

CAPABILITY PROFILE

BRISBANE | PERTH | SINGAPORE | PAPUA NEW GUINEA

PROVIDING LEADING EDGE
AQUATIC ENVIRONMENTAL SERVICES





©Hydrobiology Pty Ltd 2017

Disclaimer:

This document contains confidential information that is intended only for the use by Hydrobiology's Client. It is not for public circulation or publication or to be used by any third party without the express permission of either the Client or Hydrobiology Pty. Ltd. The concepts and information contained in this document are the property of Hydrobiology Pty Ltd. Use or copying of this document in whole or in part without the written permission of Hydrobiology Pty Ltd constitutes an infringement of copyright.

While the findings presented in this report are based on information that Hydrobiology considers reliable unless stated otherwise, the accuracy and completeness of source information cannot be guaranteed. Furthermore, the information compiled in this report addresses the specific needs of the client, so may not address the needs of third parties using this report for their own purposes. Thus, Hydrobiology and its employees accept no liability for any losses or damage for any action taken or not taken on the basis of any part of the contents of this report. Those acting on information provided in this report do so entirely at their own risk.

CONTENTS

Hydrobiology Overview	4
Catchment Management and Waterway Health	7
Erosion and Sediment Management	8
Environmental Chemistry	9
Coasts and Port Studies	10
Case Study – ADCP	11
Capability Focus – Hydroacoustics	12
Mining – Monitoring and Impact Assessment	13
Capability Focus – Mine Pit Lakes	14
Ecotoxicology	15
Capability Focus – Desalination Ecotox	16
Coal Seam Gas – Water Management	17
Risk Assessment and Management	18

OUR SERVICES

- LAND & WATER MANAGEMENT
- ECOLOGY & IMPACT ASSESSMENT
- RISK ASSESSMENT
- ENVIRONMENTAL CHEMISTRY
- COASTS & PORTS

SPECIALISTS IN AQUATIC ENVIRONMENTAL SCIENCES

FIELDS

- PROJECT APPROVALS
- BASELINE DATA COLLECTION
- MONITORING PROGRAMS
- REMOTE AREA FIELDWORK
- TROPICAL SYSTEMS
- TEMPORARY WATERS

SECTORS

- MINING
- OIL AND GAS
- GOVERNMENT
- PORTS
- NRM
- WATER SECTOR

HYDROBIOLOGY OVERVIEW



Hydrobiology is an Australian environmental consulting company, offering integrated services in the physical, biological and chemical processes of environmental systems with a particular emphasis on the aquatic environment.

We have key technical strengths in the areas of risk assessment, impact assessment, environmental hydrology, ecotoxicology, aquatic ecology, river mechanics, water quality, and contaminated sediment management.

Hydrobiology's focus is technical excellence and high level scientific expertise delivered within a commercial framework.

We are able to provide our clients with the best possible understanding of environmental risk for their environmental and impact management needs.

LOCATIONS

Hydrobiology has two offices in Australia (Brisbane and Perth), a regional base office in Singapore and a representative in Port Moresby, PNG.

We operate world-wide and have conducted studies in Australia, Bangladesh, Cameroon, Congo, East Timor, Fiji, Indonesia, Iran, Laos, Solomon Islands, Philippines, PNG, Sierra Leone, Suriname and Tanzania.

CLIENTS

Hydrobiology has worked for a range of clients across all sectors requiring environmental assessments of aquatic systems.

CLIENTS HAVE INCLUDED:

- AECOM
- Apache Energy
- Aurecon
- Australian government
- Barrick
- BC Iron
- BHP
- Brisbane CC
- Camlron (Sundance)
- Cardno
- Centennial Coal
- Chevron
- Coffey Environments
- DHI
- ERIAS Group
- FMG
- Glencore
- Gold Coast CC
- Golder Associates
- Harmony Gold
- Hatfield
- INCO (Vale)
- Lane Xang Minerals
- LNG
- Logan CC
- Lorax Environmental
- Mt Isa CC
- Melbourne Water
- MMJV
- Nautilus Mining
- Newcrest
- Newmont
- NT Government
- Oil Search
- Ok Tedi Mining
- Origin Energy
- PNG Conservation and Environment Protection Authority
- QGC
- QLD DERM
- QLD Energy Res.
- Ramu Nickel
- Redland CC
- Rio Tinto Iron Ore and Alcan Weipa
- SKM/Jacobs
- SLR
- SRK
- Sunwater
- Tasmanian Govt (DPIPWE)
- URS
- WA Govt (Dept Regional Devt)
- Water Corp. (WA)
- Woodlark Mining
- WorleyParsons/Advisian

HYDROBIOLOGY OVERVIEW

OUR SERVICE AREAS



LAND & WATER MANAGEMENT

- Geomorphology / Sedimentation
- Environmental hydrology
- Impact mitigation and rehabilitation



ECOLOGY & BIODIVERSITY MANAGEMENT

- Baseline, routine and EIA
- Project design advice
- Impact mitigation



RISK ASSESSMENT

- Environmental risk assessment
- Ecotoxicology
- Contaminated sites



ENVIRONMENTAL CHEMISTRY

- Water and sediment quality
- Baseline, routine and EIA
- Effluent / ARD / ASS



COASTS & PORTS

- Port environmental studies
- EIA / Baseline / Dredging (NAGD)
- Physical and chemical oceanography

HYDROBIOLOGY OVERVIEW

OUR PROJECTS



Hydrobiology has undertaken hundreds of projects for dozens of clients since inception in 2001. This section presents a selection of projects across our range of service areas.

MINING

- Rio Tinto – Amrun EIS, Weipa REMP. Design and monitoring services
- Newcrest – Gosowong environmental assessment
- Xstrata – Tampakan Aquatic Ecology ESIA
- BC Iron – Surface water monitoring of Pilbara drainages.
- Newmont – Mt Leyshon water and sediment quality review
- LXML MMG– Sepon Biomonitoring Program and Peer Review
- McArthur River Mine – Human Health and Ecological Risk Assessment
- BHP – Samarco tailings dam failure ecology and geomorphology expert assessment and guidance

OIL & GAS

- Oil Search – Receiving environment monitoring and review
- ExxonMobil – PNG LNG sedimentation, geomorphology and ecology
- LNG – Discharge product water impact assessment
- Origin Energy – CSG APLNG baseline surveys
- QGC – CSG baseline surveys and ecotoxicity assessments
- Santos – CSG ecotoxicity assessment

COASTS AND PORTS

- Rio Tinto – Cape Lambert MEQMP
- Xstrata – Zanaga port marine baseline and SAP
- API – Pt Anketell port baseline studies
- Newcrest – Port Hedland operations audits
- Port of Townsville – Dredging SAP and ecotoxicity
- PNG Ports – Relocation of the Port of Port Moresby
- Port of Brisbane - Various

CATCHMENT MANAGEMENT

- QLD DERM – Catchment management plans, Brisbane River Flood Study
- Sunwater – Sustainable sand yields from rivers, BUA monitoring
- Brisbane City Council – Urban waterway management
- Office of Water Science – Temporary Waters ANZECC guideline review

WATER SECTOR

- Water Corporation (WA) – Kununurra WWTP upgrade EIS
- PNG Power – Ramu 2 Hydropower Project
- Melbourne Water – Desalination discharge ecotoxicity EIS
- Gold Coast Water – Ecotoxicity for recycled water
- World Bank – Naoro-Brown Hydropower Project

CATCHMENT MANAGEMENT & WATERWAY HEALTH



OUR SERVICES

Hydrobiology assists local and state government and regional natural resource management organisations in implementing sustainable catchment management policies and practices through the delivery of sound science in the areas of aquatic ecology, water quality, sediment quality, fluvial geomorphology, habitat assessment and river restoration.

SKILLS AND TECHNIQUES

Hydrobiology has undertaken catchment management and waterway health projects, ranging from specific issue-based assessments to broad catchment-scale studies. We have experience working in urban streams and both rural coastal and inland catchments. Hydrobiology offers experience in catchment management planning and waterway health assessments based on the assessment of water quality, sediment quality macroinvertebrates, fish and in-stream/riparian habitat condition. We have undertaken studies using a range of rapid assessment techniques including; EHMP, AUSRIVAS, State of the Rivers, ISC and a combination of the Pfankuch and Rosgen stream type and channel stability assessment methods. Hydrobiology can also undertake detailed research-based tasks tailored for the specific study objectives

and develop locally suitable assessment protocols for projects outside of Australia.

Our key skills and techniques include:

- Aquatic ecological surveys and research to underpin waterway health, in-stream habitat and integrated catchment planning studies;
- The design and implementation of water and sediment quality monitoring programmes;
- Geochemical processes and ecotoxicity risk assessment;
- Assessment of in-stream and riparian habitat condition and processes;
- Characterisation and quantification of sediment loads entering waterways;
- Assessment of river restoration and rehabilitation options and recovery potential;
- Assessment and mapping of in-stream habitat distribution as part of resource inventories and strategies;
- Assessment of the impacts of fish barriers; and
- Environmental flows and water resource planning studies.

APPLICATIONS

- Environmental Impact Assessment (Project Approvals)
- Catchment Management/ Water Resource Plans
- Environmental Management Plans
- Effluent/discharge water risk and impact assessment
- Baseline and monitoring program design, training and implementation
- River restoration and rehabilitation
- Capacity building and peer review
- Diversion monitoring and performance assessment
- Water harvesting impact assessment and planning

EROSION & SEDIMENT MANAGEMENT



OUR SERVICES

Hydrobiology undertakes investigations and provides advice on matters relating to erosion and sediment budgets at a catchment scale, riverine sediment transport and deposition, erosion and sediment management and sediment sourcing.

SKILLS AND TECHNIQUES

Issues of erosion and sediment management are important for a wide variety of projects including erosion and sediment management at a site scale (e.g. construction and operations EMPs for minesites and infrastructure developments, instream sand & gravel extractions), at a river reach or subcatchment scale (e.g. longer term management of sediment fluxes) and at a basin scale (e.g. understanding the “source to sink” erosion & sediment transport process).

Estimates of landscape erosion are often made using USLE-type models or their more sophisticated derivatives (e.g. SedNet). Integrated erosion and sediment transport models are also available for management planning (e.g. SedCAD) and basic riverine sediment transport predictions can be made using models such as Goldsim, @risk, HEC-RAS or HEC-6.

DEM Differencing techniques are also an extremely useful tool in providing estimates of erosion and deposition on catchment-, reach- or site-based scale.

Hydrobiology's key skill is our ability to appreciate and integrate the processes of erosion and sediment transport across these different spatial and temporal scales. We are also able to integrate the various key disciplines such as soil erosion processes, fluvial geomorphology, catchment hydrology, geochemistry and channel hydraulics.

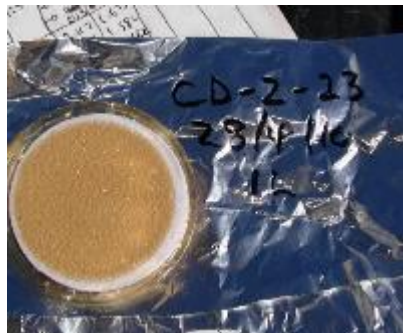
Our investigations have included field coring, soil sampling and geochemical characterisation, geomorphological field investigations, desk-based erosion and sediment transport forecasting, and the use of the latest GIS technologies to understand sediment movement.

Hydrobiology has key experts in these areas and collaborates with other experts as part of our technical quality assurance process.

APPLICATIONS

- Predictions of riverine sediment impacts from mining construction activities
- Likely catchment erosion processes under PMP conditions for dam raising study
- Project environmental approvals (EIS, SEIA)
- Baseline data collection;
- Investigative studies to inform management options
- Support ecotoxicity assessments
- Pollutant fate studies
- Environmental and human health risk assessments.

ENVIRONMENTAL CHEMISTRY



OUR SERVICES

Hydrobiology provides services in aqueous environmental geochemistry for baseline, investigative, operational and project closure requirements. Environmental geochemistry is the study of the chemical, physical and biological processes that control water and sediment quality. There are strong links with our ecotoxicology expertise allowing for an integrated assessment of the controls and impacts on environmental values. Hydrobiology often provides specialist technical assessors and advisors for projects with specific water and sediment quality issues.

SKILLS AND TECHNIQUES

Hydrobiology has expertise and experience in investigative techniques for environmental geochemistry. These include advanced sampling and analysis techniques developed in partnership with various laboratory service providers for specific projects.

Hydrobiology has applied geochemical sampling techniques to a range of aquatic environments from marine to rivers, lakes and wetlands. We have studied some of south-east Asia's most important lacustrine systems including the Malili Lakes (Indonesia), Lake Buluan (Philippines) and lakes Murray, Kutubu, Chambri and Lelua in PNG. This experience has complimented our mine pit lake expertise and studies of Australian reservoirs.

Hydrobiology has developed in-house methods for ultra-trace metals sampling in the low parts per trillion range in fresh and marine waters. This is achieved through using clean materials and techniques suitable for comparison of data to stringent environmental protection criteria. Sampling of small scale gradients in toxicant concentrations across the sediment-water interface can be used to estimate transfer rates to/from the overlying waters.

Senior staff members are regularly asked to present at industry conferences and lead workshops for environmental management professionals in the area of monitoring and impact assessment.

Our key skills and techniques include:

- Monitoring program design and implementation;
- Acid Rock Drainage (ARD)/Acid Sulphate Soils (ASS) assessments;
- Waterbody chemical, physical and biological process investigations;
- Geochemical speciation sampling and modelling (e.g. PHREEQC);
- Effluent discharge/receiving water interaction;
- Mine pit lake studies; and
- Sediment disturbance impact assessment (e.g. dredging).

APPLICATIONS

- Project environmental approvals (EIS, SEIA)
- Baseline data collection
- Investigative studies to inform management options
- Support ecotoxicity assessments
- Environmental and human health risk assessments
- Disaster crisis investigations
- Pollutant fate studies

COASTS & PORT STUDIES



OUR SERVICES

Hydrobiology provides a range of technical services critical to baseline, impact and hazard/risk assessments to assist port developers, port authorities, coastal industries and local councils. Our team offers skills and experience in marine ecology, water and sediment chemistry, ecotoxicology and coastal hydrology and geomorphology.

SKILLS AND TECHNIQUES

Hydrobiology has extensive experience in monitoring the physical marine environment (sediment / water quality, physical oceanographic) and ecosystem components (e.g. macrobenthos, fish, seagrass, coral and mangrove communities) as part of baseline studies, compliance monitoring and impact assessment.

Hydrobiology offers sector-specific technical skills in estuarine and marine flora and fauna ecology, hydroacoustics (fish biomass monitoring), habitat mapping, water and sediment quality monitoring, biomonitoring, ecotoxicology and developing and implementing risk assessment frameworks.

Our staff are highly proficient in the use of environmental guidelines such as the ANZECC/ ARMCANZ (2000) and the National Assessment

Guidelines for Dredging (2009) and have experience in applying a range of risk assessment frameworks (including the Australian Standards and US EPA).

Our key skills and techniques include:

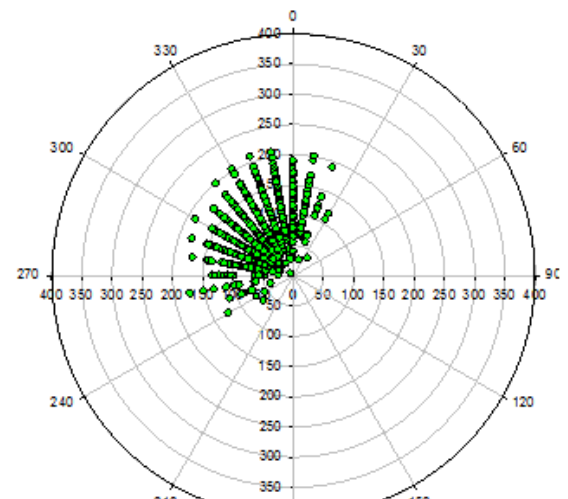
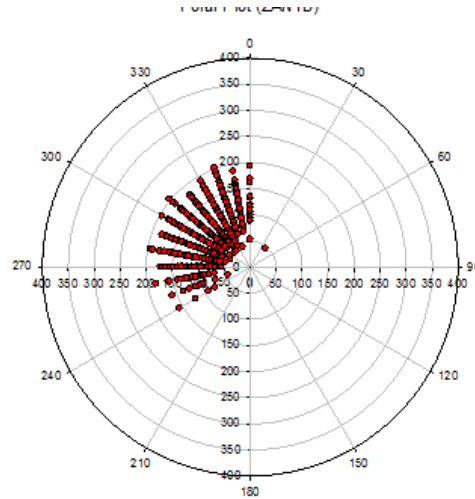
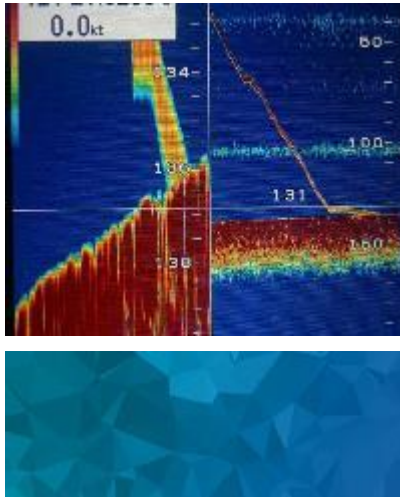
- Compliance monitoring (water, sediment and ecology);
- Conducting surveys and performing analyses to measure appropriate indicators of environmental state and assess environmental quality in marine habitats;
- Monitoring program design and evaluation;
- Coastal Hazard Assessments;
- Dredged material assessment (NAGD);
- Towed and diver operated video / photo mapping and assessment of benthic habitat;
- Hydroacoustic assessment of fish distribution and biomass;
- Risk assessment of industrial discharges (e.g. desalination, treatment plant effluents etc.) and stormwater run-off;
- Site inspections and audits;
- Approvals; and
- Physical oceanographic measurements (currents - ADCP, sedimentation, profiling, logger deployment).

APPLICATIONS

- Baseline assessments
- Impact assessments and approvals (e.g. port development, desalination plants)
- Site audits
- Environmental monitoring design and implementation (for compliance and management)
- Port authority / coastal industry Environmental Management Plans
- Sampling Analysis Plans and dredge characterisation
- Disposal ground habitat mapping and monitoring

ADCP

CURRENTS, FLOW, SEDIMENT TRANSPORT AND WAVES



OUR SERVICES

Hydrobiology provides a range of aquatic science services critical to baseline, impact and environmental risk assessments to assist port developers, port authorities, coastal industries and local councils. Our team offers skills and experience in marine ecology, water and sediment chemistry, ecotoxicology and coastal geomorphology.

SKILLS AND TECHNIQUES

This capability focus sheet provides specific information on the ADCP (Acoustic Doppler Current Profiler) methods and applications utilised by Hydrobiology. ADCP methods use changes in the speed and frequency (doppler shift) of sound as it passes through the water column to measure a range of useful parameters for marine, estuarine and river flow studies including:

- Ocean / estuarine current direction and speed;
- River flow (discharge);
- Marine and river suspended sediment;
- Wave heights and direction; and
- Water column stratification.

Hydrobiology has ADCP instruments (RDI Workhorse) that it can deploy in bottom mounted (seafloor) or boat mounted (GPS tracked spatial mapping survey) configurations. This data can then be further processed to obtain current speed and direction statistics, sediment transport loads and directions (Sediview software) and/or wave condition statistics. Alternately, raw data can be used for 2-D and 3-D hydrodynamic model calibrations and verification.

Our key skills and techniques include:

- Boat deployed "snapshot" mapping of currents (using differential GPS);
- Boat deployed river cross section flow and sediment discharge;
- Longer-term deployments for static current measurements (up to 70 m of water column with current speed and direction recorded every 0.5 m);
- Providing inputs and collaboration with hydrodynamic modelling for data acquisition and deployment design;
- Combination of ADCP measurements with other marine capabilities (e.g. hydroacoustic

APPLICATIONS

- Port development – baseline oceanographic and environmental studies
- Aquaculture projects
- Desalination discharge assessments;
- River hydrology and sediment transport studies (geomorphic)
- Estuarine water movement and exchange studies
- Effluent (e.g. TWW) and pollutant transport studies

HYDROACOUSTICS

FISH ABUNDANCE, SEAGRASS AND MACRO-ALGAE MAPPING



OUR SERVICES

Hydrobiology is, to our knowledge, the sole consultancy supplying Hydroacoustic sampling services in Australia. This highly specialised technology provides a unique method of measuring and mapping fish density, biomass and distribution in both freshwater and marine ecosystems. Using sonar-based analysis, the system scientifically, non-destructively and reproducibly measures fish resources. This is often a key concern of client projects where there is existing fishing in their project impact area and/or potential to impact fish from project activities.

SKILLS AND TECHNIQUES

This capability focus sheet provides specific information on the Hydroacoustic methods and applications utilised by Hydrobiology.

HYDROACOUSTIC METHOD

Hydroacoustics is a well-established science that has become standard for monitoring fisheries resources, for example, in most European countries. Hydrobiology staff have used Hydroacoustic sampling methods on a number of projects since the 1980s and is the leader in Australia in terms of method development and implementation for Hydroacoustic sampling.

In essence, the system is a highly accurate echosounder (Biosonics DT-X), with the ability to measure fish biomass, distribution, movements, size ranges and habitat characteristics, such as the dimensions of submerged macrophyte habitat and the distribution and extent of various benthic habitats. The measurements can be mapped as data are geo-referenced. The system used by Hydrobiology is designed for 'shallow' operation and can be used to a maximum depth of about 40 m.

This system is best suited for the fish monitoring techniques used by Hydrobiology and the typical types of habitats we work in.

The method measures and maps:

- Fish biomass (length/size), location and depth;
- Bottom type (if calibrated using additional sediment grabs/video);
- Macrophyte (underwater plants/seagrass) cover;
- Can be used as a monitoring tool for changes over time and to locate high / low biomass areas for project design and impact mitigation.

ADVANTAGES OF HYDROACOUSTIC SAMPLING

Non-destructive – Favoured by locals where regular monitoring occurs or there are cultural sensitivities about sampling and killing fish for research. Also favoured where there are rare or endangered species;

Safer – Can be operated off large and small boats (even canoes) so does not require personnel to enter the water. Avoids dangers of entanglement and dangerous fauna (e.g. sharks and crocodiles);

Efficient – Can cover large areas in a relatively short period of time.

Unique – Gathers information not available through traditional capture and video/visual methods. Can resolve behaviour and sample in depths that other methods cannot;

Robust – Provides quantitative and non-selective data (i.e. does not depend on fish being selectively caught by specific fishing methods as is traditional).

MINING

MONITORING AND IMPACT ASSESSMENT



OUR SERVICES

Hydrobiology provides services in developing and implementing baseline and impact assessment monitoring programs and environmental risk assessments. We specialise in mining and infrastructure projects across all phases from feasibility, construction, operation, closure to post closure. Our team offers expertise and experience in water and sediment quality, hydrology, sediment transport, marine and freshwater ecology and ecotoxicology.

SKILLS AND TECHNIQUES

One of the key areas that sets Hydrobiology apart is our extensive experience in conducting international "best practice" studies in remote areas with difficult logistics. Hydrobiology has developed field planning and support systems to facilitate working in remote Australia and developing nations across the globe. We have operated for major mining clients in Australia, Cameroon, Fiji, Indonesia, Laos, Papua New Guinea, Philippines, Republic of Congo, Sierra Leone, Solomon Islands and Suriname.

Hydrobiology offers a range of complimentary technical skills in data collection, impact and risk assessment for mining clients. These skills are across a wide scope of

aquatic sciences including water and sediment quality monitoring, freshwater and estuarine/marine ecology, and ecotoxicity testing. These skills are used to develop and implement risk assessment frameworks and environmental management plans.

Hydrobiology use experience and technical skills to provide scientifically robust study designs, underpinned by an appropriate choice of biological and physical parameters at appropriate spatial and temporal scales.

We can develop programs following recognised national and international standards including Australian Standards (e.g. 5667.x), AusRIVAS, ANZECC/ARMCANZ and NAGD.

Our key skills and techniques include:

- Baseline, operational and closure monitoring relating to freshwater and aquatic ecosystems;
- Monitoring program review, auditing and training;
- Risk and environmental impact assessments;
- Characterisation and quantification of sediment loads and geomorphic changes;
- Surface water hydrology and environmental hydraulics; and
- Geochemistry (water and sediments).

APPLICATIONS

- Project environmental approvals (EIS, SEIA)
- Baseline data collection
- Compliance monitoring (including training and auditing)
- Hydrological, water balance, erosion and sedimentation investigations
- Environmental management plans (EMPs)
- Environmental and human health risk assessments
- Capacity building and peer review

MINE PIT LAKES

CLOSURE PLANNING, WATER QUALITY, REMEDIATION



OUR SERVICES

Hydrobiology can provide assessment of the geochemical and biological processes of mine pit lakes and work with mining companies to explore remediation and closure options. These services can be utilised in the production of mine closure plans and contaminated site remediation. These services can be combined with traditional effluent discharge studies to assess mine pit lake dewatering options and impacts to receiving environments.

SKILLS AND TECHNIQUES

This capability focus sheet provides specific information on the mine pit lake assessment methods and applications utilised by Hydrobiology.

EXISTING MINE PIT LAKE ASSESSMENT

Hydrobiology can bring together its range of expertise and experience in the aquatic sciences to provide multiple lines of investigation into the present condition and processes occurring in mine pit lakes.

Mine pit lake waters can be highly variable in quality from the surface to bottom waters. Due to the physical structure of the typical mine pit lake, they often have multiple layers (stratification) of differing water quality based on density differences. Each layer can have its own suite of contaminants of concern and highly variable concentrations. Knowing the physical, biological and chemical structure of your pit lake water column is a key step in identifying remediation and management options.

Methods employed in pit lake research include:

- High resolution vertical profiles of "field" parameters including pH, temperature, conductivity, turbidity, dissolved oxygen, chlorophyll (phytoplankton/algae) and Photosynthetically Active Radiation (PAR);

- Laboratory analysis of a reduced number of vertical samples depending on the water column structure identified by field parameter profiling;
- Bathymetry and bottom hardness mapping using GPS referenced boat mounted sonar. Useful for determining the total volume of each lake layer as well as location of hard substrate and recent sedimentation/slumping that might not be present on mine plans;
- Geochemical modelling to assess the likely form (e.g. complexed or free ions) of contaminants and major ions in the pit lake waters. Modelling of mixing of receiving waters or other sources of water available to the mine (e.g. underground dewatering discharge);
- Experimental application of remediation options including "limnocorrals" or fencing off small areas (~3m²) of the lake to test additives/options before expanding to full lake scale works.

MINE CLOSURE PLANNING

As many open pit mines operate below the water table, mine closure often means that a pit lake will form once active dewatering stops. The shape of the final void, the depth to the water table, evaporation rates and the host rock geology can be used to estimate to likely water quality within the pit lake upon closure. Understanding the water quality is critical to understanding remediation and discharge options, particularly if a positive water balance is possible. Hydrobiology has internal resources as well as links to academic groups to provide assessment of mine closure options with respect to mine pit lakes.

ECOTOXICOLOGY



OUR SERVICES

We have specialist expertise in aquatic ecotoxicology which we utilise in a professional consulting capacity for clients in a range of industries and sectors including mining, desalination, local government (e.g. stormwater, desalination and WWTP assessment), processing (effluent discharge) and project development (e.g. dredging and sediment disturbance).

SKILLS AND TECHNIQUES

Hydrobiology has extensive experience in monitoring macrobenthos, fish, seagrass and coral communities as part of impact assessment, ecosystem health and habitat association studies. Hydrobiology offers sector-specific technical skills in freshwater, estuarine and marine flora and fauna ecology, hydroacoustics, water and sediment quality monitoring, biomonitoring, ecotoxicology and developing and implementing risk assessment frameworks.

Our staff are highly proficient in the use of environmental guidelines such as the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000), and the National Assessment Guidelines for Dredging (2009) and other international guidelines, and have experience in applying a range of risk assessment frameworks (including the Australian Standards, CCME, IFC, OECD, WHO and US EPA).

Hydrobiology has also contributed to standard development in this field.

Our key ecotoxicology skills and techniques include:

- Conducting surveys to assess diversity of flora and fauna, and other appropriate bioindicators of environmental quality in freshwater and marine habitats.
- Risk assessment of deep-sea sediment load discharge;
- Risk assessment of industrial and urbane water discharges.
- Design and implementation of ecotoxicology testing programs, which may include:
 - Direct Toxicity Assessment (DTA) of industrial or urban discharge waters;
 - Focused studies of the toxicity of specific chemical contaminants;
 - Developing site specific guidelines.
- Sediment toxicity testing to assess the suitability of dredge material for sea disposal;
- Derivation of Species Sensitivity Distributions (SSD);
- Designing and analysing efficient monitoring programmes to evaluate ecological recovery;
- Evaluation of the trophic movements in food chains through examination of contaminant levels in biota;

APPLICATIONS

- Project environmental approvals (EIS, SEIA)
- Management of mine, desalination and other industrial discharges
- Guideline development (for project management and risk minimisation)
- Investigation of fish kills and stakeholder claims of impact to aquatic organisms

DESALINATION ECOTOXICOLOGY

DISCHARGE IMPACT ASSESSMENT



OUR SERVICES

Hydrobiology provides services in discharge impact assessment for desalination projects. These services range from testing of the toxicity of the proposed/actual discharge to local and standardised aquatic species to receiving environment baseline surveys. These services are typically provided for project approvals purposes, though are also utilised in operational monitoring, process investigations and due diligence.

SKILLS AND TECHNIQUES

In Australia, seawater desalination has been identified as a way to reduce dependence on water impoundments as the sole source of community drinking water, and effectively make the potable water supply drought-proof. Prior to construction and operation of Australian desalination plants, investigations are required to determine the toxicity of a range of possible discharges. This includes lab-derived and pilot-plant brines which encompass a number of different mixtures of brines and desalination process chemicals, as well more focused assessments of individual process chemicals. Hydrobiology has been involved in these investigations in various roles, including:

- Inception and design of testing regimes;
- Interpretation of toxicity data and delivery of outcomes to stakeholders;
- Calculation of trigger value and safe dilutions of the various effluent components.

Through these different levels of involvement, Hydrobiology have been at the forefront of the environmental impact assessment of desalination plant effluent and process chemicals and now have vast experience in the design and implementation of toxicity testing programs and delivering outcomes in an efficient, timely and cost effective manner.

Our key skills and techniques include:

- Brines and process chemicals - The following items are taken into consideration during the design and implementation of the program:
 - Use of as many locally relevant species in the toxicity testing as possible;
 - Use of as many accredited toxicity tests in the assessment suite as possible;
 - Implementation of non-standard testing if deemed appropriate;
- Ecotoxicity data analysis, including:
 - Use of ANZECC/ARMCANZ (2000) methods to derive trigger values and safe dilutions;
 - Use of best available data from the suite of toxicity tests (i.e. IC10/NOEC);
 - Derivation of acute to chronic ratios to convert acute test results to chronic values for use in calculating "High Reliability" trigger values;
 - Expressing results in easy to understand terms;
 - Delivery of technical and summary reports and presentations to stakeholders.

COAL SEAM GAS WATER MANAGEMENT



OUR SERVICES

Understanding the potential environmental impacts and developing appropriate management strategies for coal seam gas (CSG) water on receiving surface ecosystems is proving to be a challenge in this rapidly-developing industry. This applies to both the quality and quantity of CSG water. Hydrobiology has expertise in these two key areas through its close involvement with the State Government Water Resource Planning process, combined with our expertise in the fields of ecotoxicology and water quality, with particular reference to ecotoxicological assessments of seawater desalination plant treated water and brine, and surface hydrology.

Hydrobiology is on the Federal Government panel of providers for expert services in relation to CSG impact assessment and recently completed the Chemical Risk Assessment Manual: for CSG chemicals on behalf of the Australian Government.

QUALITY OF CSG WATER

The toxicity of an effluent can exacerbate, nullify or have no effect on particular components of a waste stream. Chemical testing alone will not allow for a complete understanding of the possible toxic effects of the combined elements in the discharge. The results of ecotoxicity testing can be used to develop dilution factors for the safe discharge of treated CSG water to the receiving aquatic environment and allow for the implications of an accidental release of brines to be assessed.

QUANTITY OF CSG WATER

CSG operations also produce large volumes of water. Some of this may, ultimately, be released to receiving river systems. Depending on the actual volume and scale of the receiving river system, such releases may significantly alter the hydrologic characteristics of the receiving watercourses. Environmental flows assessments involve understanding what flow regimes are important for particular watercourse ecosystems, with specific reference to timing, duration and volume of flows. The manner in which CSG water may be released to downstream ecosystems is an important aspect of CSG water management.

Our key skills and techniques include:

- Liaise with regulators to ensure work program will gain government approval;
- Facilitate and coordinate the collection of samples for ecotoxicity assessment;
- Oversee the ecotoxicity assessment of CSG water samples at a NATA accredited ecotoxicity laboratory;
- Use industry best practice to derive trigger values and safe dilutions for the release of both treated CSG water and brines to the receiving aquatic environment;
- Ability to link environmental flows to ecological outcomes;
- Hydrologic modelling for ecosystem health assessments;
- Produce scientifically defensible reports.

APPLICATIONS

- Baseline assessments
- Impact assessments and approvals
- Environmental monitoring design and implementation (for compliance and management)
- Environmental Management Plans

RISK ASSESSMENT & MANAGEMENT



OUR SERVICES

Hydrobiology can provide services in risk assessment and management with respect to impacts to aquatic ecosystems. Using a combination of risk modelling and designing innovative and targeted data/knowledge acquisition programs, we build more certainty around understanding your project risks. These services can be applied to assess cumulative impacts, monitoring programs and the relative benefits between various project options.

SKILLS & TECHNIQUES

Understanding and quantifying uncertainty in environmental systems lies at the heart of managing environmental risk. Environmental systems are rarely simple, usually variable, sometimes unpredictable and normally subject to a high level of uncertainty. Because environmental management is principally about managing risk, dealing with uncertainty is critical.

It is often very difficult or even impossible to predict environmental outcomes based on such uncertainty. Environmental systems behave in complex and random ways. Combine this with a poor understanding of the environmental processes, variables and parameters, and risk management can be very difficult.

In the field of erosion and sediment transport, for example, there are a wide range of models available, some of which can give quite different results for the same set of input parameters or produce the same results with different combinations of input variables and

parameters (the equifinality issue). Having selected a particular model, it is then often difficult to determine appropriate values for input parameters based on lack of field data, and the spatial and temporal variability of those variables and parameters. Overall, then, confidence in outcomes is often low. Similar analogies can be found in numerous other types of environmental systems.

Although - according to the old adage - all models are wrong, but some are useful, uncertainty can be incorporated into almost all modelling analyses using Monte Carlo methods, whereby uncertainty can be identified and quantified by repeatedly running a particular model with inputs selected at random from their pre-defined probability distribution functions. By analysing hundreds or thousands of possible outcomes, the probability of certain results occurring can be determined. The Monte Carlo framework therefore explores the reality and complexity of environmental systems, can deliver a range of outcomes including an understanding of system behaviour, dominant processes and their interactions and, ultimately, assist risk assessors and managers.

Hydrobiology has used the Monte Carlo methods in a variety of risk assessment projects including river hydraulics, erosion and sediment yield and the analysis of wildlife movement. Some typical applications are described below.

Our key skills and techniques include:

- Monte Carlo modelling
- Statistical analysis
- Data quality and gap analysis

APPLICATIONS

- Risk Registers
- Evaluating data collection priorities
- Identifying critical variables of complex environmental systems
- Identifying how processes, variables and parameters interact
- Environmental risk assessment
- Prioritising management actions for situations where data and resources are limited



TECHNICAL EXCELLENCE
AND HIGH LEVEL
SCIENTIFIC EXPERTISE
DELIVERED WITHIN A
COMMERCIAL FRAMEWORK

PROVIDING OUR CLIENTS
WITH THE BEST POSSIBLE
UNDERSTANDING OF RISK
FOR THEIR ENVIRONMENTAL AND
IMPACT MANAGEMENT NEEDS



27 / 43 Lang Parade
Auchenflower 4066
QUEENSLAND



PO Box 2151
Toowong 4066
QUEENSLAND



+61 (0)7 3721 0100 P
info@hydrobiology.biz

www.hydrobiology.biz