient

The 1993-94 results are summarised in a paper by Thompson and Hosja "Nutrient limitation of phytoplankton in the upper Swan River estuary, Western Australia" accepted for publication in Marine and Freshwater Research.

Abstract below:

During 1993-94 the phytoplankton community in the upper Swan River estuary had a peak chlorophyll a concentration of 57 mg m^{-3} during early summer (December 1993), and a second peak of 35 mg m^{-3} during late autumn (May 1994). Mid-summer was characterised by low cell densities and low chlorophyll a concentrations. We assessed the potential of the phytoplankton community for nutrient limitation with dilution bioassays given nutrient mixes deficient in one of the following: nitrogen, phosphate, silicate, iron, trace metals, chelators, or vitamins. During the mid-summer period of low

phytoplankton abundance, nitrogen was the nutrient with the greatest potential to limit algal biomass. During mid-summer, ambient N:P ratios tended to be near unity and bioassays indicated that the available pool of N was up to 20 times more limiting to biomass development than available P. Also during midsummer, bioassay treatments given no nitrogen and control treatments given no nutrients showed little growth, reaching chlorophyll a concentrations ~ 1/30 of those given a full suite of nutrients. Chlorophyll a concentrations in the bioassay control treatments given no nutrients were correlated (r^2=0.74) with measured surface nitrate concentrations suggesting nitrate inputs may be a major factor controlling phytoplankton biomass in this ecosystem. The correlation between surface nitrate concentration and rainfall (r^2=0.69) further suggests that rainfall may be the most important mechanism supplying nitrate to the surface waters of this estuary.

2. 1994-95 on 9 sites with continuous data between sites

◊ continuous measurements of phytoplankton abundance
- novel technique development
- (CSIRO, Peter Thompson)

species distributions
- weekly at nine stations (SRT; Vas Hosja, Sarah Grigo)

physical and chemical data
- DIN. total N
- SRP, total P
- chl*a,c,b*
- (SRT; Neil Dixon, Misha Cousins)

primary production data
- weekly P vs I curves for each site
- (CSIRO, Craig Manning)

bioassays
- weekly measures nutrient limitation at 3 sites
- (CSIRO, Peter Thompson, SRT, Tom Turri)

The results from 1994-95 are in the process of being written up as a manuscript for publication.

3. Field work is ongoing for 1995-98 with $187,000 from the Estuarine Research Foundation of WA and continued support from the Swan River Trust (now the Rivers and Estuaries Branch of the Water and Rivers Commission). This work is focused primarily on vertical migration and identifying nitrogen sources for mid-summer algal blooms. David Hamilton (UWA-CWR), Jacob John (Curtin) and Peter Thompson (CSIRO-DF) provide supervision to students working on:

Nitrogen uptake---------- Jane Rosser
Microheterotroph grazers ---------- Jane Rosser
Phytoplankton sinking rates ---------- Luke Twomey
Phytoplankton in the Canning River ---------- Wilma Vincent
Vertical migration---------- Toby Salmon

Summary

We have completed the first step in our studies on phytoplankton ecology of this ecosystem. The data we have collected will provide a detailed description of the phytoplankton ecology in the Swan River/estuary and identify the sensitivity of the phytoplankton to physical and chemical perturbations. Over the past few years we have eliminated some factors from consideration and identified others as needing more research. As our understanding of the ecosystem improved we have evolved the original objective. Currently we are trying to assess the source of nitrogen for summer algal blooms. Preliminary results for 1996 suggest that vertical migration is an important mechanism used by phytoplankton to access sufficient light and nutrients for growth and that ammonia derived from internal nitrogen recycling is the primary N source. If true, it may be necessary to assess at what time in the annual cycle the ecosystem switches from external loading to internal recycling. Management strategies for controlling algal blooms fuelled by recycling of particulate organic nitrogen may be quite different from those targeted at dissolved inorganic nitrogen.

1 PID 71 Macroalgal processes
Project Leader: Dr. Paul Lavery

funding source	ERF	+ w = weeks ahead or - w = weeks behind	
expected total cost	$81,000	name of organisation doing the project	Edith Cowan University
date of project start	June 1995	which projects depend on this one ?	Modelling 66
proposed date of project completion	June 1998	on which projects does this one depend	none
is this project on schedule ?	yes		

Review

THE ROLE OF MACROALGAE IN NUTRIENT AND CONTAMINANT CYCLING IN THE SWAN RIVER ESTUARY

1. Specific aims & deliverables

Macroalgae are a conspicuous but poorly studied component of the Swan River system. Elsewhere, there is growing awareness of the important role these plants can play in the cycling of nutrients and in directly affecting water quality of shallow estuaries. This influence can be both direct, by acting as a store and release for nutrients, and indirect by their ability to affect key chemical features such as redox potential and organic loads to sediments which in turn affect key nutrient cycling processes. This project combines with others examining seagrasses and invertebrates to develop a better understanding of the benthic nutrient cycling processes in the Swan-Canning Estuary.

The proposed work will address the following specific aims which reflect the major processes by which macroalgae can influence nutrient cycling in the Swan River.

1. Determine the macroalgal assemblage of the estuary, in terms of species composition, distribution, biomass and seasonal variation.
2. Determine the tissue nutrient content of the key macroalgal species, and so estimate the nutrient pools which macroalgae represent on a seasonal basis.
3. Determine the nutrient uptake kinetic of the key macroalgal species, and so determine the rate at which they which may deplete nutrients from the water column.
4. Determine the effect of macroalgal accumulations on water quality parameters and microbial populations in the water column and benthos, and what effect this has, if any, on benthic flux of dissolved nutrients and N-losses from system through denitrification.

2. Progress

At this stage the project is progressing in accordance with the initial timetable. Detailed mapping of macroalgae in the lower reaches of the estuary was completed in December 1995, with a resultant species list, distribution map and biomass estimate being developed. A total of 31 species have been recorded, and in December 1995 there was a total macroalgal biomass downstream of Heirrison Island estimated at 408 tonnes dry weight, with an area of 540 ha. Preliminary estimates suggest that this represents a nitrogen pool of approximately 8 tonnes at any one time. Maximum biomass will probably not occur until late summer/early spring.

Regular seasonal surveys have been conducted in August and November 1995 and February 1996. These have indicated seasonal variation in species composition and biomass, but reveal that overall the species richness is diminished compared with Allender's surveys of 1970. Species richness is by far concentrated in the lower estuary, downstream of Heirrison Island. Gracilaria is the most cosmopolitan of the species, being found at all of the sampling sites. Species richness is lowest in the upper region of the estuary, dominated by Gracilaria

Tissue nutrient analysis is due to commence following the next seasonal survey, in May. Nutrient uptake kinetics will be characterised in April-May this year, dissolved nutrient flux experiments in September 1996 and microbial denitrification experiments in 1997.

1 PID 72 Halophila ovalis ICO
Project Leader: Dr. D I Walker

funding source	WAERF	+ w = weeks ahead or - w = weeks behind	
expected total cost	$78,570	name of organisation doing the project	University of WA Botany Dept
date of project start	1/3/95	which projects depend on this one ?	WAERF modelling 66
proposed date of project completion	1/3/98	on which projects does this one depend	
is this project on schedule ?	yea		

Review

BIOGEOCHEMICAL CYCLING BY *HALOPHILA OVALIS* IN THE SWAN RIVER

Progress

This project has been underway for a year. Progress has been made on all the aims (italics below) of the research where the first three aims require data collection and experimental work. These all build to the final objective of determining the overall role that *H. ovalis* plays biogeochemical cycles in the Swan River.

i) describe the present distribution of Halophila ovalis in the Swan-Canning system - ***COMPLETED***

The distribution and abundance of seagrass and macroalgae in the Swan-Canning Estuary were mapped in December 1995. In addition, physical parameters such as salinity, temperature, and dissolved oxygen were recorded. The distribution of seagrass (460.9 ha) was similar to that mapped in 1982 by Hillman *et al.* (1985) but with an overall loss of approximately 137 ha. Total seagrass biomass was 346.51t DW. Three seagrass species were recorded: *Ruppia* sp., *Zostera mucronata* and *Halophila ovalis. Zostera mucronata* was confined to the inlet channel of the estuary; salinity was thought to be the controlling factor in its distribution. *Halophila ovalis,* the dominant seagrass in the estuary, was most prominent in the estuarine basin. The distribution of *H. ovalis* was thought to be limited upstream by higher turbidity levels (i.e. reduced light penetration). Downstream, *H ovalis* distribution may have declined as a result of competition with *Z. mucronata.* or physical disturbance which allowed *Z. mucronata* to grow in the area where *H. ovalis* previously occupied. Epiphytic, benthic and free-floating algae were surveyed and distribution was seen to approximate that of seagrass. When compared to a study by Allender (1970) algal communities were noted to have declined, with a total loss in some areas. Total algal biomass recorded was 408.53 t DW.

ii) determine the extent of nutrient cycling by Halophila ovalis through uptake, decomposition and remineralisation,

Literature Review - ***COMPLETE***

Surveying of sites, sample protocols developed, methods checked. - ***COMPLETE***

Bi-monthly sampling and analyses of nutrient cycling. Information passed to modeller as it becomes available. -- ***IN PROGRESS***

As part of a three year PhD study, monthly field trips are carried out to assess the biomass and nutrient dynamics of *Halophila ovalis.* These field trips will continue until spring 1997. This will form the foundation of a more detailed study into the nutrient dynamics of *Halophila ovalis* and oxygen release from the roots into sediments. Biomass of the above ground and below ground plant material shows an overall increase over late spring and summer as the temperature and salinity of the estuary also increase.

iii) investigate the influence of H. ovalis in sediment and water column oxygenation through photosynthetic activity

Experimental work on sediment oxygenation and nutrient cycling. Information passed to modeller as it becomes available. ***BEGUN***

Objectives

The seagrass *Halophila ovalis* (R.Br.) Hook f. is the dominant benthic plant of the Swan/Canning estuary, southwestern Australia. Previous research (1982-1984)has been carried out on the biomass, distribution and primary production of this plant in relation to environmental factors (Hillman 1985, Hillman *et al.* 1995). Although this work provided a thorough understanding of the distribution and productivity of *Halophila* at the time, there was no attempt to investigate the role of the seagrass in

affecting aspects of the Swan-Canning system such as water quality, through oxygenation of sediments and/or water column, and nutrients, by acting as a pool, sink or source.

The aims of this research are to:-

i) describe the present distribution of *Halophila ovalis* in the Swan-Canning system

ii) determine the extent of nutrient cycling by *Halophila ovalis* through uptake, decomposition and remineralisation,

iii) investigate the influence of *H. ovalis* in sediment and water column oxygenation through photosynthetic activity

iv) and hence, determine the overall role that *H. ovalis* plays biogeochemical cycles in the Swan River.

Progress

i) describe the present distribution of *Halophila ovalis* in the Swan-Canning system - ***COMPLETED***

The distribution and abundance of seagrass and macroalgae in the Swan-Canning Estuary were mapped in December 1995. In addition, physical parameters such as salinity, temperature, and dissolved oxygen were recorded. The distribution of seagrass (460.9 ha) was similar to that mapped in 1982 by Hillman *et al.* (1985) but with an overall loss of approximately 137 ha. Total seagrass biomass was 346.51t DW. Three seagrass species were recorded; *Ruppia* sp., *Zostera mucronata* and *Halophila ovalis*. *Zostera mucronata* was confined to the inlet channel of the estuary; salinity was thought to be the controlling factor in its distribution. *Halophila ovalis,* the dominant seagrass in the estuary, was most prominent in the estuarine basin. The distribution of *H. ovalis* was thought to be limited upstream by higher turbidity levels (i.e. reduced light penetration). Downstream, *H ovalis* distribution may have declined as a result of competition with *Z. mucronata.* or physical disturbance which allowed *Z. mucronata* to grow in the area where *H. ovalis* previously occupied. Epiphytic, benthic and free-floating algae were surveyed and distribution was seen to approximate that of seagrass. When compared to a study by Allender (1970) algal communities were noted to have declined, with a total loss in some areas. Total algal biomass recorded was 408.53 t DW.

1 PID 73 Macrobenthos
Project Leader: Dr. J A Davis

funding source	WAERF	+ w = weeks ahead or - w = weeks behind	
expected total cost	$81,000	name of organisation doing the project	Murdoch University
date of project start	1 August 1995	which projects depend on this one ?	Model construction 66
proposed date of project completion	31 July 1998	on which projects does this one depend	-----
is this project on schedule ?	yes		

Review

THE ROLE OF THE MACROBENTHOS IN NUTRIENT AND PARTICULATE FLUXES IN THE SWAN RIVER ESTUARY

The objective of this project is to determine the role of the macrobenthos in water quality processes, in particular nutrient and particulate fluxes, in the middle and upper regions of the Swan River Estuary. This will be done by examining the following hypotheses.

1 Changes in benthic macroinvertebrate communities are related to longitudinal and seasonal changes in physiochemical parameters, such as salinity and temperature. An investigation of the spatial and temporal changes in the benthos will contribute to the fundamental understanding of the ecological processes within the Swan River. The distribution of introduced species will also be determined and the effects of salinity and temperature on these communities and the tolerance of certain species will be estimated. Comparisons of the composition of the benthic macroinvertebrate communities between deep (>3.0m) and shallow (<1.5m) locations will provide information on the effect of stratification and nutrient sinks on the benthos. This information will provide further input for the Swan River model.

2 Seagrasses and macroalgae beds provide shelter and an increased number of ecological niches for aquatic organisms. Their dense roots and rhizomes also help to stabilise bottom sediments. A study of the differences in the composition of the macroinvertebrate communities in relation to the presence of a) seagrass and b) macroalgae will determine how important these habitats are to the benthos.

3 Quantification of the role of various members of the macrobenthos, in both uptake of suspended material and release of nutrients, particularly nitrogenous compounds, will provide important information on ecological processes occurring within the Swan River Estuary. Determination of the rates of uptake of suspended material by dominant species will reveal whether, or not, these species play a significant role in water quality processes.

4 Sediment dwelling invertebrates, such as polychaetes and molluscs, can affect the exchange of nutrients between the sediments and the water column. This can occur through bioturbation or as a result of the excretion of nutrient-rich waste products. Construction of tubes in the sediment increases the surface area of the sediment/water interface at which chemical and microbiological processes occur. Burrowing activity can also increase the depth of the oxidised layer, which will facilitate the adsorption of phosphorus by the sediments. Experimental determination of the effect of the benthic species on the sediment/water nutrient exchange will reveal the importance of the benthos in nutrient cycling within the estuarine system. The release of nutrients by different species will be compared to determine whether changes from populations of original species to more tolerant or introduced species may have contributed to an increase in sediment/water nutrient fluxes.

Progress

1. Distribution and abundance of the benthic invertebrates in the upper and middle estuary.

A comprehensive survey of the spatial and temporal distribution and abundance of the benthic macroinvertebrates of the Swan River Estuary is currently underway. This will enable population densities and distribution of suspension feeders within different river habitats and the relationship between selected species and environmental parameters to be determined. Historical changes will be determined, as far as possible, by comparison with earlier studies including Rose (1994), Shaw (1986), Wallace (1977), Chalmers *et al.* (1976) , Thomson (1946) and Monro (1938).

Sites are located between Fremantle Harbour and Meadow St. Bridge, Guildford. Comparison of benthic communities in seagrass and sandy sediments is being undertaken at Melville Water, as this region of the river has the greatest density of seagrasses (Hillman 1992, Hillman 1995). Two deep

sites are located in the middle estuary (Freshwater Bay and Pelican Rocks) and two in the upper estuary (Nile St. and Kingsley St.).

A pilot study carried out in August 1995 revealed that five replicate samples will adequately estimate the species diversity and abundance of the benthic macrofauna. Sampling was undertaken in August and November 1995 and February 1996. Sample processing is currently underway.

Sediment samples have been collected to determine organic content and grain size. Environmental parameters including temperature, salinity, dissolved oxygen, turbidity, pH and redox potential were recorded at each site during sampling.

2. Quantification of rates and volumes of uptake of particulate matter by selected benthic species.

Rates of removal of suspended matter by selected species of bivalves and polychaetes will be determined from experiments in laboratory channels and *in situ* chambers. Concentrations of chlorophyll a will be used as a measure of particulate uptake. The effects of differing near-bed flow regimes, temperature, salinity, oxygen concentrations and concentrations of suspended material on removal rates will be examined. Rates of removal by both polychaetes and bivalves will be compared.

3. Bioturbation and excretion by polychaetes and bivalves.

The importance of bioturbation and excretion of the benthos on the release of nutrients into the water column will be determined using cores held under controlled laboratory conditions. The rate of release of nutrients from the sediments with and without benthos, and the rate of excretion of nutrients from the benthos, will be determined. Further *in situ* experiments may also be conducted.

1 PID 74 Fish and Macrobenthos
Project Leader: Prof. I C Potter

funding source	WAERF	+ w = weeks ahead or - w = weeks behind	
expected total cost	$123,293	name of organisation doing the project	Murdock University
date of project start	June 1995	which projects depend on this one ?	Integrated Ecological Model 66
proposed date of project completion	June 1998	on which projects does this one depend	none
is this project on schedule ?	yes		

Review

MACROBENTHIC AND FISH FAUNAS OF THE UPPER SWAN ESTUARY: INTERRELATIONSHIPS AND INFLUENCES OF DINOFLAGELLATES AND BLUE-GREEN ALGAE

Project objectives

The first objective of this project is to determine the distribution and composition of the fish and macrobenthic invertebrate communities in the upper Swan Estuary during different seasons. The composition of the fish fauna will then be compared with that recorded over 15 years ago, when this region was not subjected to such severe eutrophication. The second objective is to determine the extent to which dinoflagellate and blue-green algal blooms affect the macrobenthic and fish faunas. The final objective is to determine the relationships between the dietary compositions of four dominant benthic carnivorous fish and the distribution and densities of benthic invertebrates.

Project Review

Summary of progress

- Three of the eight seasonal samples have been collected.
- All of the fish community data, and the majority of the macrobenthic and dietary data, have been processed and entered on computer.
- Fish community data have been subjected to preliminary analyses.

Sampling methodologies

Three sites within each of two regions in the Swan River, and in one region in the Canning River were selected in July of 1995. Seasonal sampling commenced in August (winter sample), and further samples have been collected in spring (October-November 1995) and summer (January-February 1996). During each sampling trip, three seine and three gill net samples and six macrobenthic grab samples were taken from the shallow and deep waters, of each region. N.B. Gillnets were not suitable for use in Canning River. Sampling in the upper Swan River was also carried out in mid-February, when a dinoflagellate bloom was reported by Vas Hosja of the Waterways Commission, and two weeks after the first reports of this bloom. Replicate samples of fish and macrobenthos were collected from both within the area affected by the bloom (Swan Upper) and in the area downstream of the bloom (Swan Lower).

Laboratory procedures

Macrobenthic samples have been sieved and stored. Samples from the first two seasons have been sorted, and the number of individuals of each species has been recorded. This data and the associated environmental data have been entered onto a computer database.

All seine and gill net samples from each of the sampling trips have been processed. This involves counting of the number of individuals of each fish species and measuring their combined weight. The total length of all fish has also been measured. Fish and environmental data has been entered onto a computer database, checked for accuracy and subjected to preliminary analyses.

Four species were selected for dietary analyses, namely the black bream, *Acanthopagrus butcheri*, yellow-tail trumpeter, *Amniataba caudavittatus*, Wallace's hardyhead, *Leptatherina wallacei*, and Swan River goby, *Pseudogobius olorum*. A maximum of 20 individuals, covering a wide size range, was selected from each region, and their stomachs removed and stored in 70% alcohol. Microscopic analyses have enabled the stomach fullness, and the frequency of occurrence and percentage contribution to the total numbers and volume of each prey category to be recorded for each stomach. Data have been entered onto a computer database and checked for accuracy.

Preliminary results for the fish communities

A total of 27 fish species were captured using seine nets (22 species) and composite gillnets (14 species). The seine net catches in the shallows were dominated by small fish, such as hardyheads (e.g. *Pranesus ogilbyi, Atherinosoma elongata* and *Leptatherina wallacei*) and gobies (e.g. *Favonigobius lateralis, Pseudogobius olorum, Afurcagobius suppositus,* and *Amoya bifrenatus*), and at certain times of the year by small representatives of larger species such as the Perth herring, *Nematalosa vlaminghi, A. caudavittatus* and *A. butcheri.* The gillnet catches included larger representatives of the last three species, and also individuals of the sea mullet, *Mugil cephalus* and the bar-tailed flathead, *Platycephalus endrachtensis.*

There are indications that fish numbers in both shallow and deep waters decline following dinoflagellate blooms, such as in the Swan Upper, and are lower than in nearby areas (i.e. Swan Lower), which are not subjected to blooms.

Future sampling

Our fourth seasonal sample for both the macrobenthos and fish, which coincides with the six-week post-bloom sample, will be taken in the beginning of April. Our second year of seasonal sampling will be completed by April 1997. Sampling will also be carried out during further blooms in the summer of 1996/1997. Sample processing, data analyses and report preparation will be completed shortly thereafter.

1 PID 75 Zooplankton grazers vs phytoplankton
Project Leader: Dr. R J Rippingale

funding source	WAERF	+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	Curtin University
date of project start	July 1995	which projects depend on this one ?	66
proposed date of project completion	June 1998	on which projects does this one depend	none
is this project on schedule ?	yes		

Review

INTERACTION BETWEEN CRUSTACEAN ZOOPLANKTON GRAZERS AND PHYTOPLANKTON AS PART OF THE ENERGY AND NUTRIENT DYNAMICS OF THE SWAN-CANNING ESTUARY

The major objectivesare:

1. To document the seasonal changes in abundance and distribution, and diel changes in the vertical distribution of crustacean zooplankton in the Swan Estuary.
2. To determine the grazing rate of dominant species of crustacean zooplankton feeding on dominant species of phytoplankton, and assess the adequacy of these phytoplankton species as food for crustacean zooplankton, in terms of survival, growth and fecundity.
3. To determine the rate of faecal pellet production by dominant crustacean zooplankton, the pellet settling rate and their contribution to the nutrient pool, under a variety of feeding regimes.
4. To document biological information on dominant crustacean zooplankton.

Review

Fortnightly monitoring of crustacean zooplankton abundance and distribution in the Swan-Canning Estuary during Spring 95, Summer 95/96 and Autumn 96 has shown a definite pattern of succession, with the estuarine species of copepods *Acartiura clausi* predominating in the higher salinity water (> 25 ppt.) and *Sulcanus conflictus* from Maylands to Success Hill. There are several species of truly marine copepods occurring in low numbers from Blackwall Reach to the Narrows. This monitoring is planned to be continued until June 1997, to give a full range of seasonal patterns of distribution and abundance.

In conjunction to fortnightly monitoring, sampling has been carried out every three hours for 24 hours at Ron Courtney Island twice in November 95 (during a Chlorophyte bloom) and three times during January 96 (during a dinoflagellate bloom). This data will be used to examine patterns of diurnal migration. Sampling has also been carried out at four locations in the middle Swan (Maylands, Ascot, Kings Meadow and Marshall Park) during the day and then again at night, in order to examine diurnal distributional patterns along a 13km stretch of the Swan. Further samples will be taken during blooms in 1996 and 1997.

In order to measure grazing rate, several experiments have been carried out both in the field and in the laboratory, during the Spring 95 and Summer 95/96 blooms. The method used involved measuring the loss of chlorophyll over time, both in darkness and during the day, and at the surface and the bottom of the river. Most of these experiments were carried out using natural assemblages of grazers at natural concentrations incubated for a standard period of six hours. However, several have been carried out with known numbers of known grazers and the experiments stopped at varying time periods, to test the assumption that grazing rate remains constant. This will also show whether food has become limiting over time, thereby affect grazing rate. Several experiments have also been carried out using natural assemblages of grazers divided into size fractions (44-100, 100-300, >300 microns). This is to determine which group of grazers is removing the greatest amount of chlorophyll. Another series of grazing experiments have been carried out using starved and pre-fed copepods. This is to test the theory that feeding history determines grazing rate. Samples from all grazing experiments are still be analysed.

The use of distribution and abundance data with estimates of grazing rate will determine the potential for crustacean zooplankton grazers to remove algal biomass in the Swan-Canning Estuary.

Preliminary studies have been carried out on the nutritional value of phytoplankton species for copepods. During the dinoflagellate bloom in Autumn 96, three species of field caught copepods were maintained in the laboratory for 20 days fed only on dinoflagellates. The adults produced eggs and the resultant nauplii then grew to adults. This has shown that dinoflagellates can support populations of copepods, despite low numbers of copepods seen in affected parts of the estuary during the

dinoflagellate bloom. Further investigation will be carried out to determine whether growth rate was the same as would be expected in the field and whether some other factor (such as low oxygen) prevented copepod production during the dinoflagellate blooms. It is anticipated that a variety of phytoplankton will be trialed as food for copepods.

All faecal pellet work is still to be carried out. It is anticipated that this will begin during the winter months using laboratory reared copepods and phytoplankton cultures. It is assumed that the role of faecal pellets in the nutrient pool will be of greatest importance when copepod production is high and nutrients for phytoplankton growth has become limited. An estimate of the quantity of pellets produced, how quickly they settle to the sediments, and the amount of recyclable nitrogen available will indicate their importance as a source of nutrients for phytoplankton.

1 PID 76 Jellies

Project Leader: Dr. R J Rippingale

funding source	WAERF	+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	Curtin University
date of project start	Jan 1995	which projects depend on this one ?	PID 66
proposed date of project completion	Dec 1996	on which projects does this one depend	none
is this project on schedule ?	yes		

Review

THE ROLE OF JELLIES (CNIDARIA:SCYPHOZOA) IN THE ENERGY AND NUTRIENT DYNAMICS OF THE SWAN ESTUARY

Project objective.

To describe the ecological role and assess the importance of Scyphozoan jellies in the Swan - Canning estuary. Specific objectives include;

- determination of the biomass of medusae during summer,
- estimation of the rate of exudation of organic matter from the jellies to the open water,
- estimation of the nutrient (Nitrogen) content of the tissues of the brown jelly and of the algae living in symbiosis with the jellies,
- determining the food taken by jellies and extent to which predation by jellies might have impact on populations of other organisms.

Review of the project in respect of meeting the objectives.

Population estimates for the brown jelly, *Phyllorhiza punctata*, have been carried out in the lower estuary. A net (opening $0.8m^{-2}$) was towed over a distance of 50m to samples medusae from among obvious patches with higher population density and from surrounding areas where the animals were less abundant. The displacement volume of each medusa was recorded. To estimate biomass from displacement volume data, 25 individual medusae were homogenized and two 27mL samples taken for dry mass estimates. Corrections were made for the salt content of the medusae by taking 27mL samples estuary water to dryness by the same method as for the medusae.

Population estimates of the white jelly, *Aurelia* sp, have not been made. This will be undertaken when the animals can be expected to reappear in the estuary in early spring 1996.

Two methods have been used to determine whether *P. punctata* exudes significant quantities of organic compounds into the surrounding water. Eight medusae of with displacement volume ranging from 200 - 2100mL were individually held in 15L of freshly collected estuary water in white plastic buckets. The buckets were positioned in the shade and half submerged in water such that the animals were not exposed to temperature changes. Two samples of the water (2 mL and 350mL) were taken before the medusae were put in place and again after the medusae had been in the water for two hours in mid morning daylight. Water samples were cooled on ice immediately. The 2mL samples were frozen for later analysis using an infra red carbon analyser. The 350mL samples were aerated for ten minutes, to bring them to oxygen saturation, then treated as samples for BOD_5 at 25°C.

An initial BOD_5 trial with two samples from each of 10 medusae showed significant oxygen depletion in water in which medusae had been held for two hours. A second trial gave similar results. Further trials are planned.

Samples are yet to be analysed with the infra red carbon analyser.

Chlorophyl content of the symbiotic algae associated with *P. punctata* medusa has been measured at 13 - 14 ug chlorophyll $\underline{a}.mL^{-1}$ of tissue after extraction with two different organic solvents. This concurs with comparisons of chlorophyll made by fluorimetry of samples of estuary water and samples of medusa tissue. The chlorophyll concentration in the medusa is several hundred times greater than for the open water.

Freezing of homogenized samples of medusae facilitates separation of algal symbionts from the tissues of the medusae. Samples treated in this way are held in frozen storage for analysis of nitrogen content. This will be completed during 1996.

Medusae of *P. punctata* have been collected and preserved for examination of gut content to determine whether animal prey is taken as food. So far, small numbers of prey items have been identified in the cavity of small (~2cm diameter) medusae.

Laboratory work with live animals has established techniques for maintaining both *P. punctata* and *Aurelia* sp through repeated asexual generations at the polyp stage. Both species can be kept indefinitely in the laboratory at the polyp stage. Progress has been made towards establishing the conditions which stimulate strobilation and continued growth of ephyra stages in the laboratory. When this achieved , laboratory work can continue on aspects of the feeding biology of these animals during the period of the year when medusae are not present in the estuary.

1 PID 77 Cycling of nutrients
Project Leader: Dr. C Oldham

funding source	WAERF	+ w = weeks ahead or - w = weeks behind	
expected total cost	$196,971	name of organisation doing the project	UWA, ECU
date of project start	May 1995	which projects depend on this one ?	66
proposed date of project completion	Dec 1997	on which projects does this one depend	-----
is this project on schedule ?	yes		

Review

SWAN RIVER SEDIMENT STUDY

1. Overview of objectives:

The primary objective of the first stage of the project was to establish the sediment characteristics of the estuary. This work was undertaken within the background of a series of "pilot studies", focusing on wider issues of stratigraphy, sedimentology, sediment inputs and their redistribution. These preliminary studies were undertaken so as to facilitate the identification of the relevant problems, which would need to be considered in any attempt at obtaining an understanding of the sediments characteristics, stratigraphy and dynamics of the estuarine facies.

2. Sediment sampling strategy:

After an initial field evaluation of the estuarine depositional settings and the characteristics of the sediments, the decision was made that sediment coring would be required. The collection of only shallow surface samples was considered inappropriate because of the "static" impression of deposition that this would provide. During the first year of this study, cores were obtained through diving operations, use of percussion and vibro-coring techniques and, more recently, the use of a modified Tonka corer. Cores recovered were variable in length ranging from 1-6m. Cores have now been recovered from all of the estuary's geomorphological and facies settings. To date some 150 .cores have been recovered. It is anticipated that an additional 100 cores will be obtained within the next six months. The areal extent of the sampling program has been from just downstream of All Saints Church, Upper Swan to the Fremantle Traffic Bridge. All of the deep sediment sinks of the lower estuary have now been sampled. The core sampling strategy has led to a good overview of the general sediment and depositional characteristics of the estuary, which has been complemented by an evaluation of the bedload sediment storage bodies in the middle and upper Swan reaches.

3. Sediment inputs and resuspension:

Given the almost total lack of suspended sediment data that currrently exists and the prevailing broad spectrum of opinion as to rates of suspended sediment inputs into the estuary, a pilot study was undertaken to establish the likely suspended sediment concentrations. During the period, July 14 - August 4 1995, point suspended sediment sampling and associated turbidity measurements were undertaken at Point Reserve, Bassendean. Suspended sediment concentrations in the range of 40-80 mg/l were recorded. These measurements give further credence to the impression gained from the wider alluvial sedimentology, which suggests that the amounts of suspended sediment discharged into the Swan Estuary are likely to be low. It is stressed that these conclusions are based on very limited data and that a more comprehensive study may lead to their rejection. The suspended sediments obtained were studied through SEM-EDAX techniques.

There are ongoing attempts at wave regime forecasting and "shear strength" characterisation of sediments to establish the likelihood and controls of resuspension. Sediment textural characteristics, bulk density, water content and vane shear strength are used to characterise the sediments. Resuspension under different wind-waves is presently being measure by traverses through the estuary, as well as site-specific water column profiling. Few data are available at present.

4. Results of the preliminary core analyses:

Detailed stratigraphic work has been undertaken on a number of cores. The work consisted of:

i Pollen stratigraphy - to facilitate the dating of cores. Pine pollen was used.
ii Chemical stratigraphy - consisting of P and N and selected heavy metals determinations.
iii Magnetic susceptibility - for the identification of likely changes of suspended sediment input rates.

The results of one such core analysis at shown in the accompanying figures. Again it is stressed that these results are preliminary and were undertaken so as to provide an initial indication of the stratigraphy and the sediment characteristics.

The greatest problem that has so far been encountered in the determination of sediment deposition rates has been the identification of undisturbed sites. The analyses of cores inevitably point to the fact the sediment column is likely to have been disturbed. And although "all" records of dredging have been obtained, it is clear these are incomplete. This has been demonstrated by anecdotal evidence provided by local "residents". Long cores (6m) are now being recovered through diving operations in the deep water locations in the lower estuary and will be dated using 210-Pb at the Institute of Environmental Physics, University of Heidelberg. These cores are considered to be relatively undisturbed.

5. Progress:

At the specific level:

a) the availability of the core samples which are now being analysed and will form the basis for sediment mapping of the estuary, and
b) an understanding of the sediment characteristics of the major estuarine facies.

More generally: the initial studies have given a wider appreciation of the sediment regime of the estuary and they appear to indicate one which sees limited inputs, limited output and hence has a very high retention potential.

1 PID 78 Soluble organic matter in Ellen Brook
Project Leader: Nicole Sampson

funding source	WAERF & CSIRO	+ w = weeks ahead or - w = weeks behind	
expected total cost	$100,000,=	name of organisation doing the project	UWA/CSIRO
date of project start	14 August 1995	which projects depend on this one ?	Swan River Model 66
proposed date of project completion	August 1998	on which projects does this one depend	none
is this project on schedule ?	yes		

Review

THE DYNAMICS OF SOLUBLE ORGANIC MATTER IN THE ELLEN BROOK CATCHMENT

Supervisors: Dr. Robert Gerritse (CSIRO) and Prof. Graham Aylmore (UWA)

Background:

The Swan River has experienced an increase in the occurrence of algal blooms in recent years, particularly in the upper reaches of the river. This appears to be due to a large input of nutrients from Ellen Brook, especially from agricultural fertilisers. Ellen Brook also contains high levels of dissolved organic carbon (DOC) and iron and contributes probably more than 90% of the total inputs of organic matter (OM) and Fe to the Swan River. The grey sandy soils which make up 30% of the catchment have low P retention properties and contribute most of the P and DOC leached into Ellen Brook.

The soil OM is derived from tannins and oils in the leaves and bark of native vegetation in the Ellen Brook catchment, which has largely been cleared. Thus the levels of OM in the soils are slowly being depleted from the catchment and as a consequence, levels entering the Swan can be expected to progressively decrease. This might significantly change the ecology of the two rivers.

It is thought that the type and concentration of OM plays an important role in river ecology in that it serves to reduce the severity of algal blooms. Organic matter shades light required for photosynthesis and thus limits algal growth. A reduction of OM levels could mean that algal blooms in the Swan will become increasingly intense.

This research is important from a management perspective in terms of the effects of inputs of dissolved OM from Ellen Brook to the Swan River. Little is known about the time scales involved in leaching and degradation of OM from the catchment of Ellen Brook or the potential increase in intensity of algal blooms in the Swan River from increased light penetration.

Objectives:

The study aims to quantify the sources and rates of decline of soil OM and associated trace elements following the changes in land use which have occurred in the Ellen Brook catchment and to elucidate the mechanisms involved in the leaching and transport processes. This information is lacking and is vital to the effective long term management of water quality in the Swan River.

Deliverables:

1. In order to quantify release rates of dissolved OM to streams from different soil types in the Ellen Brook catchment and to estimate a dissolved OM run-down time, column leaching experiments, laboratory analyses of soil profiles and characterisation of soil particles using an electron scanning microscope will be undertaken.

This will provide information on:

- the extent to which OM has degraded, the sources and nature of OM and associations between OM and N, P and Fe and other trace elements.
- the rates of desorption of OM, the amount of OM removed from soil under normal rainfall leaching conditions and the expected time period for the depletion of OM from the catchment.
- the structure and morphology of soil and the characterisation of soil particles and OM.

2. The determination of the relative amounts of OM and associated trace elements in different size fractions of stream water will involve the fractionation of water by molecular weight of dissolved and suspended particles. These fractions will be characterised in terms of spectral quality, concentrations of OM and a range of nutrients, salts and trace metals and C-13 and C-14 contents.

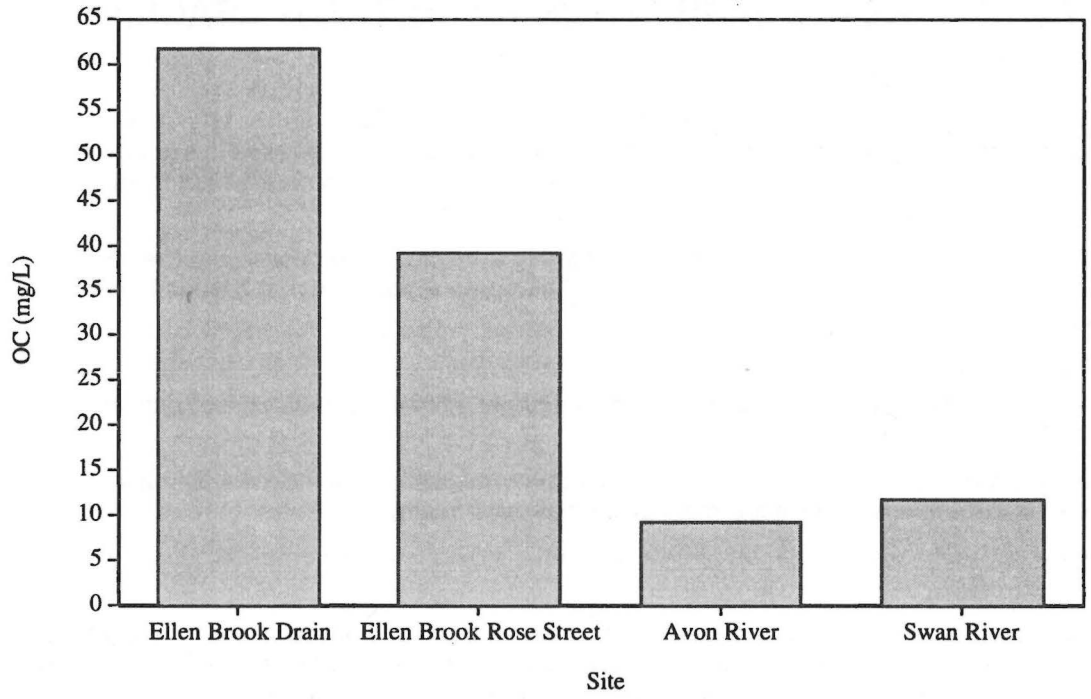
3. The rates of decline in concentrations of OM and associated trace elements obtained from leaching studies will be linked to a simple catchment scale hydrological model for estimating the time scale of the decline of dissolved OM in Ellen Brook.

Progress:

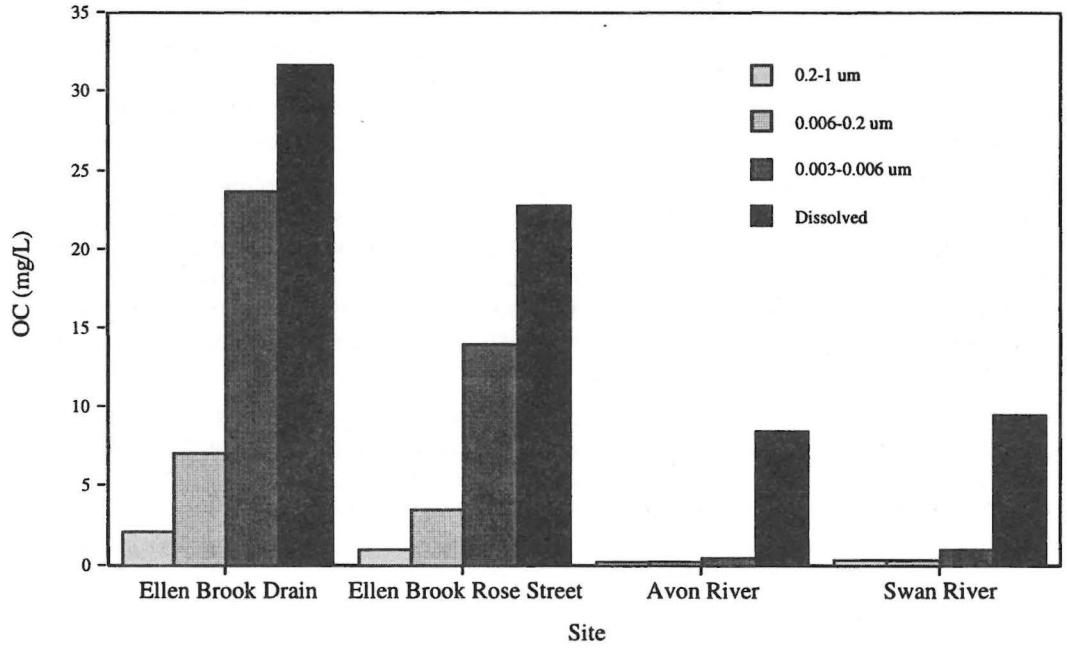
In the 6 months since the commencement of this study much work has been carried out on the fractionation and characterisation of stream water from Ellen Brook, an Ellen Brook drain, and the Avon and Swan Rivers. It can be seen from the graphs below that Ellen Brook, especially the Ellen Brook field drain, contains very high concentrations of OC and that OC exists largely in the dissolved fraction of stream water. The sampling and fractionation will continue this winter.

A database of the spectral characteristics of OM-rich water and concentrations of OC, nutrients and ions has also been established. The analysis of trace metals is presently being sought using an adapted XRF method and the soil column leaching study is in the early stages of development.

GRAPH 1: Organic Carbon content of water sampled from 4 stream sites



GRAPH 2: Organic Carbon content in 4 fractions of water sampled from 4 stream sites



1 PID 60 Soil water & nutrient dynamics: turf / leaching
Project Leader: Prof. L A G Aylmore

funding source	WAERF	+ w = weeks ahead or - w = weeks behind	-----
expected total cost	$161,042	name of organisation doing the project	soil science & plant nutrition / the university of WA
date of project start	1 July 1995	which projects depend on this one ?	-----
proposed date of project completion	30 June 1998	on which projects does this one depend	-----
is this project on schedule ?	yes		

Review

SOIL WATER AND NUTRIENTS DYNAMICS IN THE ROOTING ZONE OF TURF GRASSES IN RELATION TO NUTRIENT LEACHING

Irrigated turfgrass areas consume large inputs of water, nitrogen and phosphorous fertilisers. Excessive or poorly balanced water and nutrient applications to turfgrass can result in significant leaching of nitrogen and phosphorous. This in turn causes a deterioration in quality of both the ground water and surface water resources within the Swan River Estuarine System.

This project aims to determine how current turf management practices can best be modified to optimise water and nutrient usage and minimise loss of nutrients beyond the root zone of turfgrass grown on sandy soils.

Specific objectives are:

To quantify spatial and temporal patterns of water and nutrient uptake within sandy soil profiles supporting turfgrass.

Devise and test alternative soil, plant and management practices which will reduce water use and nutrient export from turfgrass areas while maintaining turfgrass quality

Create a model to predict water, nitrogen and phosphorous movement within the rootzone of turfgrassed sandy soils.

Our work will provide an improved understanding of water, nitrogen and phosphorous movement in sandy soils of the Swan Coastal Plain. This is a prerequisite for the development of soil modification, irrigation and nutrient application practices designed to minimise nutrient leaching.

Work to date has concentrated on measuring the water retention and hydraulic properties of typical sandy soils on the Swan Coastal Plain. This has involved laboratory measurements of soil water retention and hydraulic properties in situations varying from disturbed soils with no turf present, through to large undisturbed soil cores with established turf. Results indicate that variation in the water retention and hydraulic properties within this group of soils is significant and can be attributed primarily to differences in distribution of sand grain size (for soils with little organic matter). Organic matter content has a dominant effect on soil hydraulic properties in surface (0-15cm) soils

In collaboration with TINS project personnel we have measured soil moisture regimes under varying irrigation treatments at two field sites. We now have an extensive database relating soil moisture movement to environmental conditions over the entire range of moisture potentials at which turfgrass will survive and for both winter and summer irrigated situations. Data collected provide a basis for designing more efficient irrigation regimes and will be utilised in planning experiments to determine nitrogen and phosphorous dynamics under realistic soil moisture conditions; the next phase of work planned for this project.

There is a strong interaction between the water and nutrient requirements of turfgrass. Optimum water and nutrient application strategy will also vary with season, soil, plant and management factors. Quantifying these factors and integrating their effects and interactions into an information package accessible to turf managers will be the most significant outcome of this work.

1 PID 61 Economic valuation of S / C estuary
Project Leader: I M Briggs

funding source	WAERF	+ w = weeks ahead or - w = weeks behind	
expected total cost	$54,322	name of organisation doing the project	Agricultural and Resource Economics Faculty of Agriculture The University of WA
date of project start	October 1995	which projects depend on this one ?	none
proposed date of project completion	July 1997	on which projects does this one depend	none
is this project on schedule ?	yes		

Review

THE ECONOMIC EVALUATION OF THE SWAN-CANNING ESTUARY

Project Objectives:

The aim of this project is to incorporate economic and environmental principles to evaluate policies for estuarine management. In the case of estuaries, there is little conflict between the concept of enhanced water condition and environmental quality. This is because users of the estuary resource primarily depend on good conditions to enhance commercial and non-commercial benefits. However, land and water activities in estuary catchments may not be conducive to protecting downstream water quality. Thus, many of W.A's estuaries have been adversely affected by inappropriate management and uninformed decisions about the effects of land and water use and natural events. As a consequence some economic, social and environmental values have been compromised.

The major objectives of the project are as follows:

- Estimate the value of estuary resources used by commercial and non-commercial groups and individuals.
- Evaluate the costs and benefits of estuary management.
- Appraise the economic instruments which might be applied to sustainable environmental management of the estuary.
- Evaluate alternative funding mechanisms.

Short review

The major objectives of the project are as follows:

- Estimate the value of estuary resources used by commercial and non-commercial groups.
- Evaluate the costs and benefits of estuary management.
- Appraise the economic instruments which might be applied to sustainable environmental management of the estuary.
- Evaluate alternative funding mechanisms

Market values of riverside properties are useful in assessing the level of demand for the estuary amenity, since properties with river views/access are more expensive than similar properties without those amenities. Initial statistical analysis of unimproved property values in the riverside suburbs between Fremantle and Perth showed that the river component of unimproved land values ranged between 17% to 65%. The amount of annual stamp duty and land tax then attributable to higher property values resulting from river views was estimated to be around $ 1.8 million (Briggs 1995). In April 1996, updated unimproved land values will be available and further analysis of all Perth riverside suburbs will be undertaken. In addition, commercial rental values from the CBD will also be analysed for the effect of river views. It is expected that this complete valuation of all Perth suburbs will yield an annual duty and tax value of up to 10 million dollars. This revenue will be one of the evaluated funding sources available for estuary management.

The project has developed a contingent valuation questionnaire to assess the communities valuation of the Swan Canning estuary. This contingent valuation will examine the valuation of three community groups: recreational users, residents of riverside suburbs, and general Perth residents. It has been determined that the most appropriate method is to use a payment card, combined with a double-bounded dichotomous choice question at the end of the survey to elicit a valuation. This method assesses if the willingness-to-pay (WTP) from the payments card is consistent with the answer given in the dichotomous choice question.

With the dichotomous choice method, two questions are asked to elicit the WTP. The first question offers a set bid amount. A second question offers a bid amount that is half (twice) the value of the first bid amount, if the respondent rejects (accepts) the first bid amount. The range of bid amounts offered to the survey respondents must contain the population mean. A pre-test is necessary in ascertaining a population sample mean and to determine if the survey questions are appropriate for eliciting a consistent valuation of the Swan-Canning resource. The pre-test will be conducted in May 1996. (1995) estimated that a flat rate charge ranging from $6-$13 per occupied residential household would be required to raise additional funds necessary for adequate management of the Swan-Canning. The survey will indicate if a household levy of $6-$13 is consistent with Perth residents willingness-to-pay for water quality in the Swan-Canning. The complete contingent valuation survey will be conducted in November 1996.

Few bio-economic models have been developed for estuary and/or river management, and this project represents the first attempt to develop such a model for the Swan-Canning. The framework for the bio-economic model is presently being developed. By necessity, the biological and physical components will be simplified to enable an economic framework to be overlaid. For the biological component of the model, the project will utilise available data for average nutrient loads for activity/soil type in the sub-catchments, with major point sources included. A simple bio-physical model will simulate seasonal changes in water quality indicators, including the probability of algal blooms. This will be then linked to community perceptions and demand for water quality levels elicited from the contingent survey. Fish populations levels in the estuary will also need to be incorporated. Although commercial fishing has a relatively low average value, (around $220,000 per annum since 1989), the contingent valuation survey will provide information on the recreational component of the fisheries. The project will then use the bio-economic values in a simulation management model developed in *Extend*. Alternative management options can then be assessed.

A substantial body of data on the value of possible contributions to waterway management has already been collected. These include direct use fees sources (eg. boat registrations) and indirect taxes and levies (eg. marine fuel spirit levies). The final stage of the project will involve evaluating the costs and benefits of alternative management regimes, along with possible alternative funding mechanisms such as a household levy. The project will be completed in June 1997.

Briggs, I. (1995) Who Should Pay For Managing WA's Waterway Resources?: A Swan-Canning Waterway Case Study. Paper presented at the 39th Annual Conference, Australian Agricultural Economics Society, University of WA.

1 PID 63 Heavy metal cycling in Bayswater main drain and Swan River Project Leader: Dr. C Oldham

funding source	UWA	+ w = weeks ahead or - w = weeks behind	
expected total cost	$90,000	name of organisation doing the project	UWA
date of project start	Jan 1996	which projects depend on this one ?	-----
proposed date of project completion	Dec 1998	on which projects does this one depend	-----
is this project on schedule ?	yes		

Review

A STUDY OF HEAVY METAL CYCLING IN THE BAYSWATER MAIN DRAIN AND THE ADJACENT SWAN RIVER

Principal investigators

PhD student: Yuan Yi, Centre for Water Research, UWA. Supervisor: Dr Carolyn Oldham, Centre for Water Research, UWA

Specific aims

As one of the most important industrial pollutants in the Swan River Estuary, heavy metals discharged from urban drains have been of major concern to state and local governments. Some surveys and monitoring programs of heavy metal distribution in the Swan River were carried out by the Swan River Trust in 1991 and 1993. However few studies have been done on the processes determining the characteristics of heavy metal pollutants as they enter the receiving bodies, their fate and transport and their potential impact on both the water and human environment.

The following are the specific aims for this project:

1. Identify the effects of land use and seasonal variations on heavy metal loads to the BMD from surface water and groundwater.
2. Determine the mechanisms of heavy metal transport in the drain.
3. Analyse the seasonal variation of heavy metal loads to the Swan River from BMD.
4. Optimise the strategy for control of heavy metal release from BMD to the Swan River.

Progress

Yuan Yi is further developing the aims and sampling strategies for this project in order to prepare her PhD proposal. As part of this proposal she is currently liaising with SRT, WAWA and local councils to establish a database of all existing data relevant to determining heavy metal loading to the BMD and the Swan River. It is expected that she will being a sampling program in mid-1996.

1 PID 64 Dynamics of a tidal estuary
Project Leader: Amir Etemad

funding source	CWR	+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	CWR
date of project start	1993	which projects depend on this one ?	
proposed date of project completion	1997	on which projects does this one depend	
is this project on schedule ?	yes		

Review

DYNAMICS OF A TIDAL ESTUARY

Supervisor: Jorg Imberger

The aim of this project is to understand the role of the bathymetry in the hydrodynamics of the Swan River Estuary and obtain a quantitative knowledge of the resultant mixing processes. This knowledge is an essential key to predict the distribution and residence time of materials entering the estuary.

Objectives

The objective of this study is to address these questions:

1. What is the rate of exchange and transport in time and space?
2. Where do we have active mixing and intense turbulent events and what are the controlling factors? How do they change with tide and river discharge variations?
3. What is the efficiency of mixing in the water column? Is boundary mixing important?
4. What is the evolution of internal waves due to baroclinic and barotropic forcing and their relation with turbulence dissipation?

Work Plan

Observations will be made during two seasons. It will take 5 days in March 1996 and one week in September 1997 when there is considerable freshwater discharge from the Swan and Canning rivers. Field study will consist of two parts. The first one will be in the Black Wall Reach, upstream of the Fremantle sill (shear driven turbulence). The second one will be conducted in the wider region of the basin in Melville Water (basin/boundary mixing).

Instrumentation and methodology

PFP: Portable Flux Profiler

The PFP is a portable instrument designed by CWR to investigate turbulent mixing and entrainment processes in the water column. It measures small scale fluctuations (micro structure) of the temperature, conductivity and velocity of water bodies. These data are used to infer the rate of dissipation of turbulent kinetic energy and buoyancy flux. Data are collected at 100 Hz and the vertical resolution of the sensors is about 1 mm. PFP has two pairs of temperature and conductivity sensors, plus a laser Doppler anemometer system that measures vertical and horizontal components of velocity on a millimetre scale.

Fprobe

CTD data will be collected using the F-probe built by CWR. The profiler is designed to resolve both fine-scale motions (in order of centimetres) and basin-scale motions (of order kilometres). The profiler is equipped with depth, temperature, conductivity and turbidity sensors. PH, fluorometer and dissolved oxygen sensors can be added to the probe as options. Signal enhancement software is provided to correct the different response times of the various sensors. In this way, quantities such as salinity derived from two sensors do not contain any artificial spike. The probe can be used in different modes (falling, yo-yo and towing) but it will be used mostly in falling mode. With the falling rate of 1.0 m/s it has a resolution of 2 cm.

ADCP: (Acoustic Doppler Current Profiler)

Velocity measurements will be conducted by using the ADCP built by CWR. ADCP is an acoustic Doppler system designed to measure velocity profiles. It uses coherent acoustic Doppler techniques to derive estimates of water velocity .

Thermistor/Conductivity Chain:

Thermistor/Conductivity Chains can measure the time history of the high frequency temperature/salinity structure accurately at different depths. In the way same as ADCP, the user can specify the sampling frequency and the spacing of sensors. In this way the chain can be used with optimum performance. Data acquisition / logger packages are available with a sample rate of up to one second. An array of chains will allow the identification of the internal wave spectra and energy flux through the wave number/frequency range of the internal wave field.

River discharges, meteorological data and water level changes that are monitored simultaneously by other authorities/research groups will be used in this project as well.

The deployment of the chain, ADCP, CTD and PFP will enable us to quantify paths of energy and mass flux. In this way we can trace the cascade of energy from the tide and river discharge to different scale of motions in the basin (seiching, internal waves, turbulence). This rich data set can be used to verify numerical models as well.

The first question (*What is the rate of exchange and transport in time and space?*) will be answered by analysis of velocity and density profiles. Having velocity and density evolution, enables us to measure rate of energy and mass flux in the system. In this way we will find the vertical transport rate in Swan River Estuary.

The second question (*Where do we have active mixing and intense turbulent events and what are the controlling factors? How do they change with tide and river discharge variations?*) will be answered by measurements of turbulence levels and buoyancy flux at different stations. Periodic measurements of these quantities will clarify the temporal changes due to variable forcing.

The third question (*What is the efficiency of mixing in the water column? Is boundary mixing important?*) will be answered by calculation of Richardson flux and its vertical and horizontal variation. Calculation of turbulent numbers will show the validation of empirical formula for mixing efficiency.

The fourth question (*What is the evolution of internal waves due to baroclinic and barotropic forcing and their relation with turbulence dissipation?*) will be answered by comparing the time series of the isopycnal displacement and the water level changes. Spectral analysis of the displacement will give an estimation of the dissipation and can be compared with the microstructure measurements.

1 PID 80 Environmental engineering projects contributing to SCCP Project Leader: Dr David Hamilton

funding source	Various	+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	Environmental Engineering UWA
date of project start	1994	which projects depend on this one ?	none
proposed date of project completion	ongoing	on which projects does this one depend	none
is this project on schedule ?	n/a		

Review

PROJECTS CONTRIBUTING TO SCCP

Project objective

The Department of Environmental Engineering of the University of Western Australia has compiled a list of undergraduate and postgraduate theses and a register of present student studies on the Swan River, dating back to 1990.

Review of project in respect of meeting its objectives

Undergraduate theses:

Astill, W. D., 1995. Feasibility of engineering solutions in the Swan River Estuary water quality problems. (Honours thesis, supervisor: J. Imberger.)

Noid, C., 1995. Controlling algal blooms in the Swan River Estuary using destratification techniques. (Pass project, supervisor: J. Imberger.)

Kalnejais, L. H., 1995. The hydrodynamics of the Swan River Estuary: An hydraulic model study. (Honours thesis, supervisor: J. Imberger.)

Mack, A. J., 1995. Phytoplankton succession in the Swan River. (Pass project, supervisor: D. Hamilton.)

Rodgers, S. J., 1995. An investigation of the leaching properties of fertilisers applied to various soils of the Swan Coastal Plain (Pass project, supervisor: C. Oldham.)

Welsh, A. L., 1995. Chromium and zinc in the Swan River Estuary (Honours thesis, supervisor: C. Oldham.)

Barr, S., 1994. The ecological response of south-western Australian estuaries to nutrient enrichment. (Honours thesis, supervisor: J. Imberger.)

Burling, M. C., 1994. Hydrodynamics of the Swan River Estuary: A numerical study. (Honours thesis, supervisor: C. Pattiaratchi.)

Carrier, M., 1994. Observations at the salt wedge interface of the Swan River Estuary. (Honours thesis, supervisor: D. Hamilton.)

Chandrasekaran, S., 1994. Nutrient release from Swan River sediments. (Honours thesis, supervisor: D. Hamilton.)

Read, L. K., 1992. Dissolved oxygen in the Swan River Estuary. (Honours thesis, supervisor: J. Imberger.)

Robinson, P., 1990. Swan River tidal height analysis. (Pass project, supervisor: C. Pattiaratchi).

Postgraduate thesis:

Stephens, R. Dynamics of the Swan River Estuary. (Masters thesis, supervisor: J. Imberger). A paper from this thesis is 'in press' in Marine and Freshwater Research.

Honours theses and pass projects in 1996:

K. Eade (Management feasibility study, supervisor: J. Imberger).

T. Salmon (Phytoplankton migration study, supervisor: D. Hamilton).

G. Ghosa (Study on sea breeze effects, supervisor: C. Oldham).

1 PID 84 Phytoplankton dynamics
Project Leader: Dr. Jacob John

funding source	Curtin University Swan River Trust WAERF	+ w = weeks ahead or - w = weeks behind	
expected total cost	$275,000	name of organisation doing the project	Curtin University & CSIRO
date of project start	July 1995	which projects depend on this one ?	Modelling and Prediction} of algae blooms
proposed date of project completion	1997	on which projects does this one depend	
is this project on schedule ?	yes		

Review

PHYTOPLANKTON DYNAMICS AND ECOLOGY IN THE SWAN-CANNING RIVER ESTUARY: STUDIES ON FACTORS CONTROLLING BIOMASS

Project objectives

1. To study the population dynamics of phytoplankton blooms in the Swan and Canning Rivers - initiations, peaks, decline, duration, vertical migration and horizontal distribution - Diatoms, Dinoflagellate, Chlorophytes, Cryptophytes, Chrysophytes and Cyanobacteria.
2. To investigate the mechanisms involved in nutrient uptake, especially Nitrogen, by the phytoplankton. Uptake of NH4, the effect of stratification on primary production rates.
3. To test the hypotheses that the microheterotrophs may play a vital role in regulating phytoplankton blooms. Grazing as a factor controlling duration and decline of blooms - Microheterotrophy may be important.
4. To identify the physical and chemical factors triggering phytoplankton blooms and those leading to shift in blooms. Recurrence of short-lived Dinoflagellate blooms during summer and autumn following the *skeletonenna* blooms along the estuary - moving up the upper estuary. Factors involved in *shift* in blooms.
5. Cyanobacterial blooms in Canning River and their significance to the Swan River.

Canning River

Research student Wilma Vincent completed an Honours project in 1995 supported by WAERF, the Swan River Trust and Curtin University, and is currently continuing work on the Canning River for a PhD program. $4,000

Population dynamics, succession, and the ecology of phytoplankton in the upper reaches of the Canning River were investigated from February 1994 to December 1995 for the first time. A massive bloom of the toxic cyanobacteria *Anabaena circinalis* and *Anabaena spiroides* (0.82 mg/L of Chlorophyll *a*) occurred at the beginning of the study.

It was found that cyanobacteria, most frequently *Oscillatoria* species form the major proportion of the phytoplankton numbers in this freshwater river. Diatom populations increase at the end of the winter, but the first summer bloom is of small chlorophyta, closely followed by coccoid cyanobacteria. A series of blooms of various chlorophyta and cyanobacteria then follow through the summer, with increases in colony size, until *Anabaena*, or *Anabaenopsis* occur in high numbers in late summer. This pattern is characteristic of eutrophic systems. The shaded creek site has lower summer populations than the lower sites and a much lower range of phytoplankton types. The unusual intrusion of salt water into the system at the beginning of the 1995-6 summer was associated with an increase in centric diatoms and then dinoflagellates. Concentrations of Chlorophyll *a*, phosphates and nitrogen compounds were characteristics of a eutrophic system. Winter runoff increases the nutrients which are recycled via sedimentation, zooplankton and microbial action. Factors which contribute to the Cyanobacterial dominance are the high nutrients with low N:P ratio, and low penetration of light linked to the high gilvin content. The toxic Cyanobacterial species were associated with high water temperatures and low salinity.

Swan River

Research student **Luke Twomey** completed his Honours in 1995 (supported by WAERF, Curtin University and the Swan River Trust) and is currently continuing work on dinoflagellates in the Swan River on a PhD scholarship from Curtin University. $4,000

Phytoplankton community composition, productivity and biomass characteristics of the Swan River Estuary were assessed from March to December 1995. Additionally, the first ever intense study on phytoplankton conducted in 1980-81 by John was compared with that of 1994-5. Summer and autumn were characterised by blooms of diatoms and dinoflagellates. The physical and chemical water quality variables were greatly influenced by the onset of winter rainfall which in turn influenced the phytoplankton dynamics. Salinity was of critical importance in the seasonal succession of phytoplankton. There were prolonged periods of Chlorophyte blooms in the upper estuary in the spring. The phytoplankton assemblage in autumn were predominantly dinoflagellates which could be directly associated with the high salinity and high nutrients. The phytoplankton biomass was limited by the concentration of nitrite+nitrate throughout autumn, which in turn effectively lowered the N:P ratio during this period. Dinoflagellate and diatom blooms coincided with an increase in the ammonium concentration. The comparison of phytoplankton data from 1980-81 and 1994-5 displayed an increase in the biomass of the upper estuary during summer, as well as an increase in the frequency of blooms of dinoflagellates in the upper estuary in autumn. The ability of phytoplankton to vertically migrate was investigated in the laboratory.

Jane Rosser (PhD student at Curtin University, funded by WAERF and Curtin University) has been monitoring phytoplankton blooms in the upper reaches of the Swan River during spring, summer and autumn 1995-6. Samples of the major Chlorophyte blooms in the spring and diatom and dinoflagellate blooms in summer and autumn have been collected and analysed for species composition and identification. The grazing effects of microheterotrophs on phytoplankton blooms have been investigated. Mechanisms of N uptake by phytoplankton by N15 experiments both in the lab and in the field have been under intense investigations as ammonia is identified to be an important nutrient in the regulation of phytoplankton blooms. The lab based experiments are being conducted in the CSIRO laboratory. A thorough literature survey has been completed. The project objective for the time period has been achieved.

GROUP 2

Water and Rivers Commission & CSIRO

2 PID 1 SCCP water quality data analysis (WRC)
Project Leader: Neil Dixon

funding source		+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	WRC
date of project start		which projects depend on this one ?	
proposed date of project completion		on which projects does this one depend	
is this project on schedule ?			

Review

EDITOR'S NOTE:

No review for the above project was received at the time of publication

2 PID 7 Sediment mapping
Project Leader: Malcolm Robb

funding source		+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	WRC
date of project start		which projects depend on this one ?	
proposed date of project completion		on which projects does this one depend	
is this project on schedule ?			

Review

EDITOR'S NOTE:

This project has been suspended pending the outcome of PID 77

2 PID 9 Algal remote sensing and surveilance
Project Leader: Peter Hick

funding source	SCCP	+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	CSIRO
date of project start		which projects depend on this one ?	
proposed date of project completion		on which projects does this one depend	
is this project on schedule ?			

Review (includes PID 10 DMSV algal surveilance)

ALGAL REMOTE SENSING AND DMSV FOR ALGAL SURVEILLANCE

These projects are part of a larger project, "The automatic remote monitoring of water quality and remote sensing of algal and cyanobacterial blooms in Australian inland and estuarine waterways". The work was principally funded and initiated by the CSIRO Multi-Divisional Blue-Green Algal Program and has been reported to our close collaborators, the Swan River Trust, at an international conference and to CSIRO under the title of ***"Remote sensing of algal blooms in the Swan River" by P. Jernakoff, P. Hick, C. Ong, W.Hosja and S. Grigo.***

The remote sensing component was seen as important because there is a need for cost-effective techniques to detect algal blooms over large areas and to monitor, in near real-time, the widely distributed water bodies in Western Australia. The ability to spectrally discriminate between types of blooms was also a major objective of the study. The majority of algae problems in the eastern states of Australia are caused by cyanobacteria, the Swan/Canning system experiences blooms of blue/green, green, diatom and dinoflagellates.

The use of airborne instruments as a low-cost, operational supplement to traditional boat-based sampling for assessing the spatial and temporal extent of algal blooms, coupled with basic field studies of in-water reflectance, using multi-band radiometers, supported the controlled laboratory studies. These studies indicated that significant spectral differences between blue/green and green algae and red diatom/dinoflagellates were measurable.

Two different types of airborne multi-spectral remote sensing instruments were evaluated in the study. They were:

1. the CASI (Compact Airborne Spectrographic Imager) which provided excellent spectral discrimination having 288 bands in imaging-spectrometer mode and 14 bands in spatial-imaging mode. However, the CASI produces very large data sets, that require significant time to process and analyse. The system is not available at short notice and is expensive to operate, but is an ideal tool to determine how many spectral bands, and at what band centres, are necessary to discriminate bloom types; and
2. the DMSV (Digital Multi-Spectral Video) provides less spectral resolution, having only 4 interchangeable filters, although the bands could be selected, based on determinations from the CASI data, to provide maximum discrimination of algal blooms. The DMSV is less expensive to operate and is locally based, and therefore normally available at short notice.

Because of the logistical constraints in measuring sufficient replicates of in-water spectra, during flight times, the study examined the implications of bloom stability (in space and time) between airborne data collection and the data collected from ground surveys to calibrate and validate airborne data.

Quantifying algal blooms using in-water data coupled with remotely-sensed data requires ground sampling to be done simultaneously, or within a very short period, of the remote sensing flight. Flights must coincide with the biological activity of the phytoplankton (i.e. daily afternoon migration of cells to the surface waters) and at times of the day that will minimise sun-glint for accurate assessment of bloom distribution. If this does not occur, the relationships between bloom distribution and abundance, and remotely-sensed images will be poor.

A good relationship between the biological data and the images is obviously necessary for detection and estimating bloom concentrations. However, in situations where blooms are rapidly changing, remote sensing provides an effective tool to describe in a qualitative sense, the dynamic nature of the bloom at a single period of time, over large spatial scales.

Peter Hick ,Senior Research Scientist, CSIRO Division of Exploration and Mining, Leeuwin Centre for Earth Sensing Technologies

2 PID 11 Aquatic sediment chemistry
Project Leader: Dr. Grant Douglas

funding source	SCCP	+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	CSIRO
date of project start		which projects depend on this one ?	
proposed date of project completion		on which projects does this one depend	
is this project on schedule ?			

Review

BENTHIC CHAMBER EXPERIMENTS

Experiments with *in-situ* benthic chambers have been conducted at five sites (Perth Waters, Freshwater Bay, Heirisson Island, Tonkin Overpass and Ron Courtney Island) in the Swan River Estuay to assess nutrient release and oxygen consumption rates. Research was undertaken using a large (*ca.* 650L volume, sediment surface area 0.78m^2) fibreglass dome which is used to isolate a section of the bottom sediments over a period of 4-5 days. This study was carried out in the Swan River Estuary using the BankWest/CSIRO/Swan River Trust research barge.

Rates of oxygen consumption within the benthic chambers are closely related to temperature (0-500 mg/m^2/day) below *ca.* 18^oC. Above *ca.* 18^oC oxygen consumption rates increase rapidly and may be in excess of 4000 mg/m^2/day. Preliminary analysis of tracer (D_2O) behaviour within the benthic chambers is currently being undertaken to investigate aspects of solute mixing processes and porewater-riverwater exchange.

Nutrient release rates vary markedly between sites but do not exhibit the same relationship to temperature as in the case of oxygen consumption rates. Interestingly, nutrient release rates do not increase with the onset of anoxia. The highest release rates for nutrients are 137 mg/m^2/day (NH_3-N), 64 mg/m^2/day (PO_4-P) and 441 mg/m^2/day (Si). The reason for differences between nutrient efflux rates between sites may be threefold: differences in the composition of the underlying sediments, differences in groundwater flux (fluxes ranged from 900-9000 mL/m^2/day) and short-term changes in the chemistry of the upper layer of bottom sediments bought about by decay of phytoplankton blooms. This latter point is thought to have been at least partially responsible for large differences (increases) in nutrient fluxes and oxygen demand after the collapse of a phytoplankton bloom at the Ron Courtney Island sample site.

Rates of Fe and Mn release from the bottom sediments suggest that there may be on occasion a significant efflux of Mn (maximum 29 mg/m^2/day). It does not appear, however, that significant Fe is released. Modelling of Fe and Mn speciation suggests that there may be significant oversaturation with respect to reduced Fe-S species.

Comparison of nutrient efflux and oxygen consumption rates from the Swan River Estuary with similar in-situ benthic chamber studies around the world suggest that rates of nutrient release are comparable to many other estuarine/near shore systems and in particular that of Port Phillip Bay.

2 PID 14 Destratification trial
Project Leader: Malcolm Robb

funding source	SCCP	+ w = weeks ahead or - w = weeks behind	-12
expected total cost	$50K	name of organisation doing the project	CWR
date of project start	Feb 1995	which projects depend on this one ?	Action Plan
proposed date of project completion	1997	on which projects does this one depend	none
is this project on schedule ?	no		

Review

Objective:

To evaluate artificial destratification by conducting an in-river trail.

Review:

Project started in Feb 1995 as a student project within CWR.

Literature review: complete.

Equipment design: complete but not reported.

Trail proposed for Oct/Nov 1995 did not proceed.

Project restarted Feb 1996 by CWR:

Project re-scope 90% complete. (Target for trial was April 1996.)

In mid Feb 1996 the target date of April 1996 for the trial was considered not achievable due to previous commitments and the contract for the project was not completed.

The likelihood of appropriate stratified conditions in the river occurring before next spring are low. The project will be renegotiated with a view to a trial in the spring of 1996.

2 PID 15 Sediment manipulation
Project Leader: Dr. Grant Douglas

funding source	SCCP	+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	CSIRO
date of project start		which projects depend on this one ?	
proposed date of project completion		on which projects does this one depend	
is this project on schedule ?			

Review

INVESTIGATION OF TECHNIQUES FOR SEDIMENT REMEDIATION

The progressive eutrophication of estuarine and freshwater systems throughout Australia and overseas is often reflected in an increase in both phytoplankton bloom frequency and biomass, often with a shift to more nuisance species (*e.g.* cyanobacteria). A significant proportion of the research into and management of, estuarine and freshwater systems has focussed (with varying success) on reducing inputs of nutrients from the catchment. It is now recognised, however, that increased internal loadings derived from sedimentary nutrient stores accumulated over years to decades constitute a major barrier to the effective management and restoration of estuarine and freshwater systems. Thus, if effective sediment-nutrient management strategies can be identified and adopted to modify internal nutrient loadings, this will equip natural resource managers with a powerful tool for both short- and long-term estuarine and freshwater system management.

The objectives of the sediment remediation project are as follows:

- Prepare a literature review of sediment remediation techniques with potential application to the Swan River estuary (completed).
- Evaluate selected existing and innovative sediment remediation technologies in terms of both their short (*ca.* day to week) and medium (*ca.* week to month) term effectiveness in modifying (reducing) internal recycling sediment-nutrient stores.
- Extend existing sediment remediation project to undertake preliminary evaluations of the effects of sediment remediation technologies on the microbial composition and biomass in both sediments and the overlying water column.
- If applicable, recommend (in consultation with the Water and Rivers Commission) the adoption of small (mesocosm) to large scale (*e.g.* lake/river/estuary) field trials of promising sediment remediation technologies.

Initial research will concentrate on characterisation of materials to determine physico-chemicals properties and their ability to bind various forms or dissolved nutrients (N, P and Si) and the influence of other parameters *e.g.* salinity, Eh, pH, alkalinity on uptake/biniding capacity. Bench-scale testing (using large diameter sediment cores) will be used, where appropriate, to simulate conditions naturally occurring within the estuarine and/or freshwater environments and to assess the capacity and longevity of the sediment remediation treatments to modify nutrient recycling from the sediment. Where applicable, changes in microbial composition and biomass in both sediments and the overlying water column will be assessed.

2 PID 16 River management action plan
Project Leader: Malcolm Robb

funding source		+ w = weeks ahead or - w = weeks behind	
expected total cost	$120,000	name of organisation doing the project	WRC
date of project start	1997	which projects depend on this one ?	
proposed date of project completion	1999	on which projects does this one depend	
is this project on schedule ?			

Review

EDITOR'S NOTE:

Project to commence in 1997

2 PID 19 Catchment monitoring
Project Leader: Rob Donohue

funding source	SCCP	+ w = weeks ahead or - w = weeks behind	
expected total cost	?	name of organisation doing the project	WRC
date of project start	June 1987	which projects depend on this one ?	Model of estuaries has external load requirements
proposed date of project completion	ongoing / indefinite	on which projects does this one depend	none
is this project on schedule ?	yes		

Review

ROUTINE MONITORING OF NUTRIENTS IN STREAMS OF THE SWAN-CANNING CATCHMENT

River and Estuaries Investigations / Water and Rivers Commission

Program contacts: Malocolm Robb, Rob Donohue, Pip Wittenoom, Leith Bowyer

1. Program objectives

Eutrophication has been identifies as the greatest threat to estuarine health in the south west of Western Australia. As eutrophication proceeds the ecology of the systems change and the natural community of estuarine plants and animals may be replaced by less desirable groups. The availability of phosphorus is thought to limit productivity although nitrogen limitation may be important seasonally. Biological evidence of eutrophication have been seen in the Swan-Canning Estuaries for many years.

In response to growing concerns about the trophic state of the Estuaries the Swan River Trust commenced, in 1987, routine surveillance of nutrient concentrations in 15 of the major tributary inflows to the Swan-Canning Estuaries. The aims of the monitoring program was to provide estimates of the external load of nutrient entering the estuary every year, to identify the major contributory sub-catchments, and to detect trends in loading over time. The results up to 1992 have been reported in SRT Report No. 20 (1994).

2. Review

The data generated by the program show that a large proportion of the nutrient load entering the estuary come form the Swan Coastal Plain, with the Avon River, Bayswater Main Drain, Ellen Brook and the Southern River being significant contributing catchments. These data have been made available to researches within the SCCP program. The loading estimates are also being used by the Department of Environmental Protection to derive loading targets for the Swan-Canning Environmental Protection Policy.

A review of the literature on methods of estimating contaminant loads in rivers carried out by the SRT in 1993 showed clearly that the sampling methods employed were inappropriate for the estimation of mass loads. The fixed-interval sampling regime used produces inaccurate and imprecise estimates of load. The REI Section of the WRC is currently running a project, in association with the US Geological Survey, aimed at deriving accurate and precise estimates of load in rivers. The first storm-event triggered automatic sampling station will be located on Ellen Brook and will be operational for the 1996 wet year. The technology will also be transferred to the other major contributing streams in the catchment during 1996.

3. Future

The data from the fixed-interval monitoring network however is a cost effective sampling regime for the statistical analysis of spatial differences in water quality within catchments and trends in nutrient concentrations over time. This type of information is crucial to catchment managers in their decision making, and for the setting of management targets. Therefore, the fixed-interval monitoring will be continued indefinately, in tandem with the automatic storm event based sampling.

2 PID 20 Stormwater design
Project Leader: Alan Hill

funding source	SCCP & NLP	+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	WRC
date of project start		which projects depend on this one ?	
proposed date of project completion		on which projects does this one depend	
is this project on schedule ?			

Review

PRACTITIONER MANUALS FOR WATER SENSITIVE DESIGN

This project has been divided into three modules. The modules are:

1. demonstration case studies of the implementation of water sensitive design to implement water quality management
2. revision of the water corporations urban drainage manual to incorporate water sensitive design and water quality management
3. preparation of a techniques for urban stormwater quality manual

The objectives of the work were:

- to develop techniques and processes to better manage water quality in waterways
- to translate the water sensitive design guidelines into a design manual
- to test and validate methodologies
- to demonstrate and promote the application of water sensitive design

In review the following has been achieved:

- water sensitive design is <u>being</u> implemented through an extensive major strategic level case study by consultants Evangelisti & Associates, Land Vision and V&C Semeniuk Research Group in the Middle Canning Catchment, focusing particularly on the Southern River Forrestdale Banjup area. In addition, the water sensitive stormwater management strategy prepared for the Byford Mundijong Townsites by Evangelisti & Associates are also being promoted as a demonstration case study for implementation in Perth's south east Corridor and elsewhere. A neighbourhood scale case study based on an outline development plan is also underway on Woodlupine Brook in the Shire of Kalamunda's Wattle Grove.
- The general understanding and acceptance of water sensitive design by practitioners involved in the urban development process has made Perth a recognised national leader in integrated water resources management and urban development
- The revision by consultants GB Hill of the Water Corporation's (owner and manager Perth's main drain network) urban drainage manual is in draft form. This work has the potential to improve and continue to improve water quality management as specified required practice.
- Final negotiations are proceeding following advertising and submissions to award the contract to consultants to investigate and prepare the techniques for water quality management manual.

Conclusion

This work is progressing well. The Middle Canning Catchment Water Resources Management Study reflects state of the art implementation of the technology of water sensitive urban design. The techniques for water quality management manual is similarly poised to make a significant contribution to water quality management technique understanding and required implementation in the State.

The Urban drainage manual once completed, will simply require that future drainage construction contracts with the Water Corporation are consistent with best practice. This will be a significant achievement.

The Water and Rivers Commission as project manager is pleased to have been able to participate in the NLP regional initiative, to demonstrate an approach to addressing the planning of key, current, hydrologically complex, water resources management and urban development problem areas, and to provide and incorporporate ecologically sustainable solutions in the government decision making process. It is a very challenging task. We are also pleased to incorporate requirements for better practice in the Urban Drainage Manual and further develop techniques for directing and indeed complying practitioners to using better practice in future. All three tasks will contribute significantly to the health of the Swan River.

2 PID 44 Swan River nutrient project
Project Leader: Dr. Peter Thompson

funding source		+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	CSIRO
date of project start		which projects depend on this one ?	
proposed date of project completion		on which projects does this one depend	
is this project on schedule ?			

Review

EDITORS NOTE:

This project was a coordinating group of Swan River researchers which provided peer review by CSIRO, universities, and WWC officers.

It was disbanded when the Swan River Group led by CWR (Dr. David Hamilton) was set up.

2 PID 56 Turf irrigation and nutrient study
Project Leader: Dave Deeley

funding source	LGA.'s, RAIPR (no State Government Funding)	+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	RAIPR (Royal Australian Institute for Parks & Recreation) AG Woodward Clyde Consultant
date of project start	Stage 1 - 1990 Stage 2 - 1994	which projects depend on this one ?	nil
proposed date of project completion		on which projects does this one depend	nil
is this project on schedule ?			

Review

TURF IRRIGATION AND NUTRIENT STUDY

Background

There is considerable potential to improve the management of irrigated turf on the sandy soils of the Swan Coastal Plain. These sandy soils have very low moisture holding capacities, low fertility and very low nutrient retention capacities. As opposed to heavier soils, managers of turf on the very sandy soils of the Swan coastal plain must provide small regular applications of water and nutrients to optimize turf growth. This means that there is very little margin for error in turf management and water and nutrient applications must be closely monitored in order to avoid under or over application. There are consequently a number of economic and environmental incentives to optimizing turf management.

Differing public usage patterns, turf types and variations in soil types mean that turf managers must develop management strategies appropriate for each particular location. Improved technology permits more accurate determination and application of irrigation water. This combined with comprehensive soil and tissue testing for the main nutrients has the potential to allow turf managers to closely match management programmes to the desired level of turf production for each location.

In 1990 the first stage of the Turf Irrigation and Nutrient Study (TINS) identified several areas where improvements in turf management could be achieved. This second phase of the TINS investigation aims to determine the magnitude, cost and efficacy of improved management practices for irrigated turf on the Swan Coastal Plain. This project was conceived funded and managed through the Royal Australian Institute for Parks and Recreation.

Aim

To produce a Turf Management Handbook for use by managers of irrigated turf on public land. The handbook will identify management strategies closely matching desired levels of turf production for particular locations on the sandy soils of the Swan Coastal Plain.

The second phase of the TINS study aims to achieve the following detailed outcomes;

1. Irrigation

- To gain a better understanding of the turf / water relationship. This understanding will be developed by investigating the following areas;
- Assess crop coefficients (% of EPAN required) for turf noting variations caused by species, soil and climatic conditions;
- Determine the optimum irrigation frequency for various user requirements taking into account soil conditions including non-wetting soils;
- Evaluate the performance of selected turf species under different levels of water stress and at various levels of fertility.

2. Nutrition

- Describe the relationship between soil and plant fertility and plant growth and condition by:
- Continued plant tissue analysis in order to determine nutrient levels required to give desired plant responses on a seasonal basis (NPKS);
- Continued soil testing to support plant tissue tests and to help in establishing optimum fertilizer blends to be used with various soil and turf types; and
- Determining special requirements for micro-nutrients that may be required by turf on the coastal sands

3. Soil Modifcation

- The impacts of soil modifications need to be assessed including:
- extent of nutrient leaching under various soil type / management scenarios
- Minimum soil phosphate retention index (PRI) needed to prevent P leaching
- Costs / benefits of soil amendment for minimization of nutrient leaching and water deep percolation

4. Economic Consideration

- There are costs and benefits associated with various management options which need to be identified. These include:
- Impact of upgrading irrigation equipment and potential offsets in reduced pumpage costs,
- Impact of improved irrigation scheduling

Impacts of improved nutritional regime on fertilizer costs, mowing and renovation costs, potential reductions in ancillary maintenance

2 PID 57 Swan spatial modelling project
Project Leader: Dave Deeley

funding source	NLP, SRT, MDU	+ w = weeks ahead or - w = weeks behind	
expected total cost	$35,000	name of organisation doing the project	SRT
date of project start	1994	which projects depend on this one ?	nil
proposed date of project completion	1996 - 30/06/96	on which projects does this one depend	nil
is this project on schedule ?	yes		

Review

SPATIAL MODELLING OF LANDUSE IN THE SWAN COASTAL CATCHMENT

Background

The Swan River Trust and other agencies have been monitoring nutrient loads to the Swan-Canning estuary for some years. These ongoing investigations have shown that much of the substantial nutrient load originates from the sandy coastal plain soils, particularly the fringing rural areas east of Perth. Investigations have been hampered by an inability to monitor down to the bottom of catchments because of tidal influences in low lying drains. This means that nutrient loads and streamflow for up to 30% of the coastal plain catchment cannot be directly measured and must be estimated.

The Swan River Trust and Curtin University have previously undertaken a collaborative investigation into landuse and nutrient export for the Jane Brook catchment, and the Leschenault catchment. Remotely sensed spatial data offers a cost effective method of assessing landuse over large areas, and Western Australia through the Leeuwin Center is a world leader in the interpretation of remotely sensed data. The Jane Brook and Leschenault catchment investigations used remotely sensed data combined with appropriate ground truthing to develop landuse classification schemes. Landuse patterns were then related to soils information and nutrient loads measured at the bottom of the various sub-catchments.

Waterway managers need to have an indication of the magnitude and spatial patterns of sediment and nutrient loads being delivered to waterways so that the development of appropriate management practices can be prioritized.

Methods and outcomes

Data from water quality monitoring undertaken by the Swan River Trust from 1987-1992 will be summarized for fifteen sub-catchments. Relationships between landuse, soil type and runoff water quality will be established towards an identification of nutrient and sediment export hot spots.

Remotely sensed data (Landsat Thematic Mapper) will be used to develop a landuse classification scheme for Ellenbrook and for other coastal plain catchments. Contour information will be used to generate digital terrain models and to derive slope class information. Digital data describing soil type, clearing history and vegetation status will be combined with landuse and slope information and local expert knowledge to develop empirical relationships between runoff, P loss through soil erosion, and P loss from leaching.

Coarse-resolution, raster-based spatial models developed and calibrated for sub-catchments where water quality information is available will be used to estimate runoff and P loss for ungauged areas. A series of maps showing estimates of runoff and P loss will be developed and published in a technical report at the completion of the project.

Sources and magnitude of nutrient and sediment loads to the Swan-Canning estuarine system will be much better understood, forming a good conceptual framework for the establishment of appropriate water quality targets and management practices.

2 PID 58 Estuarine health indicators
Project Leader: Dave Deeley

funding source	NLP, WRC, MDU	+ w = weeks ahead or - w = weeks behind	
expected total cost	$770,000	name of organisation doing the project	Murdoch University
date of project start	1 Jan 1994	which projects depend on this one ?	nil
proposed date of project completion	31 Dec 1996	on which projects does this one depend	nil
is this project on schedule ?	yes		

Review

ESTUARINE HEALTH INDICATORS PROJECT

Issues

Waterway managers need to define health indicators for a diversity of waterways from streams to large estuaries. Reliable target setting and performance monitoring can only follow a thorough understanding of the relationships between current and historical catchment landuse and trends in runoff and estuarine water quality.

Data gathered during investigations into the state of estuaries and the catchments of the Swan, Peel-Harvey, Leschenault and other southwest systems have been reported on. In the past, funds have not been available to integrate, compare and contrast processes and relationships within the considerable body of information that has been gathered for these systems.

The estuarine health indicators project will assemble and interrogate a large body of existing information. When combined with additional strategic monitoring in other southwest estuaries, this information will form the basis of defining the health status of each, and a provide a framework for setting catchment and estuarine targets.

In short the project aims to evaluate a range of physical, chemical and biological health indicators for selected waterways in southwest Western Australia,

Methods and status

Literature review

An interrogation of the international literature is well advanced. Computer and manual literature searches have been undertaken. Databases searched include; current contents on disk, streamline abstracts on disk, University of Minnesota on-line Gopher facilities. Over 1000 relevant research papers have been obtained and incorporated into a bibliographic database using Endnote software. Preliminary synthesis of the literature has been undertaken, and a draft review document has been prepared.

Historical data acquisition

A vast body of existing data has been catalogued, although historical data availability decreases with increasing distance from Perth. Data include 100 year daily rainfall for a number of stations from Perth to Esperance, streamflow from, in some cases, 1940 to the present, catchment water quality since the early 1970's, and estuarine water quality from the mid-1940s and 1970's. For most south coast estuaries there is no estuarine water quality data and few relevant runoff quality data.

Gathering additional data

Summer and winter field trips to various estuaries have been competed. A planned visit to Fitzgerald inlet in winter was not possible due to very wet conditions and a CALM dieback quarantine requirement. This location has subsequently been dropped from the project leaving 5 sites within each of 9 estuaries and a marine reference location (total of 50 sites).

The completed field trips gathered information describing estuarine physical, chemical and biological processes. Chemical analyses for water and sediment samples have been largely completed and data analysis and reporting is well advanced.

A series of periphytometers (artificial substratum to collect slimy growths in estuaries), were successfully deployed in the Swan, Peel-Harvey, Leschenault , Hardy, Broke, Walpole-Nornalup, Wilson, Oyster Harbour and a pristine ocean reference site at Dongarra. Each estuary has shown distinct differences in periphyton density and accumulation rates, and some discrimination with distance from the ocean is apparent, consistent with prevailing nutrient concentrations.

Zone enrichment investigations are *in situ* experiments where artificial substratum are subjected to a plume of moderately fertilized water to define the responsiveness of the system. Construction and

calibration of the equipment has been undertaken and trials have been undertaken in the Swan, Peel-Harvey, Hardy, Broke, Walpole-Nornalup, Wilson and Oyster Harbours. Periphyton response to zone enrichment was observed in the Swan, Hardy and Oyster Harbours. Little or no response to added nutrients was observed in the Peel-Harvey Broke, Walpole-Nornalup and Wilson Inlets where tannin, reduced or elevated salinities may have influenced periphyton response to added nutrients.

Biological samples (phytoplankton, zooplankton and benthic macroinvertebrates), have been collected and identified and enumerated to the species level.

Data analysis

Preliminary statistical analysis of catchment and estuarine data has commenced. Parametric and non-parametric statistical summaries have been commenced on Peel-Harvey estuarine data from 1945 to 1992 , and on the historical Swan estuarine and catchment data (1945-1995). Nonparametric tests of trend have been evaluated for the historical data record.

Univariate (H', E_p), and multivariate (ABCs, MDS) will be undertaken on phytoplankton, periphyton and benthic macro-invertebrate samples and results of nonmetric multi-dimensional scaling will be related to results of the principal components analysis of physical and chemical estuarine and catchment data.

Data modelling

Time series models have been developed for some catchment and estuarine water quality data. Spatial models describing some key catchment and estuarine processes have been assembled. Validation, testing and further refinement of these models will be undertaken in 1996.

Defining indicators of estuarine health

A range of physical, chemical and biological measures are in the early stages of evaluation as to their ability to discriminate sites between and within estuaries, while integrating over spatial and temporal scales.

Outcomes

- recommendations to Government of a suite of indicators to be used to assess the status and susceptibility of estuaries in the southwest of WA,
- to provide information for catchment and waterway managers undertaking target setting, management planning and performance auditing.

2 PID 59 Phytoplankton ecology project
Project Leader: Was Hosja.

funding source		+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	WRC
date of project start	June 1995	which projects depend on this one ?	
proposed date of project completion	ongoing	on which projects does this one depend	
is this project on schedule ?	yes		

Review

PHYTOPLANKTON STATUS

PHYTOPLANKTON ECOLOGY UNIT SUPPORT FOR SCCP PROJECTS.

Staff: Wasele Hosja, Water and Rivers Commission
Sarah Grigo, Water and Rivers Commission

Collaborators: D Deeley, Water and Rivers Commission
N Dixon, Water & Rivers Commission
M Cousins, Water and Rivers Commission
Andrew Mack, Water and Rivers Commission
Christopher Benson, Water and Rivers Commission

Introduction

In response to increasing phytoplankton blooms, the Swan River Trust had been collecting surface phytoplankton samples from the Swan River estuary from as early as 1978. The first confirmed *Nodularia* bloom in the Swan River at Midland was confirmed by Agriculture WA in December 1981.

Between 1979 and 1987 surface phytoplankton was collected at 5 sites in the Swan River on a quarterly basis and analysed by the Chemistry Centre of WA. Reports of blooms in the Swan-Canning during that period were followed up by opportunistic 'spot' surface sampling of those blooms.

In 1992 a significant fish kill occurred in the Swan River between Rivervale and Guildford, due to severe anoxia of the water column water. In the summer of 1992/93 the SRT monitored the behaviour of the salt water intrusion and for the first time, an assessment of the vertical distribution of phytoplankton, at 6 sites of the upper Swan River between CBD waters and Bassendean at fortnightly intervals.

In 1994, the SRT adopted the strategy of integrated profile sampling for phytoplankton in the water column as a standard in order to reduce the observed variability of surface phytoplankton sampling with respect to the vertical distribution of flagellates. A summary of Swan-Canning historical major surface phytoplankton bloom sampling data was produced (Hosja and Deeley, 1994).

Project aims

Swan / Canning

Collect and analyse integrated (0-5metres) phytoplankton on a weekly basis from the

- Swan River estuary between Bicton and Bassendean
- Canning River upstream of the Kent Street Weir.
- Canning River estuary.

Deliverable

Provide weekly summary updates of Swan-Canning River estuary and Canning River phytoplankton density and composition for the Swan River Trust and to be available for the SCCP-Net projects.

Indicate to relevant SCCP project leaders when phytoplankton blooms are occurring or are imminent.

Achievements and milestones

To assist sample site selection, an orientation cruise was held for interested SCCP project leaders on the 1 September 1995. Participants were provided with maps and summaries of historical physico-chemico and phytoplankton data.

The current integrated phytoplankton monitoring project commenced its second year in June 1995. The project in its current form is ongoing after commencement in June 1994.

The SRT supported a Curtin University honours project in 1994/95 to assess the phytoplankton and nutrient status of the Canning River upstream of the Kent Street Weir.

In 1995/96 the Swan River Trust sampled the integrated phytoplankton of the upper Canning River between Cannington and Langford.

Measurement of spatial and temporal variation in integrated phytoplankton.

Swan

The 1994/95 field sampling program resulted in 33 sampling trips over 9 sites. Up to mid-March 1996 of the current 1995/96 programme, 35 sampling trips have beef Kent St Weir.Sampling of phytoplankton at 8 sites upstream of Kent St Weir has been carried out weekly since 26 October 1995. A total of 22 trips have been carried out up to Mid March.Summary data of the current phytoplankton monitoring project for the first 5 months of the current project will be available by April 1996.Canning River EstuaryThe Swan River Trust has been collecting integrated phytoplankton samples from two sites upstream of Riverton Bridge. A total of 22 trips have been carried out up to mid-March.Summary data of the current 1995/96 Canning estuary phytoplankton monitoring project will be available by August 1996.OutcomesSwan River estuaryNo cyanobacterial blooms were recorded in the Swan River estuary between 1994-1996. There have been a series of blooms in the Swan River Estuary mostly due to phytoflagellates. Timing and the difference between integrated and surface sampling were highlighted on a number of occasions in January and February 1996. Intense surface blooeasonal changes in abundance and distribution, and diel changes in the vertical distribution of crustacean zooplankton in the Swan Estuary.

2. To determine the grazing rate of dominant species of crustacean zooplankton feeding on dominant species of phytoplankton, and assess the adequacy of these phytoplankton species as food for crustacean zooplankton, in terms of survival, growth and fecundity.3. To determine the rate of faecal pellet production by dominant crustacean zooplankton, the pellet settlingm discolouration due to the aggregation of flagellates at the surface were observed in the afternoon though not evident in the morning. The integrated samples provided a better weekly barometer of phytoplankton populations.

Upper Canning River

There have been minor occurrences of cyanobacteria in the Canning River with *Anabaenopsis*, *Microcystis*, *Anabaena* and *Oscillatoria* present. No significant cyanobacterial blooms have occurred.

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GROUP 3

Catchment Management

3 PID 25 Ellen Brook catchment management plan
Project Leader: Wes Horwood

funding source	SCCP	+ w = weeks ahead or - w = weeks behind	
expected total cost	$401,000	name of organisation doing the project	Swan River Trust
date of project start	April 1995	which projects depend on this one ?	Swan Avon Regional Initiative
proposed date of project completion	April 1998	on which projects does this one depend	Swan Avon Regional Initiative
is this project on schedule ?	yes		

Review

Project objective

To reduce the nutrient load to the Swan-Canning Estuary from the Ellen Brook catchment as well as improving the environmental health of the area.

This is being achieved through development of a catchment management plan that contains a series of recommendations and strategies that address local environmental concerns. Extensive community, local government and State agency involvement is part of the process to ensure strategies are widely accepted and conflict is minimised during implementation.

Project review

Stage one of the project called for the identification of issues, consultation with relevant authorities and interest groups and the involvement of community groups in collection of information.

Relevant authorities and community groups have been contacted, informed about the project and asked if they would care to take part in the process.

A preliminary meeting was held in the Chittering Shire offices to see how the community in Ellen Brook wanted to proceed. The result of this meeting was the formation of the Ellen Brook Integrated Catchment Group (EBICG).

EBICG has strong support from the three local governments of Chittering, Gingin and Swan as well as strong backing by the Chittering Valley Land Conservation District Committee. Other groups in the catchment including the Gingin Land Conservation District Committee, Ellenbrook Reserves Group, Swan Valley Noongar Community and the Chittering Ratepayers Association are also actively involved.

The State agencies of Agriculture WA, Water and Rivers Commission, Conservation and Land Management and Ministry for Planning are represented on the EBICG. Other agencies such as Main Roads, ...RAAF, CSIRO have nominated contact people should EBICG need their input.

EBICG first met in late January and has been meeting on a monthly basis since. At the first meeting EBICG resolved to produce an Issues Paper within three months. The preliminary meetings have been setting the direction for the group and establishing the goals it will be pursuing. The Issues Paper is likely to be produced on schedule.

A significant amount of information relating to this catchment has also been collected. As far as possible information has been accessed in digital form for easy storage and retrieval. This information includes:

- Hydrology and Hydrogeology
- System 6 vegetation
- Current landuse
- Road and cadastral information
- Landsat/SPOT TM imagery from 1995
- Metropolitan Region Scheme
- Federal, State and local government electoral boundaries
- Soil types
- 1995 aerial photography
- Wetland information

Series of maps have been generated using this information for use with the community and local government to identify the area of concern and aid in the location of specific details.

More than 60 projects related to natural resource management in Ellen Brook have been identified as currently underway in the catchment. EBICG will be looking at these projects to make suggestions to the relevant people to ensure maximum benefit from the projects.

Stage one of the project has progressed quite well. Community groups are aware of the process that we are embarking on and have indicated strong support. Local government are also very keen to see the process succeed and have come on board. Stage agencies have also responded positively which bides well for success.

Stage two, which is the clear identification of issues and development of strategies to address these issues is about to begin. So long as the participants continue to feel they are or will gain from the process this stage should proceed without undue difficulty.

The Ellen Brook Integrated Catchment Group is a very positive, progressive group. This group has the potential to be as successful as the Blackwood Catchment Group in the south-west.

3 PID 26 Upper Canning catchment plan
Project Leader: Nicole Siemon

funding source	NLP	+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	SRT
date of project start		which projects depend on this one ?	
proposed date of project completion		on which projects does this one depend	
is this project on schedule ?			

Review

UPPER CANNING RIVER CATCHMENT PLAN

Description:

Preparation of a catchment plan for the upper Canning River Catchment to address issues such as siltation and weeds. Preparation of the plan will involve extensive community, local and State government involvement at all stages of the planning process.

Aims:

The catchment plan will:

- Provide an inventory of the river environment and its degradation problems.
- Involve community groups and relevant authorities in developing recommendations to improve the river's health.
- Provide guidelines on rural and urban activities such as fertiliser use, revegetation to control erosion and rehabilitate streams and wetlands, and fencing remnant vegetation and streams from stock.
- increase community awareness about the causes and solutions to the environmental problems of the river environment.
- Include an implementation plan.
- Coordinate community involvement in collecting information, identifying issues and solutions and implementing recommended actions in the plan.
- Liaise with relevant authorities and interest groups throughout development of the plan.
- Contribute to promotion of this plan, threats to the rivers health and actions people can take, through media, education campaigns, publications, demonstrations and displays, events.
- Provide information to meet community needs, through publications, workshops, answering enquires.
- Support community involvement in catchment and river management through providing advice, training opportunities, and information, fostering networking, and supporting school involvement in Ribbons of Blue and other action-based education initiatives.

Milestones achieved:

- Establishment of the Canning Catchment Steering Group to coordinate catchment management in the Canning Catchment.
- Creation of extensive links in and between community groups, State and local government authorities and the SRT.
- Weed control and management workshops raising awareness of river issues such as weed control. Development of a weed control program for private and public land.
- Advise on weed control, provide speakers or information on general land management and issues on concern. This indicates that the press releases and other promotional activities are reaching the targeted audiences.

Future actions:

Communication and liaison

- Continue to cultivate and strengthen communication links between the SRT, community, local and State agencies to encourage catchment awareness.

Continue promotional activities to reach the community at large who aren't affiliated with groups through displays which are tangible to people living in the catchment ie. aerial photograph DTM overlays, stencilling drains, shopping centre displays.

Information release

- Finalise and release pamphlet outlining river processes with a focus on water and silt management for residents abutting the river and a similar one for catchment members.
- Develop guidelines for residents living on the river.
- Develop technical guidelines for local government and Ministry for Planning to assess subdivision design from a water and soil conservation perspective, ecological perspective and stabilisation of development sites.
- Liaise with Main Roads Department and Council to place "Welcome to the Canning River catchment" signs put up at strategic locations.
- Prepare and circulate guidelines for developers about SRT requirements in subdivision plantings.

Catchment issue discussion groups

- Forming issue discussion groups under the Canning Catchment structure to facilitate the development of the catchment plan, prepare issue papers and develop strategies to manage the issues.
- Prepare catchment plan with a detailed river rehabilitation plan.

Activities

- Develop timeline of activity days for 1996 with community groups.
- Commence implementation of a coordinated water quality monitoring programme between Ribbons of Blue, schools, Council, SRT and community groups.
- Continue programme for training groups and individuals in weed management and river processes by holding training days, field days and developing demonstration sites.

3 PID 29 Urban landcare
Project Leader: Louisa Barnacle

funding source	SCCP	+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	SRT
date of project start		which projects depend on this one ?	
proposed date of project completion		on which projects does this one depend	
is this project on schedule ?			

Review

Description:

This role of this position is to guide community, local government and any formalised catchment management groups to facilitate better understanding of waterways and catchments. The role also involves consultation with Agriculture of WA, Water and Rivers Commission, Water Corporation, Ministry for Planning, local government authorities and Department of Environmental Protection.

The Swan River Trust has already been working closely with local government assisting them in identifying sources of pollution within their local catchments and developing an integrated approach to resolving any issues. Many of these local authorities are at stage where they need to use technical data as a basis for an integrated management process.

In addition there are a number of community groups established with similar objectives. These groups are requesting assistance in managing their local foreshore and waterway areas. Consequently it is desirable to link these groups in a coordinated manner to other catchment groups.

Aims

The aims of the project are:

- To assist in the process of integrated catchment management.
- To facilitate the exchange of technical information between government agencies, local government and community groups.
- To assist groups in identifying and resolving catchment management issues;
- To identify roles and responsibilities of the players involved in local catchment management of the study area and establish a data base of this information;
- To prepare a document outlining the local areas involved, process used and outcomes achieved.
- To encourage individuals and community groups to become involved with local authorities and government agencies to develop and implement local area integrated catchment approaches.
- To promote the concept of integrated catchment management.

Milestones achieved:

- Contributions to establishment of the Bannister Creek Group to lead to development of a Catchment Management Committee to coordinate activities to improve the water quality and address issues such as water quantity, planning and vegetation management.
- Creation of extensive links in and between community groups, State and local government authorities and the SRT. These communication links are enabling some issues to be dealt with in a proactive manner, keep Council and SRT staff up to date with community concerns about things happening within each municipality which could impact on the river. It also allows dissemination of information to improve the efficiency of group activities such as rehabilitation programs etc.
- Contribution to establishment of the Belmont Main Drain Catchment Committee. City of Belmont, SRT, Ascot Waters, WATC, Catchment Management Branch of Department of Environmental Protection and Water Corporation meet monthly or bi-monthly to focus on water quality issues in Matheson Road Drain and discharge through Ascot Waters development.
- Implementation of the Bayswater Integrated Catchment Management Plan is continuing with SRT support.
- City of Canning Integrated Local Area Planning Study resulted in publication of urban landcare manuals and a proposal to redevelop the City of Canning Town Centre. City of Canning is now looking to employ a Catchment Officer.
- Contributing to the development of successful funding applications by community groups.
- Assist in the development of a Hills Catchment Management Plan and contribute to the implementation of a public consultation process.

Future actions:

Communication and liaison

- Continue to cultivate and strengthen communication links between the SRT, community, local and State agencies to encourage catchment awareness.
- Continue promotional activities to reach the community at large who aren't affiliated with groups through displays which are tangible to people living in the catchment ie. aerial photograph DTM overlays, stencilling drains, shopping centre displays and pamphlets.

Information release

- Finalise and release pamphlet for suitable species for rehabilitation projects within each municipality.
- Stencilling program information.

Catchment issue discussion groups

- Continue to encourage and facilitate the formation of catchment management groups involving all aspects of the community, local and state government and industry.

Activities

- Develop timeline for sharing stencilling kit amongst school and community groups.
- Assist in the implementation of a coordinated water quality monitoring programme between Ribbons of Blue, schools, Council, SRT and community groups.
- Coordinate programme for training groups and individuals in regional seed collection, weed management and river processes by holding training days, workshops and field days.

3 PID 31 SCCP community relations
Project Leaders: Karen Majer & Tim Larcombe

funding source	SCCP	+ w = weeks ahead or - w = weeks behind	
expected total cost	$1995/96 $78,000	name of organisation doing the project	Swan River Trust
date of project start	Feb 1995	which projects depend on this one ?	none
proposed date of project completion	Dependent on continuing funding	on which projects does this one depend	Informative product depends on the outcomes of all projects
is this project on schedule ?	yes		

Review (includes PID 32,33,34,35)

SCCP COMMUNITY INVOLVEMENT AND AWARENESS

Objectives

The objective is to raise awareness and support community involvement in river and catchment management by:

- providing timely and relevant information about the Cleanup Program,
- presenting the outcomes/progress of the Program through technical and community forums, and providing opportunity for debate on future directions,
- supporting community groups and other key stakeholders through training, advice and information to help them to care for the river environment and become involved in catchment management,
- promoting the activities of the Cleanup Program and raising awareness in the general community of river health, local issues and opportunities to get involved.

Progress to date

A Community Relations Officer was appointed in February 1995.

Publications (PID 32)

Major project publications to date include: SCCP program document *Action for the Future*; bi-monthly newsletter *Riverview* (6 issues); Catchment Management Series Nos 1, 2, & 3. Objectives of "timely and relevant" information will increasingly depend on the outcomes and milestones of other projects and their summary in publicly consumable form. Major planned milestones include a video *Living with Streams* , (joint project with Water and Rivers Commission), launch scheduled for World Environment Day, 5 June 1996. Upcoming publications: SCCP-Net document available for Technical Forum, April 12; Directory of community groups; *Algae Alert! Algae Blooms in Estuaries of the southwest of WA*, booklet; Don't let your river go down the drain, A3 poster.

Forums (PID33)

The Technical Forum on 12 April 1996 is a major SCCP milestone – occurring 2 years since the launch of the program in May 1994. Conservation groups working to protect the river environment and other community groups will be supported and informed of SCCP progress at World Environment Day, 5 June Community Forum.

Training and support (PID 34)

Opportunities for community groups to access funding to attend training courses, and speakers fees to enhance information exchange between groups, have been widely promoted through Riverview and other environment newsletters. One project has been sponsored to date. Feedback from this City-Rural ICM exchange, organised by the Bayswater Integrated Catchment Management, was very positive. One-off training work-shops organised by the Trust's SCCP team have been successful in the past. However there has been little community response to the offer of training grants and there is a need to review community needs and interest in this area so that the Trust can direct resources where they will be most effective.

Community awareness (PID 35)

A media/promotion strategy for the Cleanup Program was developed 1994. Activities to date include: media releases, bi-monthly newsletter; mediawatch analysis of program profile and river issues; community talks; displays and promotional events to raise community awareness of the program; distribution of information including catchment management pamphlets and SCCP *Action for the Future* document; radio and newspaper features promoting activities of project staff and community groups involved in river restoration. Highlights include: World Environment Day and Water Week river

cruises; Earth 2000 column *Riverwatch*, a display on the Swan River and issues in its catchment mounted at the State Landcare Conference, Royal Show and various other locations including local councils, agriculture society shows and shopping centres. Although no evaluation of the level of media and community awareness of the program has been undertaken to date, it is believed that the profile of SCCP and river health issues, particularly algal blooms, has been significantly raised.

3 PID 36 GIS mapping
Project Leader: Brett Harrison

funding source	SCCP	+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	SRT
date of project start		which projects depend on this one ?	
proposed date of project completion		on which projects does this one depend	
is this project on schedule ?			

Review

GIS MAPPING

Even though the SCCP has been running for the past 18 months, the last six months that have seen an increasing demand from SCCP members for their mapping requirements. During this time, the mapping area has been busy capturing important data sets that will no doubt be used as base information for future SCCP mapping.

In November/December 1995, three students from UWA spent a good proportion of their holidays capturing data and converting it into a digital format. Their focus was on three catchments (Ellen Brook, Southern River and Upper Canning River) that have suffered severe degradation due to human settlement. By using aerial photography (Jan 1995) they have been able to capture major and minor watercourses , ridge lines, dams, quarries and mines for the Ellen Brook Catchment. The data was cleaned in February and is awaiting a ground truthing exercise that should take place in the near future.

The students also assisted in the capture of landuse information for these three catchments. It is a detailed landuse study whereby each lot within the catchment has been categorised and given a landuse code. This code is a number (max. 4 digits) that has been taken from the Western Australian Land Use Code (WASLUC) endorsed by the Ministry of Planning. The landuse was taken from aerial photography and entered into a ORACLE Database with a linkage to a Microstation graphics design file. Like the streamline dataset for the Ellen Brook Catchment, the landuse information is awaiting further ground truthing.

One of the questions being asked is how this information can be accessed? For example, catchment officers working with SCCP have reached a stage whereby they would like to access information that has been captured or obtained from other Government Depts and community groups. They would like to view the information and also overlay various themes of data to answer questions they might have about their area of interest.

eg. BASE - Cadastre, then overlay landuse information and hydro detail.

To help design a basic framework to access these datasets, I have been working with other Government Depts to help set up a graphical query system. The outcome has been that there will be a dedicated machine in the SRT with software that can perform these queries. The system is Windows based and will require only about one hour of training for staff. If all goes well, the system will be in place and running by the end of March or early April.

In the last four months, we have been working closely with the Dept. of Transport in the capture of depth soundings for the Swan / Canning Rivers. The capture was completed in February 1996 and the data is being cleaned by the Dept. of Transport. A copy of the data should be available by the end of March.

January saw the preparation of Digital Terrain Models for Ellen Brook, Southern River and Upper Canning River Catchment. All were created with the assistance of the WALIS (West Australian Land Information System Office) Office. SPOT satellite imagery has been purchased from the DOLA Remote Sensing in Floreat and will be draped over the models.

The next six months look equally exciting and challenging as the previous. I have to mention that without the assistance of Government Departments such as WALIS, DOLA, AWA and Transport, a lot of these projects would not have got anywhere. I would like to thank them for their assistance.

3 PID 38 Bayswater Integrated Catchment Management
Project Leader: Rosemary Glass

funding source	LGDP & NLP	+ w = weeks ahead or - w = weeks behind	-14 -52 on commuinity feedbak
expected total cost	$150,000	name of organisation doing the project	BICM implementation committee
date of project start	LGDP 1/5/94 (.5 time) NLP 1/5/95 (full-time)	which projects depend on this one ?	none
proposed date of project completion	Oct 1997	on which projects does this one depend	none
is this project on schedule ?	No for the development of a 5 year implementation plan, Yes for the implementation of the strategy.		

Review

BAYSWATER INTEGRATED CATCHMENT MANAGEMENT

Project objectives

Originally proposed

1. Develop an implementation plan for the strategy that identifies the opportunities and constraints related to each recommendation, for an initial five year time span.
2. Obtain a full time officer to ensure continuity and facilitate the high profile of the project so that it will not be shunted down the priority ladder of other organisations.
3. Hold discussions with agencies and stakeholders to establish priorities for allocating resources in budgets.
4. Initiate a community project each year.
5. Use experience gained through development and implementation of the Bayswater ICM Strategy as a model for other urban catchments within the Perth metro. area.
6. Coordinate implementation to ensure that resources are directed effectively and efficiently and that the aims of the strategy are achieved in an organised rather than ad hoc way.

Review of project

Schedule

The original schedule did not anticipate the transition phase needed between the old steering commitee and new implementation committee who took on a new, undefined role with nearly all new members including new leadership and a new coordinator. This initially consumed a lot of energy while the new BICM gained their own identity.

Progress report

The original works plan or time schedule:	***Actual outcome:***
Engage Coordinator	Coordinator commenced 1-5-1995.
Review opportunities and constraints for 72 rec.s.	Not done as rec.s rewritten as projects.
Develop priorities for implementation.	C'tee priorities obtained initially, however, priorities for projects being reviewed.
Develop a five year implementation plan.	Not complete. Being done for projects.
Conduct workshops to increase community knowledge and understanding of BICM	Not done as inappropriate until know the plan for implementation better Community Task Group planning a schedule of reporting back to residents and a community survey is scheduled for 1996. A team building or belated induction workshop held Sept. 95 for BICM c'tee.
Identify and commence a community project.	5 held over 2 years. Numerous current.
Seek adoption of the IP by agencies.	Visiting mayors to introduce IP and approaching council and state agency staff to achieve projects. Receiving positive responses.

Negotiate budgetary allocations from agencies.	Ongoing for projects and components of projects.
Review appropriateness of recommendations.	Ongoing. Rewriting 72 rec.s as 7 overall projects linking related and dependent recommendations.

Outcomes progress report:

1. Implementation of the catchment management plan.

- Three task groups have formed to concentrate on the more important roles of the main committee.

2. Improved quality of non point source water.

The residential area of the catchment was given highest priority by the Water Authority for deep sewerage infill. This will result in 80% of the catchment being deep sewered.

Two related projects currently being pursued are:

- Trial revegetation of the drain channel and banks and pursuit of policy change by Water Corporation on piping drains. The aim is change management of the drain for water quality.
- Pursuit of deep sewerage of the light industrial area which forms most of the remaining 20% of the catchment. It is being reviewed to determine demand and cost for deep sewerage, plus options for onsite treatment.

3. Increased community awareness and action.

Reporting back to the community being planned for this year. A community attitudes survey is also scheduled, plus surveying of residents alongside proposed planting sites.

Ongoing awareness raising through media articles on BICM, media coverage of events, articles in environmental newsletters, presentations and catchment tours for conferences, visitor and student groups. Runner up in State Landcare Living Streams Award.

Two catchment group exchanges: Swan-Avon eastern and metropolitan groups, hosted by BICM; BICM and the BCCG.

4. Cooperation between agencies and community groups.

Being achieved for components of planting projects. The 7 overall projects are too underdeveloped to pursue further as yet.

5. Local government adopting and implementing the principles of catchment management.

Adoption by Bassendean Council of BICM Strategy and the Water Authority's WSUD Guidelines as council policy.

Stirling Council adoption of the living streams approach to all their drains, lakes and compensation basins.

Bayswater Council planning division agreed in principle to incorporation of ICM and WSUD principles into the objects of the town planning scheme.

A task group will form in 1996 to pursue common ICM and WSUD policies, through TPSs and other planning processes in the three councils.

6. Increased natural ecosystem and biological diversity through establishment of wetland filters and creek features.

Two wetland filters established and one 200m section of drain bank `streamlined' in Bayswater.

Stirling Council has planned and budgeted for all its comp. basins to be redesigned as wetland filters.

Bassendean Council reviewed one wet and one dry basin for planting for nutrient and groundwater uptake.

The Water Corporation and councils have agreed to trial three 100m sections of drain to be entirely planted as creek features in 1996 with the view to considering revegetation of the entire drain within flood control restraints in the long term.

7. Reduction in the quantity and improved waste water discharge from industry.

Possibilities for deep sewerage and onsite treatment are currently being pursued by the Water Corporation and Bayswater Council.

8. Implementation of WSUD principles in reducing the quantity and increasing the quality of water within the drainage system.

See points 5, 6 and 7.

9. Increased public access to drainage reserves.

Not being specifically pursued yet. Agreement from Water Corporation to review fencing requirements for drains.

10. The development of a community based catchment management group.

BICM has recently formed its community task group consisting of its community and conservation representatives.

11. Implementation of the Strategy.

Ongoing as shown above.

3 PID 39 City of Canning ILAP study
Project Leader: Tom Davis

funding source		+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	
date of project start		which projects depend on this one ?	
proposed date of project completion		on which projects does this one depend	
is this project on schedule ?			

Review

CITY OF CANNING INTEGRATED LOCAL AREA PLANNING PROJECT, 1994/96

The City of Canning wished to foster Integrated Management for the Canning River catchment at a time when little assistance was available and "Political will" attached to environmental matters was not strong.

The City knew, through its joint study with the Swan River Trust titled "Canning Urban Drainage Study - October, 1994", that the river was indeed polluted (the river in fact suffered blue/green algae in 1995). With the advent of the main sewer crossing over Albany Highway, to service relatively undeveloped areas of Cannington, East Cannington, Queens Park and parts of Welshpool, Council was concerned for the prognosis of "more of the same" when landowners exercised their development rights. Obviously, input of pollution from upstream was also a growing concern. This then led Council to seek support from the relevant Local Governments. A $40,000 grant to conduct a study was obtained from the Commonwealth Department of Housing and Regional Development. The study was to report on findings investigating urban ICM matters appropriate to a Local Government and Community perspective, and produce a "model" for others to utilise and follow.

The resultant Canning ILAP Study utilised environmental consultants plus a Steering Committee, comprised of Council officers, Government Agency staff, elected Council Member and, most important, business and residential Community representatives. The Study activities focussed on community consultation and input in accordance with "ILAP" principles. Apart from community representation on the Steering Committee, a search conference identified the concerns of the community at large and of the stakeholders. Towards the end of the study an information evening presented findings of the study. A key outcome of the community involvement was the identification of the "River as the heart of the City of Canning" and the view that solutions were needed on a catchment scale.

A major element of the study was the preparation of a Handbook titled "Urban Integrated Catchment Management: A Handbook for Local Government and Community Groups". This represented the "model" required of the study. This Handbook is designed to inform local authorities and community groups about Urban ICM, its components and how a process operates.

The study also chose a precinct for closer examination of opportunities and more detailed design in application of Water Sensitive Design principles. The Canning Regional Centre was chosen, even though possibly being the hardest option. Suitable strategies were developed by the consultants and strongly supported by the community.

The Canning ILAP Study was considered highly successful by the City of Canning and the Department of Housing and Regional Development. The project was able to achieve positive physical outcomes and innovative design concepts. An additional benefit was the level of integration and communication developed by planners and service managers.

Enquiries can be directed to:

Environmental Health Service, City of Canning, 1317 Albany Highway, Cannington WA 6107
Ph 231 0661, Fax 458 2353 (Handbook cost including p&h $10)

3 PID 40 Ribbons of Blue (Swan)
Project Leader: Susan Worley

funding source	NLP, in kind support from WRC sponsorship WC	+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	WRC
date of project start	secondary coordinator position early 1994, primary coordinator position 1994	which projects depend on this one ?	
proposed date of project completion	ongoing	on which projects does this one depend	
is this project on schedule ?			

Review

RIBBONS OF BLUE (SWAN REGION)

Project objective

The Swan Region Ribbons of Blue Project is part of the State-wide Ribbons of Blue strategy, and conforms to its overall objectives of promoting awareness of and involvement in water quality matters. There are two NLP funded coordinators on the project team, a Primary teacher, and a Secondary teacher, both working for three days a week. The focus of the program is on urban catchments, with major involvement from school groups involved in community and local government projects. Teachers are encouraged and assisted to link up with local area activities, as well as to increase students' knowledge, skills and awareness through an increased curriculum emphasis on water quality.

Objectives

To promote and support school and community involvement in water quality monitoring using physical, chemical, and biological parameters.

To maintain a State-wide data base to encourage formulation of action strategies.

To facilitate development of Ribbons of Blue projects from the monitoring stage through to:

- successful integration into school curricula, and school development plans.
- successful linkage between school, community, local government and Swan River Trust in local area Waterwatch projects.

To support the State-wide programme through provision of training courses, procedures, equipment and resources.

Review of project

Over the last year coordinators have supported school and community groups through field or class visits, working with the teacher/group leaders to develop a customised long term strategy. At present there are 60 Swan region schools actively involved in Ribbons of Blue either through a year long monitoring project, or a water quality focussed curriculum project. Additionally, six community groups submit data to the ROB data base.

In Jan 1996 Ribbons of Blue commenced a joint project with SRT to monitor three urban catchments on a monthly basis - Ellen Brook, upper Canning, and Southern River. Schools, community groups and individuals will submit data, and the results are to be analysed and returned to participants to provide a basis for future catchment activities. At present joint projects are being developed with two local governments, additionally there are joint school - local govt projects which no longer require ROB support.

The Swan project team conducts a six hour introductory training course each term, and shorter workshops are conducted for AAEE, teacher associations, and individual schools. The courses cover background to water quality issues, sampling and investigation strategies, use of equipment. and educational strategies. Coming up in April is a three day advanced level course with teacher, community group, and local government participants. The course is based on presentations from WRC staff, and is one example of the strong support provided by the Agency for Ribbons of Blue.

Highlight of the last year was the national Waterwatch snapshot sampling day on 25th October. There was a gala ministerial launch on the Canning River, schools from around the state assessed their local waterways by monitoring for macroinvertebrates, and the results and stories from the day were published in a national paper used to promote the Waterwatch/Ribbons of Blue programme. This successful event will be repeated in 1996, with a State paper to promote Ribbons of Blue and acknowledge sponsors.

The focus of the project for the next year is to consolidate rather than expand.

The project is ongoing and relies on NLP funding, in-kind support from Water and Rivers Commission, and sponsorship from the Water Corporation.

3 PID 42 Swan Avon ICM (resource centre)
Project Leader: Karen Majer

funding source	NLP with support from Government agencies	+ w = weeks ahead or - w = weeks behind	
expected total cost	1994-1998 $498,000 (NLP)	name of organisation doing the project	Water and Rivers Commission project managed by Swan Working Groups
date of project start	1994	which projects depend on this one ?	none
proposed date of project completion	NLP funding to June 1998, project ongoing beyond that time subject to funding	on which projects does this one depend	closely linked to Avon Resources Centre and SCCP Community involvement and awareness
is this project on schedule ?	yes		

Review

SWAN NETWORK

PART OF THE SWAN AVON RESOURCE CENTRE PROJECT

The project is establishing a "network" to provide a focus for supporting community involvement in Integrated Catchment Management in the Swan-Canning Catchment.

Objectives

The aim is to:

- Link Government, local government and community catchment management initiatives.
- Provide a "one-stop-shop" for public enquires at an "Information Exchange".
- Provide an accessible centre for information, data bases, maps and demonstrations of innovative technology.
- Provide a working base within the community for urban and rural landcare facilitators (eg. those appointed as part of the Swan and Canning Rivers Clean-up Program and ICM Program).
- Support community groups and individuals to undertake catchment management and rivercare projects by providing access to information, advice, computer networks and support.
- Provide a focus for linking Swan-Avon Catchment initiatives through links with an Avon Resource Centre and cooperative projects and information exchange

Progress to date

Year 1 (1994-95): Community Consultation

The original proposal was based on setting up a staffed resource centre.

Firm planning of where and how the centre would operate was dependant on community consultation to find out what the community wants, and identify opportunities to support or add to existing facilities or programs rather than to develop new "bricks and mortar" facilities.

In early 1995 consultants were employed to consult the Perth community to:

- identify needs and opportunities to support the community to become involved in planning and management of the environmental resources within the catchment, and
- make recommendations on the best ways to provide that support, initially through funding made available under the Swan-Avon ICM Program.

The consultants organised search conferences to gather information from key stakeholder groups (community bodies, education groups, tertiary and research institutions, volunteer groups, local and state government, recreation groups, commerce etc). They also conducted additional interviews with key groups and individuals, and took written "guided submissions". The project was advertised, including in local newspapers, to invite input from the general public and raise awareness of the issues. A model for the "centre" was developed on the basis of the community input. The model is better described as a "network" than a "centre", incorporating a central information exchange, linked to several "shop fronts" where people can access displays and information. A key factor is the role of Government and non-government Catchment Coordinators, who work with the community, especially through Catchment Coordinating Groups. The network will help raise the general community's knowledge of and involvement in the relationship between catchment activities, rivers and estuaries.

Year 2 (1995-96): Implementing the Network

The second stage of the project, in late 1995, involved developing the Stage 1 recommendations into costed and workable options for implementation. The Stage 2 consultancy resulted in negotiation of a lease of the eastern ground floor wing of the old Fisheries Building at 108 Adelaide Terrace as the network centre.

As at March 1996, the Stage 2 Consultants Report has been accepted by the Swan Avon ICM Coordinating Group and Centre establishment is being organised, including fitout and furnishing. The job of Network Coordinator will soon be advertised. Commitments of funding, staff, equipment and other support are being negotiated. It is anticipated that the Network will begin operation in mid 1996.

3 PID 43 Swan Avon ICM (communication support)
Project Leader: Karen Majer

funding source		+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	multi-agency (State & local government and community), has been coordinated by Water and Rivers Commission
date of project start	May 1994	which projects depend on this one ?	none
proposed date of project completion	ongoing	on which projects does this one depend	closely linked to Resource Centre Projects and SCCP Community involvement and awareness
is this project on schedule ?	yes		

Review

COMMUNICATION SUPPORT GROUP

Objectives

To advise the Swan Avon ICM Coordinating Group on communication strategies for the Program to:

- promote community interest, awareness, and support for ICM as a tool to achieve sustainable land and water management, protection of natural ecosystems and biological diversity, and increased community well-being,
- provide full and open access to information,
- promote understanding of ICM - what it is, why it is important, and opportunities for involvement,
- facilitate communication between community groups, local government and government agencies involved in ICM, and
- provide information, coordination, networking and involvement opportunities to support community participation in ICM,
- This is closely linked to the Swan and Avon resource centre/network projects.

Progress to date

A working group was set up in May 1994 to bring together people involved in developing Swan-Avon ICM projects with community representatives to facilitate development of community involvement aspects of the Swan-Avon ICM program and ensure that they are linked with the Swan-Canning Rivers Clean Up Program (State Government funding). The group initially provided a forum for information exchange and coordination of community involvement aspects across projects, including community awareness, information, school education, and community consultation and participation. The group has met regularly to share information as the projects have developed and consider overall communication needs. It has refined its terms of reference and adjusted membership accordingly.

The group has the following terms of reference:

1. Advise on community consultation for setting up the Swan ICM Resource Centre. (Completed).
2. Provide advice on communication strategies to the ICM Coordinating Group, based on community consultation feedback.
3. Ensure that publications and communications are consistent in their overall image, symbolism and message.
4. Ensure that community interface aspects are linked at the project level (including opportunities for interaction on NLP and broader ICM projects).
5. Provide backup, support and advice on community participation processes to assist project managers to carry out the most effective methods.

The group represents the Water and Rivers Commission, Agriculture WA, Conservation Council, Avon River Management Authority, Department of Environmental Protection, Swan River Trust, Soil and Land Conservation Council, and Local Government (WAMA).

The Communication Support Group prepared and coordinated implementation of a short-term communication strategy to inform key stakeholders about the Program in its early stages. This included briefings, media releases, a project managers forum and distribution of a leaflet. A long-term (3 years) communication strategy for the Swan Avon ICM Program has been developed. Communication

activities have been recommended, and priorities identified through consultation with the Swan and Avon Working Groups. A contract Communication Officer has begun priority tasks including a project update newsletter, booklet on the ICM Program, and organising a function to introduce the Swan Avon ICM Coordinating Group. A full-time Communication Officer position will be advertised soon.

Communication about ICM in the catchment involves many organisations and projects, including the Swan and Avon Networks which will play a key role in community support and networking. Implementation of the communication strategy will depend on working together. The Communication Support Group will continue to play a role in linking ICM projects and encouraging joint approaches.

3 PID 50 Southern River catchment management plan Project Leader: Wes Horwood

funding source	SCCP	+ w = weeks ahead or - w = weeks behind	
expected total cost	$401,000	name of organisation doing the project	Swan River Trust
date of project start	April 1995	which projects depend on this one ?	Swan Avon Regional Initiative
proposed date of project completion	April 1998	on which projects does this one depend	Swan Avon Regional Initiative
is this project on schedule ?	yes		

Review

Project objective

To reduce the nutrient load to the Swan-Canning Estuary from the Southern-Wungong River catchment as well as improving the environmental health of the area.

This is being achieved through development of a catchment management plan that contains a series of recommendations and strategies that address local environmental concerns. Extensive community, local government and State agency involvement is part of the process to ensure strategies are widely accepted and conflict is minimised during implementation.

Project review

Stage one of the project called for the identification of issues, consultation with relevant authorities and interest groups and the involvement of community groups in collection of information.

Relevant authorities and community groups have been contacted, informed about the project and asked if they would care to take part in the process. The community groups expressed support for such a project. However they indicated that there are significant restrictions on the time they have available to become heavily involved. Most community groups are specific area based, that is they have an intense interest and knowledge of a particular location but limited appreciation of what is happening in other areas of the catchment. With few exceptions, they operate in relative isolation with little time or money to allow them to easily take an interest in other areas. Networking is limited to a few key people with the bulk of the groups having little exposure.

Local government staff who have been contacted are keen to take part in the ICM process. Many recognise they have to work closely with other local governments, the community and agencies to get things done. Despite the apparent support from the staff both Armadale and Gosnells City Councils have failed to formally endorse the project. This appears to be due to uncertainty about the implications of these projects on the councils.

The major area of concern is due to the perception that most of the responsibility (and cost), as a result of the catchment management plan, could be placed on the councils with no equivalent increase in funds. Many councillors have difficulty seeing the potential benefits of integrated catchment management and have tended to focus on the potential negatives instead. However, despite this weariness Armadale and Gosnells councils have both nominated councillor and staff representatives for a Project Group to work on developing the catchment management plan.

The Southern-Wungong River Catchment Management Plan Project Group will meet for the first time in March 1996. The membership of the group consists of representatives from community groups, local government and, in time, will also include key State agencies. Other State agencies will be asked to nominate contact people who can be asked to be present when issues pertaining to their agency are being discussed.

A significant amount of information relating to this catchment has also been collected. As far as possible information has been accessed in digital form for easy storage and retrieval. This information includes:

- Hydrology and Hydrogeology
- System 6 vegetation
- Current landuse
- Road and cadastral information
- Landsat/SPOT TM imagery from 1995
- Metropolitan Region Scheme
- Federal, State and local government electoral boundaries

- Soil types
- 1995 aerial photography
- Wetland information
- Information collected as part of the Middle Canning Catchment Study (WAWA)

Series of maps have been generated using this information for use with the community and local government to identify the area of concern and aid in the location of specific details.

Stage one of the project has progressed quite well. Community groups are largely aware of the process that we are embarking on and, despite their limited time, have indicated a desire to become involved. Local government, while weary, have also come on board are ready to participate in the process.

Stage two, which is the clear identification of issues and development of strategies to address these issues is about to begin. So long as the participants continue to feel they are or will gain from the process this stage should proceed without undue difficulty.

3 PID 52 Swan Avon ICM (Coordinating group)
Project Leader: Richard Wheater (exec officer)

funding source		+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	
date of project start		which projects depend on this one ?	
proposed date of project completion		on which projects does this one depend	
is this project on schedule ?			

Review

Membership of the Swan Avon ICM (Coordinating Group)

name:	name agency:	person role:
Noel Robbins	W.R.C.	chair
Pat Hart	City of Armadale	d/chair
Mike Macfarlane	Avon Community	d/chair
Rachael Siewart	Conservation Council of WA	member
Max Hipkins	Swan community rep.	member
Doug Morgan	A.R.M.A.	member
Cllr Jan Zeck	Swan Community	member
Ken Wallace	C.A.L.M.	member
Darralyn Ebsary	Avon Community	member
Graeme Blight	Avon Community	member
Don Crawford	W.R.C.	member
Jim Dixon	M.F.P.	member
Darrel Brewin	D.A.W.A. (Northam)	member
Cllr Veronica Cooke		member
Jeff Waddington		member
Richard Wheater	D.A.W.A.	exec officer
Viv Read	A.R.M.A.	deputy
Bev Thurlow	W.R.C.	deputy

3 PID 65 Swan Avon action sites
Project Leaders: Karen Majer, Susan Worley

funding source	NLP	+ w = weeks ahead or - w = weeks behind	
expected total cost	$45,000 (NLP)	name of organisation doing the project	WRC
date of project start	1992	which projects depend on this one ?	
proposed date of project completion	Materials completed 1996, training ongoing	on which projects does this one depend	
is this project on schedule ?	no		

Review

SWAN AVON EDUCATION PROGRAM

Project objective

An education program is being produced for use by schools in the Swan Avon Catchment. The Swan Avon River Education project aims to cater to demands for educational material about the river, but more importantly to encourage use of the river as an educational resource, and to increase awareness of a whole catchment approach to a study of the river. The Secondary Schools coordinator for Ribbons of Blue in the Swan region is working on the project to develop an educational package to support teacher/student use of Swan Avon River sites in curriculum focussed activites. The package will include information resources about the river system and catchment, and curriculum support material - including on-site activities. The package will be structured to allow additional components to be incorporated. The written material will be supplemented by teacher inservice courses.

Objectives

To provide:

Hands-on activities for students, teachers, and community groups at riverside sites.

Increased support for Landcare and Waterways education in schools.

Improved understanding of catchment processes and the fostering of rural and urban links.

Enrichment of teaching in a range of curriculum areas by active experiences in the river environment.

Involvement of greater numbers of children, and through them families and the wider community, in action for the river.

Review of project.

The project, originally commenced in 1992 as the Swan Avon River Action Sites under NLP funding, has been held back due to staff changes at participating schools, the size of the advisory committee, staff changes in Ribbons of Blue, and the integration of the Waterways Commission into a new agency. The approach has been reviewed in light of these issues, and a revised strategy developed. The revised project, known as the Swan Avon River Education Project, is based on developing curriculum links through a study of the river at a range of suitable sites on the Swan/Avon. Progress on preparation of materials for pre-visit, on site, and post-visit activities commenced in March 1996.

The activities are linked to teaching program outlines and student worksheets. The educational materials will be presented in separate folders for each curriculum area, and background material about the river and resources to support the use of riverside sites will be collated into another information folder. Initially the project will focus on the science, and studies of society and environment curriculum areas. It is planned that the scope of the material be broad enough for teachers to use it with upper primary or lower secondary students, and one field work component will be targeted at upper school geography and biology. Following the new National Curriculum outcome statements, it will encourage teachers to develop themes on catchment, history and use, individual, community and management responsibilities, water quality, and natural communities, and will provide background information to support the studies of ecology, history, and management.

The aim of the educational package is the facilitate students' development of a sense of place, with the Swan Avon River as a focus.

3 PID 79 Swan Avon ICM (subcatchment management) Project Leader: Mary Gray

funding source expected total cost date of project start proposed date of project completion is this project on schedule ?		+ w = weeks ahead or - w = weeks behind name of organisation doing the project which projects depend on this one ? on which projects does this one depend	

Review

PROJECT 1. SWAN WORKING GROUP

PROJECT 2. SUBCATCHMENT COORDINATING GROUPS

These projects are part of a family of groups involved in coordinating the Swan-Avon ICM Program. The catchment management branch of the DEP is one of several government agencies, including the SRT, that supports the process of ICM in the subcatchments of the Swan-Canning region.

Swan-Avon ICM Coordinating Group (see PID 52)

Swan Working Group

Subcatchment coordinating groups currently operating in the Swan Canning region:

- Canning Catchment Coordinating Group
- Bayswater Integrated Catchment Management
- Bennett Brook Catchment Group
- Ellen Brook Integrated Catchment Group
- Belmont Main Drain ICM Committee
- Henley Brook Community project by Swan Valley Ratepayers and Residents Association no ICM Group as yet
- Shire of Mundaring ICM (early stages)

3 PID 83 Support for management of Ellen Brook & Southern River catchments Project Leader: Ross George

funding source		+ w = weeks ahead or - w = weeks behind	
expected total cost		name of organisation doing the project	A.W.A.
date of project start		which projects depend on this one ?	
proposed date of project completion		on which projects does this one depend	
is this project on schedule ?			

Review

SUPPORT FOR MANAGEMENT OF ELLEN BROOK AND SOUTHERN RIVER CATCHMENTS .

Description of the project

Land use planning has an important strategic role in ensuring agriculture is able to be developed and managed in a manner that meets economic, social and environmental objectives. The project is using the Ellen Brook and Southern River catchments as a case study for the development of strategic policy that will assist the achievement of sustaingble agriculture.

An assessment of the land resources and environmental constraints will be undertaken to determine the physical capabilities of the lands resource in each of the catchments for the development of intensive agricultural activities, focussing on horticulture. Land use planning policies will then be developed that will ensure agriculture has long term access to those resources and conditions it requires for sutainable production. A model will be developed that will be able to be applied in other parts of the Swan Avon catchment or the State.

Aims of the Project

The principle aim of the project is to intergrate the processes of catchment management, natural resources management and land use planning in a manneer that results in the sustainable development and management of horticultural enterprises being developed in the Ellen Brook and Southern River Catchments.

Particular objectives of the project are:

- To focus horticultural enterprises into areas that are most suitable for the development of such enterprises from a physical, economic, social and environmental perspective;
- To develop and implement planning policies that facilitate the sustainable development and land management of horticultural enterprises within the catchments;
- To develop a model for the integration of land use planning objectives for the sustainable development and management of horiculture into the statutory land use planning process.

Process to date

- A prliminary report on "Land Use Planning for Sustainable Horiculture in the Ellen Brook Catchment" has been prepared and a final report is currently being drafted.
- Milestones achieved
- Draft discussion paper relating to the prparation of a Statement of Planning Policy for Identfying and Planning for Productive Agricultureal Land;
- Identification of areas suitable for suitable sustainable horticulture in the Ellen Brook Catchment;
- Development of recommendations for land use and management of horticulture in the Ellen Brook catchment.

GROUP 4

SCCP Task Force

4 PID 53 SCCP Task Force
Project Leader: John Jones (exec officer)

funding source	SCCP	+ w = weeks ahead or - w = weeks behind	-----
expected total cost	$45K for year 1 (ends 6/96)	name of organisation doing the project	Swan River Trust
date of project start	July 1995	which projects depend on this one ?	none
proposed date of project completion	not determined	on which projects does this one depend	All
is this project on schedule ?	yes		

Review

SWAN / CANNING CLEAN-UP PROGRAMME TASK FORCE .

Objective:

To devise a SCCP Action Plan with across-the-board ownership.

The Task Force comprises very senior representatives of those Government Departments and Agencies which have significant roles to play in cleaning up the estuary. Its objective is to steer the preparation of an Action Plan which will improve the health of the Swan/Canning estuary. The Task Force functions by recommending proposals for action at Departmental level, and by actions initiated by its members from within their agencies.

Review:

The Task Force was inaugurated by Environment Minister Peter Foss in August 1995 and met three times in the latter part of that year. The first two meetings were to brief the members on the activities of the SCCP-Net. (The SCCP-Net is the collection projects which contribute to creating a healthier estuary: this includes both those which are funded by the Swan / Canning Clean-up Programme (SCCP), and those which are not.) The Task Force is currently identifying issues which it considers to be ***Key Issues*** in dealing with the problems of the estuary. It will prioritise them, and will work with the responsible agency to devise remedial actions.

The Task Force recognises the complexity of the problems of the Swan / Canning estuary and considers that these problems center on an excess of nutrients in the system. The issues presently in front of the Task Force relate to; the use of fertilisers, and the 'export' of nutrients from the estuary's catchment; the transport of these nutrients to the estuary, and; the storage and re-release of these nutrients from the sediments of the bed of the estuary.

It is presently approaching the problem from a three phase consideration with the following objectives:

LONG TERM	MEDIUM TERM	SHORT TERM
>20 - 100 + years	5 - 20 years	0 - 5 years
• A reduction in total nutrient load entering the Swan Canning system.	• A reduction in dissolved nutrients entering the system from 'target' areas such as Ellen Brook and nutrient sinks. • The implementation of Integrated Catchment Management practices via the S/A ICM program.	Intervention to: • Decrease nutrient release from estuarine sediments. • Improve estuarine flushing.

The Task Force sees the Forum as a vital part of the process of ensuring a full utilisation of a very wide range of supporting projects and activities.

Membership of the Swan / Canning Clean-up Programme Task Force

name	person	name agency	name remarks
Dr. Des Lord	Chair	D A Lord	Chair Task Force.
Robert Atkins	member	W.R.C.	Rivers and Estuaries investigations
Dr. Chris Barber	member	C.S.I.R.O.	Programme Manager
Terry Blanchard	member	W.A.M.A.	W. A. M. A. Officer (Bayswater)
Jim Dixon	member	M.F.P.	Manager Environmental Policy
Ross George	member	A.W.A.	Senior Research Officer Land Management
Prof. Jorg	member	W.A.E.R.F.	Director. CWR. Director WAERF
Darryl Miller	member	S.R.T.	Executive Director Swan River Trust
Clive Robartson	member	W.A.M.A.	W. A. M. A. Councillor
Barry Sanders	member	W.A.W.A.	A/General Manager Bulk Water & Wastewater Division.
Colin Sanders	member	D.E.P.	Director Policy and Strategic Studies
Garrick Stanley	member	W.R.C.	A/Director, Community Awareness and Involvement.
Bev Thurlow	member	W.R.C.	A/Director Developmentand Management Planning.
Bill Till	member	W.R.C.	Director, Waterways Protection and Enhancement.
John Jones	exec officer	S.R.T.	Executive officer Task Force. Manager SCCP.

APPENDIX

Names and Projects

28-Mar-96

A list of people contributing to the Swan / Canning Clean-up Programme.

S C C P Net

name	NiD	agency	phone	fax	(e-mail)	projects:
John Adderley	138	**City of Armadale**				
Planner						
					Canning Catchment	30
John Adeney	10	**C.S.I.R.O. (Dept Water Resources)**	**387 0310**	**383 7208**		
Phytoplankton water quality.						
					Swan studies by CSIRO	81
Greg Allen	7	**D.E.P.**	**222 7001**			
steering committe resource centre. swan avon ICM Comm Awareness Br						
					Swan avon ICM (comm support)	43
Helen Astill	102	**Edith Cowan University (Environmental Eng)**	**400 5057**	**400 5717**		
PhD Student						
					Macroalgal processes	71
Wayne Astill	150	**University of W.A. (Centre for Water Research)**				
student						
					Environmental eng projects contributing to SCCP	80
Robert Atkins	109	**Water & Rivers Commission**	**278 0524**	**278 0301**		
Rivers and Estuaries investigations						
					Task Force	53
Prof. L A G Aylmore	95	**University of W.A.**	**380 2484**	**380 1050**		
Professor of soil science						
					Soil water & nutrient dynamics: turf / leaching	60
					Soluble Org matter in Ellen Brook	78
Dr. Chris Barber	118	**C.S.I.R.O. (Dept Water Resources)**	**387 0278**	**383 7208**		
Programme Manager						
					Task Force	53
					Swan studies by CSIRO	81
Louisa Barnacle	14	**Swan River Trust**	**278 0400**	**278 0401**		
urban landcare officer. Facilitator for urban ICM.						
					upper canning catchment plan	26
					urban landcare	29
Irwin Barrett-Lennard	70					
					observer	999
Dr. J R Bidwell	92	**Curtin University (ASR)**	**470 7553**	**470 5815**		
Research Fellow. Aquatic Science Research Unit, Curtin University						
					Zooplankton grazers vs phytoplankton	75
Terry Blanchard	143	**W.A.M.A.**	**272 0650**	**272 0665**		
W. A. M. A. Officer (Bayswater)						
					Task Force	53
Graeme Blight	128	**Avon Community**	**096-471 042**	**096-471 042**		
					Swan Avon ICM (Co-ordinating group)	52
Bernard Bowen	158	**E.P.A.**				
Deputy Chair E.P.A.						
					observer	999
Fred Bremner	71					
					observer	999
Darrel Brewin	53	**Agriculture, Western Australia (Northam)**	**096 226 100**	**096 221 1902**		
Avon Landcare						
					Swan Avon ICM (Co-ordinating group)	52
I M Briggs	106	**University of W.A. (Dept Ag)**	**380 2105**	**380 1098**		
senior lecturer						
					Economic valuation of S /C estuary	61
Don Burgess	142	**Swan**	**574 6315**	**574 6463**		
Councillor						
					observer	999

name	NiD	agency	phone	fax	(e-mail)	projects:
Murray Burling	156	**University of W.A. (Centre for Water Research)**				
student						
					Environmental eng projects contributing to SCCP	80
Carina Calzoni	60	**Environment Centre**	**321 592**	**322 3045**		
					observer	999
Ian Campbell	147	**City of Gosnells**	**391 3222**			
Senior Engineer						
					observer	999
Maureen Campbell	135	**Waterbird Conservation Group**				
Community Group Member						
					Canning Catchment	30
Colin Chalmers	113	**Dept Fisheries**	**482 7323**	**481 3576**		
Programme manager Fisheries Habitat						
					observer	999
Adrian Choules	140	**Avon City rivercare group**				
Community Group Member						
					Canning Catchment	30
Cllr	164	**Veronica Cooke**	**271 2053**	**272 4412**		
					Swan Avon ICM (Co-ordinating group)	52
Mischa Cousins	145	**Water & Rivers Commission**	**278 0513**	**278 0301**		
Water quality data collection						
					estuary water quality.	1
Don Crawford	130	**Water & Rivers Commission**	**278 0300**	**278 0301**		
Manager Surface Water						
					Swan Avon ICM (Co-ordinating group)	52
P A M Crossland	98	**T.A.F.E.**				
					Jellies	76
Ian Dalton	72					
					observer	999
John Davies	37	**Water Corporation**	-	-		
senior engineer.Marine & water supply infrastructures.						
					observer	999
Ursula Davies	33	**University of W.A. (Dept Botany) (Dept Botany)**		**380 1001**		
student hons project - mapping. southern River catchment Plan mail returned unknown						
					southern River catchment Mapping	49
Dr. J A Davis	87	**Murdoch University (Bio & Env Sciences)**	**360 2939**	**310 4997**		
Senior Lecturer in Aquatic Ecology					**davis@essun1.murdoch.edu.au**	
					Macrobenthos	73
Jenny Davis	9	**Murdoch University (Bio & Env Sciences)**		**310 4997**		
swan river nutrient project						
					observer	999
Tom Davis	134	**City of Canning**	**451 0606**	**458 2353**		
					Canning Catchment	30
					ILAP	39
Dave Deeley	2	**Water & Rivers Commission**	**339 1455**			
ecologist, researcher. Special interest: esturine research, spatial modelling, stormwater design,						
					Algae data base student 10wks	4
					Turf irrigation and nutrient study	56
					Swan spatial modelling project	57
					Estuarine health indicators	58
					Phytoplankton ecology project	59
Cr. Michael Devereux	137	**City of Gosnells**				
Councillor						
					Canning Catchment	30
Jim Dixon	116	**M.F.P.**	**264 7532**	**264 7527**		
Manager Environmental Policy						
					Swan Avon ICM (Co-ordinating group)	52

name	NiD	agency	phone	fax	(e-mail)	projects:
					Task Force	53
Neil Dixon	19	**Water & Rivers Commission**	**278 0300**	**278 0301**		
Canning river water quality. Data control & distribution. Advice on sampling methods & data collection						
					estuary water quality.	1
					FOXBASE PRO database	2
					CCWA/SCCP data entry	3
					Algae data base student 10wks	4
					Backlog data student 10wks	5
					Canning river water quality	6
					Algal remote sensing	9
Rob Donohue	42	**Water & Rivers Commission**	**278 0300**	**278 0301**		
Environmental officer. Fresh water ecologist, data analyst, statistician, graphics.						
					estuary water quality.	1
					FOXBASE PRO database	2
					Algae data base student 10wks	4
					Canning river water quality	6
					catchment monitoring	19
Grant Douglas	6	**C.S.I.R.O. (Dept Water Resources)**	**387 0131**	**383 7208**		
swan river nutrients group. aquatic sediment chemistry.						
					aquatic sediment chemistry	11
					Sediment Manipulation	15
					Swan studies by CSIRO	81
					The effects of nutrients on the growth of algae	82
Ken Eade	152	**University of W.A. (Centre for Water Research)**				
student						
					Environmental eng projects contributing to SCCP	80
Darralyn Ebsary	127	**Avon Community**	**090-658 055**	**090-658 021**		
					Swan Avon ICM (Co-ordinating group)	52
Amir Etemad	75	**University of W.A. (Centre for Water Research)**	**380 1685**	**380 1015**		
PhD Student					**etemad@cwr.uwa.oz.au**	
					Dynamics of a tidal estuary	64
Tony Eyres	56	**Conservation Council**	**220 0669**	**220 0653**		
Rural Liaison Officer						
					observer	999
Patrick George	21	**Water & Rivers Commission**	**278 0300**	**278 0301**		
Water Sensitive Urban Design						
					storm water design	20
Ross George	43	**Agriculture, Western Australia**	**368 3655**	**368 3946**		
Senior Research Officer Land Management						
					Task Force	53
					Support for management of Ellen Brook & Southern River catchments	83
Dr. Robert Gerritse	30	**C.S.I.R.O. (Dept Water Resources)**	**387 0311**	**383 7208**		
Principal Research Scientist. swan river nutrients group. land use water & sediment chemistry.					**gerritse@per.dwr.csiro.au**	
					Soluble Org matter in Ellen Brook	78
					Swan studies by CSIRO	81
					The effects of nutrients on the growth of algae	82
Rosemary Glass	31	**B.I.C.M.**	**272 0643**	**272 0665**		
Catchment coordinator.						
					Bayswater Integrated Catchment Management	38
Ron Glencross	44	**Agriculture, Western Australia**	**368 3290**	**368 3355**		
-fertilizers -land use (livestock) -revegitation -water use management						
					observer	999
Susie Graham	52	**Agriculture, Western Australia**	**368 3831**			
Landcare promotions						
					observer	999
Mary Gray	17	**D.E.P.**	**221 3840**	**221 4960**		
catchment facilitator, steering committe resource centre. swan avon ICM						
					urban landcare	29
					Canning Catchment	30
					swan avon ICM (resource centre)	42

name	NiD	agency	phone	fax	(e-mail)	projects:
					Swan avon ICM (comm support)	43
					Swan avon ICM (Swan Working group)	79
Sandra Griffin	100	**Curtin University (Environmental Biology)**	**351 3132**	**351 2495**		
PhD student					**r.griffin@cc.curtin.edu.au**	
					Zooplankton grazers vs phytoplankton	75
Dr Bruce Hamilton	114	**Water & Rivers Commission**	**278 0300**	**278 0301**		
Executive Director						
					observer	999
Dr. David Hamilton	3	**University of W.A. (Centre for Water Research)**	**380 3530**	**380 1015**		
Modeller, project manager, CWR, ecologist, lecturer.					**hamilton@cwr.uwa.oz.au**	
					Co-ordinating Group for the SCCP	55
					Soil water & nutrient dynamics: turf / leaching	60
					Economic valuation of S /C estuary	61
					Heavy metal cycling in Bayswater main drain and Swan River	63
					Dynamics of a tidal estuary	64
					Integrated ecological model	66
					Integrated ecological model	66
					catchment model	67
					W/Q & hydrodynamics	68
					Groundwater & saline water	69
					Phytoplankton ecology	70
					Phytoplankton ecology	70
					Macroalgal processes	71
					Halophila Ovalis	72
					Macrobenthos	73
					Fish and Macrobenthos.	74
					Zooplankton grazers vs phytoplankton	75
					Jellies	76
					Cycling of nutrients	77
					Soluble Org matter in Ellen Brook	78
					Environmental eng projects contributing to SCCP	80
Julie Harman	157	**University of Western Australia**				
					observer	999
Brett Harrison	61	**Swan River Trust**	**278 0300**	**278 0301**		
cartographer, GIS software/hardware specialist.						
					GIS mapping	36
Pat Hart	64	**City of Armadale**	**496 1634**	**496 1634**		
Councillor						
					Canning Catchment	30
					Swan Avon ICM (Co-ordinating group)	52
					Swan avon ICM (Swan Working group)	79
Dennis Heinemann	4	**C.S.I.R.O. (Dept Fisheries)**		**387 0121**		
swan river nutrient project						
					Swan studies by CSIRO	81
David Herne	45	**C.S.I.R.O. (Dept Water Resources)**	**387 0294**	**383 7208**		
Ellen Brook studies						
					Ellen Book catchment management plan	25
					Swan studies by CSIRO	81
Dr. GL Hertzler	107	**University of W.A. (Dept Environmental Eng)**	**380 2534**	**380 1098**		
senior lecturer						
					Economic valuation of S /C estuary	61
Peter Hick	24	**C.S.I.R.O. (Dept Environmental Management)**	**387 0243**	**387 0121**		
Remote sensing. swan river nutrients group						
					Algal remote sensing	9
					DMSV algal surveilance	10
Alan Hill	11	**Water & Rivers Commission**	**278 0300**	**278 0301**		
storm water design						
					storm water design	20
					Canning Catchment	30
Max Hipkins	65	**Swan community rep. Canning River Guides**	**443 1511**	**444 3901**		

name	NiD	agency	phone	fax	(e-mail)	projects:
					Swan Avon ICM (Co-ordinating group)	52
					Swan avon ICM (Swan Working group)	79
Wes Horwood	36	**Swan River Trust**	**278 0405**	**278 0401**		
Catchment coordinator, Ellen book & southern river catchment plans. Special interests: land degradation; erosion; salinity; hydrology; hydrogeology.						
					Ellen Book catchment management plan	25
					upper canning catchment plan	26
					urban landcare	29
					Canning Catchment	30
					Southern River Catchment -nutrients	41
					Southern River catchment management plan	50
					Ellen Brook Catchment -nutrients	62
Was Hosja.	35	**W.R.C. Phytoplankton Lab**	**470 4385**	**470 6785**		
river monitoring - analysis swan river nutrients group.						
					estuary water quality.	1
					Algae data base student 10wks	4
					Phytoplankton ecology project	59
Penny Hussey	59	**C.A.L.M.**	**334 0333**	**334 0295**		
Rural advisor of nature conservation						
					observer	999
Robert Hutchison	38	**Swan River Trust**	**278 0414**	**278 0401**		
Town planner, land use control, statuary planning controls.						
					SRT management area review	27
					Stat aps review	28
Prof. Jorg Imberger	49	**W.A.E.R.F. & C.W.R.**	**380 3529**	**380 1015**		
Director. CWR. Director WAERF					**sly@cwr.uwa.edu.au**	
					Task Force	53
					WA Estuarine Research Foundation	54
Charles Jacoby	160	**C.S.I.R.O. (Dept Fisheries)**		**387 0121**		
Officer in Charge, Div Fisheries						
					observer	999
Peter Jernakoff	25	**C.S.I.R.O. (Dept Fisheries)**	**246 8205**	**387 0121**		
swan river nutrient project						
					Swan studies by CSIRO	81
Ray Julien	139	**FORCE**				
					Canning Catchment	30
Dr. J John	84	**Curtin University (Environmental Biology)**	**351 7327**	**351 2495**		
Associate Professor algologist, diatomist.					**rjacobjo@cc.curtin.edu.au**	
					Phytoplankton ecology	70
					Curtin University projects contributing to SCCP	84
John Jones	62	**Swan River Trust**	**278 0413**	**278 0401**		
Executive officer Task Force. Manager SCCP.						
					Task Force	53
					Task Force	53
					Co-ordinating Group for the SCCP	55
Linda Kalnajais	151	**University of W.A. (Centre for Water Research)**				
student						
					Environmental eng projects contributing to SCCP	80
Angie Kanandjembo	175	**Murdoch University**	**360 2229**			
Research Assistant						
					Fish and Macrobenthos.	74
Peter Kin	46	**C.S.I.R.O. (Dept Water Resources)**	**387 0205**	**383 7208**		
nutrient transport modelling						
					Ellen Book catchment management plan	25
					Swan studies by CSIRO	81
Ian Kininmonth	47	**Agriculture, Western Australia**	**368 3408**			
SPP / ag land / Ellenbrook						
					Support for management of Ellen Brook & Southern River catchments	83
Jeff Kite	48	**Water & Rivers Commission**	**278 0300**	**278 0301**		
Manager Env Br. nutrients / drainage / river restoration						
					Ellen Book catchment management plan	25

name	NiD	agency	phone	fax	(e-mail)	projects:
Verity Klemm	108	**Water & Rivers Commission**	**278 0529**	**278 0301**		
Principal Environmental Officer						
					ILAP	39
					Task Force	53
Tim Larcombe	32	**Swan River Trust**	**278 0300**	**278 0301**		
SCCP Community Relations						
					Community relations officer	31
					publications	32
					annual forum	33
					training	34
					publicity & events	35
Simon de Lastung	103	**Murdoch University (Bio & Env Sciences)**	**360 2256**	**310 4997**		
-					**l-potter@possum.murdoch.edu.au**	
					observer	999
Dr. Paul Lavery	85	**Edith Cowan University (Environmental Eng)**	**400 5454**	**400 5717**		
Lecturer					**p.lavery@cowan.edu.au**	
					Macroalgal processes	71
					Cycling of nutrients	77
Dr. R C J Lenanton	90	**C.S.I.R.O. (Dept Fisheries)**	**246 8444**	**387 0121**		
Principal Research Scientist. Finfish research. West Australian Marine Research Lab Leach St						
					Fish and Macrobenthos.	74
					Swan studies by CSIRO	81
Lotte Lent	58	**C.A.L.M.**	**334 0333**	**334 0295**		
Interpretation Officer						
					observer	999
Ian LeProvost	122	**W.A.E.R.F.**	**474 1933**	**368 2294**		
WAERF. Board member						
					Task Force	53
Dr. B Linderfelt	83	**C.S.I.R.O. (Dept Water Resources)**	**387 0314**	**383 7208**		
Post Doctoral Fellow					**jeff@per.dwr.csiro.au**	
					Groundwater & saline water	69
					Swan studies by CSIRO	81
Dr. Des Lord	50	**D A Lord & Associates**	**389 9669**	**389 9660**		
Chair Task Force.					**dal@perth.dialix.oz.au**	
					Task Force	53
Mike Macfarlane	124	**Avon Community**	**090-458 244**	**090-458 244**		
					Swan Avon ICM (Co-ordinating group)	52
Gerry MacGill	117	**M.F.P.**		**264 7527**		
					Task Force	53
Andrew Mack	146	**Water & Rivers Commission**	**278 0300**	**278 0301**		
Environmental Investigations						
					Destratification trial	14
					Environmental eng projects contributing to SCCP	80
Noela Maitland	69					
					observer	999
Karen Majer	12	**Water & Rivers Commission**	**278 0300**	**278 0301**		
Swan/Avon ICM						
					Community relations officer	31
					publications	32
					annual forum	33
					training	34
					publicity & events	35
					swan avon ICM (resource centre)	42
					swan avon ICM (resource centre)	42
					Swan avon ICM (comm support)	43
					Swan avon ICM (comm support)	43
					Co-ordinating Group for the SCCP	55
					Swan avon action sites	65
					Swan avon action sites	65

name	NID	agency	phone	fax	(e-mail)	projects:
Fiona Marr	57	**C.A.L.M.**	**334 0333**	**334 0295**		
Community Education Officer						
					observer	999
Cr. Bruce Mason	136	**City of Canning**	**451 0606**	**458 2353**		
Councillor						
					Canning Catchment	30
Prof. A J McComb	88	**Murdoch University (Bio & Env Sciences)**	**360 2191**	**310 4997**		
Professor of Environmental Science					**davis@essun1.murdoch.edu.au**	
					Macrobenthos	73
Kate McInnes	54	**Agriculture, Western Australia (Northam)**	**096 226 100**	**096 221 1902**		
swan avon ICM CG						
					Canning Catchment	30
					Swan avon ICM (comm support)	43
Sue Meeking	73					
					observer	999
Darryl Miller	144	**Swan River Trust**	**278 0417**	**278 0401**		
Executive Director Swan River Trust						
					Task Force	53
Doug Morgan	123	**A.R.M.A.**	**096-221 002**			
Chairman ARMA						
					Swan Avon ICM (Co-ordinating group)	52
Luke Morgan	15	**Agriculture, Western Australia (Northam)**	**096 226 119**	**096 221 1902**		
swan avon ICM CG						
					Swan avon ICM (comm support)	43
Peter Morrison	23	**City of Canning**	**451 0606**	**458 2353**		
-						
					Canning Catchment	30
					observer	999
Colin Noid	41	**University of W.A. (Centre for Water Research)**	**527 2137**			
student						
					Environmental eng projects contributing to SCCP	80
Pat O'Hara	165	**B.I.C.M.**				
community rep						
					Swan avon ICM (Swan Working group)	79
Dr. C Oldham	93	**University of W.A. (Centre for Water Research)**	**380 3143**	**380 1015**		
Lecturer					**oldham@cwr.uwa.edu.au**	
					Heavy metal cycling in Bayswater main drain and Swan River	63
					Cycling of nutrients	77
Michael Parker	133	**W.A.M.A.**	**321 5055**	**322 2611**		
steering committe resource centre. swan avon ICM Environmental research						
					observer	999
Gerry Parlevliet	5	**Agriculture, Western Australia**	**368 3219**	**367 2625**		
Advisor Horticulture Extension Group						
					Canning Catchment	30
					Southern River Catchment -nutrients	41
					Swan avon ICM (comm support)	43
					Task Force	53
					Ellen Brook Catchment -nutrients	62
Prof. J Patterson	79	**University of W.A. (Centre for Water Research)**	**380 3083**	**380 1015**		
Assoc Prof					**hamilton@cwr.uwa.edu.au**	
					W/Q & hydrodynamics	68
Dr. C Pattiaratchi	80	**University of W.A. (Centre for Water Research)**	**380 3179**	**380 1015**		
Lecturer					**hamilton@cwr.uwa.edu.au**	
					W/Q & hydrodynamics	68
Margaret Platell	101	**Murdoch University (Bio & Env Sciences)**	**360 2229**	**360 6303**		
Fish research. Fish and macrobenthic faunal knowledge					**platell@possum.murdoch.edu.au**	
					Fish and Macrobenthos.	74
Dr. Colin Porter	13	**—**				
Eminent person						
					observer	999

name	NID	agency	phone	fax	(e-mail)	projects:
Prof. I C Potter	89	**Murdoch University (Bio & Env Sciences)**	**360 2524**	**360 6303**		
Professor of animal biology					**i-potter@possum.murdoch.edu.au**	
					Fish and Macrobenthos.	74
Viv Read	34	**A.R.M.A.**	**096 226119**	**096 221 1902**		
swan avon ICM resource centre proj manager. Director ARMA						
					swan avon ICM (resource centre)	42
					Swan avon ICM (comm support)	43
					Swan Avon ICM (Co-ordinating group)	52
Paul Reiffer	22	**Water & Rivers Commission**	**278 0300**	**278 0301**		
Ribbons of Blue State Co-ordinator						
					ROB	40
					Swan avon action sites	65
Martin Revell	55	**Agriculture, Western Australia (Northam)**	**096 226 100**	**096 221 1902**		
Ribbons of Blue						
					observer	999
Dr. R J Rippingale	91	**Curtin University (Environmental Biology)**	**351 7922**	**351 2495**		
Lecturer Environmental Biology Curtin University					**r.rippingale@info.curtin.edu.au**	
					Zooplankton grazers vs phytoplankton	75
					Jellies	76
Clive Robartson	121	**W.A.M.A.**	**368 3349**	**474 1881**		
W. A. M. A. Councillor						
					Task Force	53
Malcolm Robb	39	**Water & Rivers Commission**	**278 0300**	**278 0301**		
project manager, scientist.						
					estuary water quality.	1
					FOXBASE PRO database	2
					CCWA/SCCP data entry	3
					Algae data base student 10wks	4
					Backlog data student 10wks	5
					Canning river water quality	6
					sediment mapping	7
					sediment mapping	7
					Algal remote sensing	9
					DMSV algal surveilance	10
					aquatic sediment chemistry	11
					Destratification trial	14
					Destratification trial	14
					Sediment Manipulation	15
					River management action plan	16
					River management action plan	16
					aquatic weeds canning river	18
					catchment monitoring	19
					stormwater policy	21
					Domestic gardens and streets	23
					Detergents	24
					Co-ordinating Group for the SCCP	55
					Turf irrigation and nutrient study	56
					Swan spatial modelling project	57
					Estuarine health indicators	58
					Phytoplankton ecology project	59
Noel Robins	129	**Water & Rivers Commission**	**474 2823**	**278 0301**		
Chairman Waterways Commission						
					Swan Avon ICM (Co-ordinating group)	52
Cath Robinson	111	**Water & Rivers Commission**	**278 0300**	**278 0301**		
Director, Community Awareness and Involvement. Member Task Force						
					observer	999
Simon Rodgers	153	**University of W.A. (Centre for Water Research)**				
student						
					Environmental eng projects contributing to SCCP	80
Tom Rose	96	**P.I.M.A.**	**535 3411**	**581 4560**		
Esturary ecology, ecological processes, statistics.						

name	NiD	agency	phone	fax	(e-mail)	projects:
					observer	999
Jane Rosser	99	**Curtin University (Environmental Biology)**	**041 990 8587**	**351 2495**		
					stormwater policy	21
					Phytoplankton ecology	70
					Curtin University projects contributing to SCCP	84
Michael Rowe	18	**slcc**	**368 3308**			
swan avon ICM CG						
					Swan avon ICM (comm support)	43
Hugh Rule	132	**Water Corporation**	**420 2420**	**420 3200**		
Manager Wastewater Treatment & Industrial Waste Branch.						
					Task Force	53
Greg Ryan	8	**W.A.M.A.**	**321 5055**	**322 2611**		
steering committe resource centre. swan avon ICM Environmental research						
					observer	999
Nicole Sampson	161	**C.S.I.R.O. (DWR) /UWA**	**387 0780**	**383 7208**		
Ph D student. Presenter for project No78					**gerritse@per.dwr.csiro.au**	
					Soluble Org matter in Ellen Brook	78
Barry Sanders	131	**Water Corporation**	**420 2420**	**420 3200**		
A/General Manager Bulk Water & Wastewater Division.						
					Task Force	53
Colin Sanders	120	**D.E.P.**	**222 7101**	**321 5184**		
Director Policy and Strategic Studies						
					Task Force	53
Mark Scatena	154	**University of W.A. (Centre for Water Research)**				
student						
					Environmental eng projects contributing to SCCP	80
Dr Bill Scott	162	**Murdoch University (Bio & Env Sciences)**				
Senior lecturer						
					observer	999
Cr. Olwen Searle	149	**City of Gosnells**	**391 3222**			
Mayor						
					observer	999
Bob Shaskey	148	**City of Gosnells**	**391 3222**			
Senior Planner						
					observer	999
Munna Sharma	159	**C.S.I.R.O. (Dept Water Resources)**		**383 7208**		
Principal Research Scientist.						
					Swan studies by CSIRO	81
Judy Shilling	74					
					observer	999
Nicole Siemon	20	**Swan River Trust**	**278 0407**	**278 0401**		
Catchment coordinator. canning upper catchment plan. Ecologist; riparian vege, fauna: weed control, rehabiliation, revege.						
					upper canning catchment plan	26
					urban landcare	29
					Canning Catchment	30
Rachael Siewart	28	**Conservation Council of WA**	**220 0652**	**220 0653**		
coordinator, swan avon ICM CG						
					Swan avon ICM (comm support)	43
					Swan Avon ICM (Co-ordinating group)	52
Dr. M Sivapalan	78	**University of W.A. (Centre for Water Research)**	**380 2320**	**380 1015**		
Senior Lecturer					**sivapalan@cwr.uwa.edu.au**	
					catchment model	67
Peter Stallwood	63	**Agriculture, Western Australia**	**108 952 143**	**250 1859**		
Midland Office office phone 250 9411.						
					Co-ordinating Group for the SCCP	55
Garrick Stanley	141	**Water & Rivers Commission**	**278 0360**	**278 0301**		
A/Director, Community Awareness and Involvement.						
					Task Force	53

name	NiD	agency	phone	fax	(e-mail)	projects:
Lynda Taman	66	**B.I.C.M.**	**375 3731**	**375 3787**		
					observer	999
Sue Graham Taylor	67	**Conservation Council**	**386 2206**	**386 2206**		
					Swan avon ICM (Swan Working group)	79
Dr. Peter Thompson	26	**C.S.I.R.O. (Dept Fisheries)**	**246 8245**	**246 8233**		
Senior Research Scientist Phytoplankton ecologist.					**Peter.Thompson@per.ml.csiro.au**	
					swan river nutrient project	44
					Phytoplankton ecology	70
					Swan studies by CSIRO	81
					The effects of nutrients on the growth of algae	82
Bev Thurlow	40	**Water & Rivers Commission**	**278 0374**	**278 0301**		
A/Director Development and Management Planning. catchment management specialist.						
					Ellen Book catchment management plan	25
					upper canning catchment plan	26
					urban landcare	29
					Canning Catchment	30
					GIS mapping	36
					Bayswater Integrated Catchment Management	38
					ILAP	39
					Southern River Catchment -nutrients	41
					swan avon ICM (resource centre)	42
					southern River catchment Mapping	49
					Southern River catchment management plan	50
					Swan Avon ICM (Co-ordinating group)	52
					Task Force	53
					Co-ordinating Group for the SCCP	55
					Swan avon action sites	65
					Swan avon ICM (Swan Working group)	79
Bill Till	110	**Water & Rivers Commission**	**278 0300**	**278 0314**		
Director, Waterways Protection and Enhancement.						
					Task Force	53
Geoff Totterdell	115	**Swan River Trust**	**278 0416**	**278 0401**		
Chairman Swan River Trust		3224911				
					observer	999
Dr. Lloyd Townley	82	**C.S.I.R.O. (Dept Water Resources)**	**387 0329**	**383 7208**		
Principal Research Scientist.					**lloyd@per.dwr.csiro.au**	
					Task Force	53
					Groundwater & saline water	69
					Swan studies by CSIRO	81
Dr. Jeff Turner	81	**C.S.I.R.O. (Dept Water Resources)**	**387 0314**	**383 7208**		
Principal Research Scientist.					**jeff@per.dwr.csiro.au**	
					Groundwater & saline water	69
					Swan studies by CSIRO	81
Luke Twomey	172	**Curtin University**				
PhD student						
					Curtin University projects contributing to SCCP	84
Fiona Valesini	174	**Murdoch University**	**360 2229**			
Research assistant						
					Fish and Macrobenthos.	74
Wilma Vinvent	173	**Curtin University**				
PhD student						
					Curtin University projects contributing to SCCP	84
Neil Viney	104	**University of W.A. (Centre for Water Research)**	**380 3525**	**380 1015**		
Researcher at cwr					**viney@cwr.uwa.edu.au**	
					catchment model	67
Jeff Waddington	163	**none**	**096-3212**	**096-224 866**		
					Swan Avon ICM (Co-ordinating group)	52
Dr. D I Walker	86	**University of W.A. (Dept Botany) (Dept Botany)**	**380 2089**	**380 1001**		
Senior lecturer Researcher, (Halophilia ovalis)					**diwalker@uniwa.uwa.edu.au**	

name	NiD	agency	phone	fax	(e-mail)	projects:
					Halophila Ovalis	72
Ken Wallace	126	**C.A.L.M.**	**098-811 444**	**098-813 297**		
Regional Manager, Wheatbelt Region.						
					Swan Avon ICM (Co-ordinating group)	52
Ray Wallis	29	**D.E.P.**	**222 7097**			
catchment management						
					Canning Catchment	30
					Co-ordinating Group for the SCCP	55
Mark Warner	16	**Water & Rivers Commission**	**278 0300**	**278 0301**		
swan avon ICM CG						
					Swan avon ICM (comm support)	43
Audrey Welsh	155	**University of W.A. (Centre for Water Research)**				
student						
					Environmental eng projects contributing to SCCP	80
Richard Wheater	68	**Agriculture, Western Australia**	**368 3212**	**368 3946**		
					Swan Avon ICM (Co-ordinating group)	52
					Swan avon ICM (Swan Working group)	79
Susan Worley	77	**Water & Rivers Commission**	**278 0300**	**278 0301**		
(ROB)						
					ROB	40
					Swan avon action sites	65
Dr. K-H Wyroll	94	**University of W.A. (Dept Geog)**	**380 2714**	**380 1054**		
Senior lecturer						
					Cycling of nutrients	77
Dr. JS Yeates	51	**AGC Woodward-Clyde**	**325 9077**	**325 9091**		
Operations manager						
					Soil water & nutrient dynamics: turf / leaching	60
Yi Yuan	76	**University of W.A. (Dept Environmental Eng)**				
PhD Student					**yuan@cwr.uwa.edu.au**	
					Heavy metal cycling in Bayswater main drain and Swan River	63
Cllr Jan Zeck	125	**Swan Community**	**296 1631**	**296 1631**		
					Swan Avon ICM (Co-ordinating group)	52
					Swan avon ICM (Swan Working group)	79