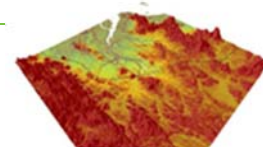


# Landscape Science & Environmental Evaluation

October 2013

## Resilient and sustainable development by design



### Overview

We offer clients the following services through our own and allied partners:

- ◆ Detailed soil survey for irrigation development
- ◆ Soil and land resources survey for agricultural capability, strategic cropping, land suitability assessment, soil carbon baseline assessment
- ◆ Acid sulfate soil risk assessment and management
- ◆ Contaminated soil survey & remediation
- ◆ Groundwater contamination monitoring and remediation
- ◆ Environmental approvals and management plans, EPBC Referrals
- ◆ Visual impact assessment
- ◆ Environmental offsets
- ◆ Due diligence biodiversity and archaeological surveys
- ◆ Final landform and cover design
- ◆ Mine closure planning
- ◆ Mine site rehabilitation
- ◆ Sediment & erosion control planning
- ◆ Project management

### Best Practice Skills & expertise

#### Detailed soil survey

**Context:** Good quality agricultural land is protected from development on the Liverpool Plains, NSW:

- ◆ Grid survey designed to identify highly productive soils
- ◆ Proposed modelling approach to extrapolate soil information to new areas.

**Solutions:** Horizon working with McKenzie Soil Management to define land capability constraints to development.

#### Erosion management

**Context:** Erosion risks are heightened during development of TFS sandalwood plantations in the Douglas-Daly, NT:

- ◆ Undertake digital terrain analysis to resolve erosion risks at irrigation planning scale.
- ◆ Recommend erosion controls most appropriate to development constrains and local conditions.

**Solutions:** Horizon developed and analysed terrain data to map erosion

risk, liaised with operations personnel to implement a management plan during plantation development.

#### Mine Landscape Restoration

**Context:** Outcomes from open cast mine rehabilitation are unreliable where there is significant relief. The problem relates to:

- ◆ detailed but unsupported botanical objectives for mine rehabilitation
- ◆ 75% of active mining & exploration in areas of high conservation value & watershed stress
- ◆ 30% in intact ecosystems of high conservation value
- ◆ concerns about the impact of mining on global biodiversity and critical ecosystems

**Solutions:** Horizon developed ecological landform design methods to link ecological studies with landform design — providing some assurance of ecological outcomes prior to construction.

#### Ecological design refers to:

- ◆ identifying the relevant ecological grain size and extent of analogue landforms
- ◆ designing ecological surveys to statistically support landform design
- ◆ predicting species distributions in the reconstructed landscape
- ◆ predicting environmental processes, such as surface water-groundwater interaction, that support ecosystem diversity
- ◆ design and evaluation of constructed covers/soils for ecosystem support

#### Hydrochemical Assessment of Caustic Impact to Groundwater

**Context:** Assessing caustic groundwater impact from alumina refining in coastal environments requires site specific groundwater trigger levels. The problem relates to:

- ◆ unreliable generic guidelines
- ◆ hydro-chemical variability in coastal groundwater systems
- ◆ plume boundaries that vary with operational issues and passive remediation processes
- ◆ regular optimization of

groundwater recovery systems is needed to maintain their efficacy

**Solutions:** Horizon developed a major ion characterisation method to classify background variation, set caustic impact trigger levels for recovery systems, define plume extents and monitor remediation using control charts.

#### Hydrochemical characterisation relies on:

- ◆ fingerprint diagrams to classify impacted and non-impacted groundwaters
- ◆ mixing model composition diagrams to identify and classify background variation
- ◆ control charts to track groundwater remediation to background conditions

#### Digital Soil Mapping (DSM)

**Context:** Soil maps are unreliable at project scales and digital soil mapping methods using statistical inference are replacing thematic mapping. Opportunities relate to applying high resolution digital soil mapping methods to:

- ◆ land resources assessment
- ◆ ecosystem survey
- ◆ environmental impact assessment

**Solutions:** Horizon applied Digital Soil Mapping (DSM) to extensive land resources assessment in northern Australia (Tiwi Islands, Christmas Island) and detailed ecosystem survey for mine rehabilitation (ERA Ranger Mine in Kakadu).

The DSM method refers to:

- ◆ robust database and survey design
- ◆ statistical modeling of soil property and soil type variation
- ◆ data-based mapping approach with an estimate of uncertainty that can be updated with new survey information.

#### Soil Carbon Farming Initiative (CFI)

**Context:** Soil carbon baseline and change measurement are the basis of the national carbon farming initiative (CFI). There are opportunities in

quantitative land evaluation to assess soil carbon status and measure change at the paddock scale using a phased survey approach:

- ◆ Phase 1: spatially nested sampling design for soil carbon to establish spatial variance to optimise detailed survey design and correlate laboratory determination with field determination using a hand-held Near Infrared Spectrometer (NIR) and a recording cone penetrometer
- ◆ Phase 2: optimised detailed grid survey to establish soil carbon status in the field using NIR.

**Solutions:** Application of Near Infrared Spectrometer (NIR) and recording cone penetrometer measurements to paddock scale soil carbon assessment.

### Environmental Impact Assessment

#### INPEX Blaydin LNG Plant

- ◆ Visual Impact Assessment
- ◆ Topography, soils, catchment impact

### Project Experience

#### Blacktip & Trans-Territory LNG Pipeline

- ◆ Surface and groundwater Impact

#### Maud Creek Gold Mine EIS

#### Christmas Island Phosphate EIS

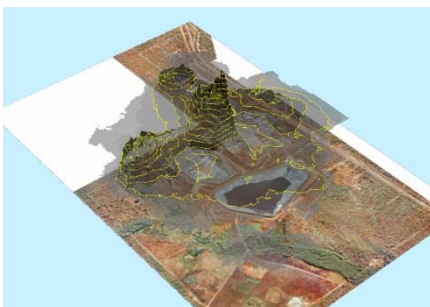
- ◆ Soil and landform impact
- ◆ Visual impact
- ◆ Mine rehabilitation plan

#### Jabiluka EIS

- ◆ Soil and landform impact

#### Woodcutters Base Metal Mine

- ◆ Contaminated site assessment

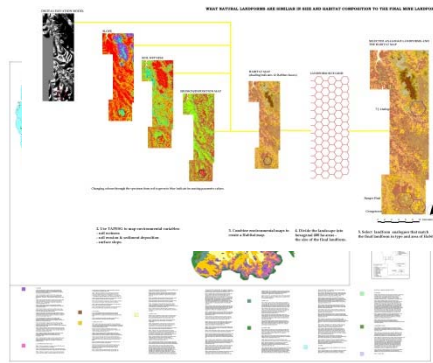


#### Client: NT Government & Tiwi Land Council

- ◆ Tiwi Islands digital soil mapping, land capability and suitability mapping

#### Client: ERA Ranger Mine

- ◆ Target natural analog landform properties and ecological surveys
- ◆ Conceptual final landform and cover design



- ◆ Ecological modeling of final landform vegetation pattern.
- ◆ Trial final landform revegetation, hydrological monitoring and modeling
- ◆ Stakeholder consultation with Traditional owners and regulators
- ◆ Progressive mine rehabilitation – revegetation
- ◆ Sediment and erosion control plans
- ◆ Stage 1 and Stage 2 Contaminated land surveys
- ◆ Stage 3 and Stage 4 contaminated land remediation and validation for independent audit
- ◆ Erosion mapping
- ◆ Irrigated waste water disposal system optimisation



#### Client: Department of Defence

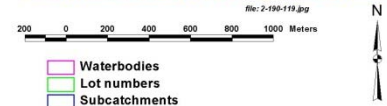
- ◆ Bradshaw training area land resources mapping for training area management
- ◆ Bradshaw training area land condition monitoring

#### Client: Sylvatech

- ◆ Site quality assessments for *Acacia mangium* plantations on Melville Island

#### Client: Rio Tinto Alcan Gove/Pacific Aluminium

- ◆ Groundwater impact monitoring and reporting
- ◆ Groundwater recovery system optimization
- ◆ Mineral waste management plan
- ◆ Environmental approvals for residue area expansion projects
- ◆ Due diligence biodiversity surveys



- ◆ 2010 Water Management Plan
- ◆ 2011 Mine Management Plan reporting
- ◆ Environmental approvals for the sewage treatment plant upgrade
- ◆ 2011 Waste discharge license report
- ◆ Waste water neutralization plant prefeasibility study, discharge options analysis

#### Client: CSIRO Land & Water

- ◆ Warren Reservoir Catchment soil mapping and water quality risk assessment GIS
- ◆ Non-point source dissolved organic carbon contamination and herbicide mobilization risk
- ◆ Site quality assessment for forestry
- ◆ Shrink-swell soil risk assessment to buried cables
- ◆ Soil formation from spoil

#### Client: CONSULMET

- ◆ Merlin Diamond Mine, Stage 3 environmental gaps analysis

#### Client: Cardno

- ◆ Girraween Lagoon estate subdivision impact assessment on surface water

#### Client: Sedgman Yates Pty Ltd

- ◆ Styx River Project, Central Queensland Strategic Cropping Land and Good Quality Cropping Land Assessment

#### Client: GSS Environmental Pty Ltd

- ◆ Peer reviewed Strategic Cropping Land and Good Quality Cropping Land assessment reports for coal mining clients.

#### Client: Department of Agriculture and Fisheries, Carbon Farming Initiative (CFI)

- ◆ Community assessor of on ground projects for CFI
- ◆ National Soil RD&E Strategy reference group member

## Equipment

### Field measurement of:

- ◆ soil bulk density, saturated hydraulic conductivity, soil water content, soil infiltration rate, soil carbon, pH and EC
- ◆ groundwater level, pH, temperature, DO, redox using low flow micropurge sampling systems.
- ◆ Automated climate, catchment and soil profile hydrological monitoring systems
- ◆ Pore water samplers and lysimetry

### We use:

- ◆ NatSoil soils database (national soils database compliant)
- ◆ ArcGIS and SAGA for geographic spatial analysis and modeling
- ◆ Minitab & R statistical tools
- ◆ SADA spatial analysis and decision assistance system for contaminated site management
- ◆ ProUCL software for statistical evaluation of contaminated site data
- ◆ CMSS catchment management support system
- ◆ TIME/CLASS Spatial Analysis catchment analysis and terrain modeling software
- ◆ Concept tool for creating dynamic conceptual designs
- ◆ Terragen virtual landscape visualization
- ◆ APSIM cropping systems simulation
- ◆ EndNote bibliographic database

We contract NATA registered laboratories that support advanced organic and inorganic chemistry and soil physical analysis (water retention, saturated and unsaturated hydraulic conductivity).

## Research Contributions

### Digital soil mapping

- ◆ Developed and applied DSM methods to large area land resources mapping in northern savanna landscapes
- ◆ Developed quantitative site quality assessment tools for plantation forestry

### Mine rehabilitation

- ◆ Developed and applied a range of statistical ecological modeling methods to mine landform design for biodiversity objectives.

### Groundwater impact assessment

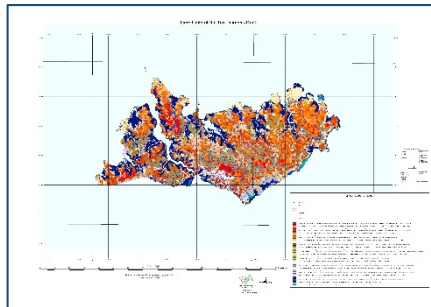
- ◆ Applied major ion characterization methods to assess caustic groundwater impact from alumina refining and setting site-based trigger and remediation objectives.

### Non-point source contamination

- ◆ Soil assessment to evaluate herbicide mobility risk in water supply catchments.

### Site quality assessment for forestry

- ◆ Statistical forest site quality modeling from soil, terrain and remote sensing data.



## Quality & Risk Management

Horizon has a quality management system that uses the principles of ISO 9001:2000 to implement business practices that focus on quality management.

We have a digital document management system that uses proprietary bibliographic and reference software (Endnote V2, Thompson Scientific) to store, access and report all controlled documents. This includes business system forms, copies of receipts and invoices, business system procedures and client reports. We do not undertake engineering design work. Our risk management approach considers each job based on:

- ◆ Professional Indemnity/Liability, commercial/Legal Liability/Public Liability
- ◆ Occupational Health and Safety



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