Mordialloc Bypass Project

Report of Ray Hatley

1 Introduction

My firm WSP prepared the impact assessment report titled Mordialloc Bypass – Groundwater Impact Assessment (Report) which is included as Appendix K to the Environment Effects Statement (EES) for the Mordialloc Bypass Project (Project).

The role that I had in preparing the Report was Principal Hydrogeologist and Technical Reviewer. Other significant contributors to the Report include WSP employees (at the time of EES report preparation):
- Alistair Stewart – Senior hydrogeologist;
- Dr Wendy McLean – Principal hydrogeochemist and isotope scientist; and
- Ellen Kwantés – Senior hydrogeologist.

I adopt the Report, in combination with this document, as my written expert evidence for the purposes of the Mordialloc Bypass Project Inquiry and Advisory Committee’s consideration and reporting in respect of the Project.

2 Qualifications and experience

Appendix A contains a statement setting out my qualifications and experience, and the other matters in accordance with Planning Panels Victoria's 'Guide to Expert Evidence'.

A copy of my curriculum vitae is provided in Appendix B.

3 Further work since preparation of the Report

Water level monitoring

Since the Report was finalised, WSP has continued to monitor groundwater levels within the Project’s groundwater monitoring bore network. This data has been appended to existing data sets and provided below. The addition of ongoing data supports the statements made in the EES and supporting technical documents.

Refer to Section 4 (Written Submissions) for further details on groundwater level monitoring.

Alternative Alignment

Details of the alternative Lower Dandenong Road / Mordialloc Bypass Freeway interchange arrangement was outlined in a technical memo dated 31 January 2019. The changes of this interchange were reviewed to assess if there would be any additional potential risks in respects to groundwater compared to the reference design. It is my expert opinion that the alternative intersection does not present any new potential risks to the groundwater system, nor is any additional work required to assess the alternative interchange.

4 Written Submissions

4.1 Submissions Received

I have read the public submissions in respect of the EES and draft Planning Scheme Amendment for the Project and identified those that are relevant to the Report and my area of expertise. These include the following submissions: 14, 28, 44, 60, 76, 83, 84, 87, 90, 92, 97, 98, 100, and 102.
4.2 Summary of Issues Raised

The submissions have raised the following issues relevant to my area of expertise:

- Impacts to groundwater - water levels and water quality
- Baseline / ongoing groundwater monitoring input to Environmental Performance Requirements (EPRs)
- Cumulative impacts to sensitive receptors arising from both the proposed Mordialloc Bypass and Level Crossing Removal Authority (LXRA) Edithvale – Bonbeach project
- Groundwater – surface water interaction, and groundwater dependant ecosystems
- Climate change.

4.3 Response to Issues Raised

Set out below are my comments and response to the issues raised by the written submissions relevant to my area of expertise.

A number of submissions raised concerns pertaining to the contamination of groundwater, disturbance and acidification of acid sulphate soils, and the impacts on the landfills arising from road construction on these pre-existing installations and any disturbance to groundwater. These issues were assessed as part of the soil and contaminated land assessment and are addressed by the contaminated land expert witness.

Impacts to groundwater

To assess the potential impacts to groundwater the groundwater impact assessment developed a numerical groundwater model, based on regional and observed data obtained throughout the prior studies and the EES process, to simulate the groundwater environment before and after project construction. This regional numerical model built for the Project was developed to conform with the Australian groundwater modelling guidelines (Barnett et al, 2012) which provide guiding principles and minimum standards of numerical groundwater models.

The primary objective of the groundwater modelling was to quantify conceptualised groundwater behaviour and impacts to groundwater resources and associated environmental values. In particular, the model focussed on assessment of the impacts to the constructed wetlands including Edithvale Wetlands; Waterways Wetlands, Braeside Park Wetlands, and the Woodlands Industrial Estates Wetlands, in response to the proposed embankment placements for the Project. The modelling also aimed to quantify cumulative impacts associated with the LXRA Edithvale and Bonbeach Projects, when considered in conjunction with this project.

The design, construction and calibration of the numerical model was tailored to meet the modelling objectives. The model is consistent with the conceptual hydrogeological model in the main report (WSP, 2018) and Section 2 of the Groundwater Modelling Report (Appendix A to the Report) and included an inherently conservative approach with parameter inputs (spatial extents, aquifer permeability and compaction quantification) giving rise to a worst-case outcome to impact assessment.

Once set up, the numerical model was calibrated to broadly replicate groundwater levels measured and flow directions calculated from Project data collected. Following calibration, the model was used to simulate the impacts of the Project on groundwater resources and associated environmental values.

The numerical model impact predictions determined that the project would have negligible impacts, with small modelled impacts to groundwater levels in the order of 0.10 to 0.15 m beneath the embankments.
themselves. There are negligible changes to groundwater levels outside the embankment areas and project boundaries.

Sensitivity analysis of the model was undertaken to assess the response of the calibrated transient model by changing model input parameters. The results show that predicted groundwater impacts (in terms of water level and flow effects) are similar (negligible) for all uncertainty runs, providing additional confidence in the predictions under calibrated conditions. The results also imply that groundwater impact to the Edithvale Wetland as a result of the embankments remains negligible under current accepted climate change scenarios.

The modelled impact (from 0.10 to 0.15 m) is virtually undetectable given that the observed seasonal variations (from ~0.5 to 1.0 m) in groundwater levels are much larger in comparison.

As per the Australian groundwater modelling guidelines, an independent peer review of the numerical groundwater model was undertaken by Dr Anthony Smith of CDM Smith. The model was deemed fit for purpose and does not contain significant technical flaws or errors.

**Baseline / ongoing groundwater monitoring input to EPRs**

When developing the groundwater monitoring bore network, ongoing monitoring was among one of the key considerations. The objectives of the groundwater and surface water monitoring program was to:

- Provide baseline water level data both seasonally and spatially across relevant hydrostratigraphic units along the project alignment.
- Provide baseline water quality data for geochemical analysis, support contamination investigations, geotechnical design, and to assist in the development of EPRs
- Support the development of a numerical groundwater impact model by providing stratigraphy, aquifer properties (hydraulic conductivity) and groundwater level data.

The Project Environmental Management Framework requires preparation of a Water Management and Monitoring Plan (WMMP) (EPR reference W5). The WMMP is to be prepared in consultation with EPA Victoria and relevant water authorities, and is required to be implemented prior to construction, during construction and for five years following opening the project to the public. The WMMP must incorporate both surface and groundwater monitoring.

Incorporating the baseline data collected to date, the WMMP must include:

- detail of the monitoring parameters, including the frequency and location of surface water monitoring points and groundwater monitoring bores
- specific trigger levels (water quality in surface water bodies and groundwater bores) and details of contingency plans in the case trigger levels are exceeded
- detailed reporting requirements
- roles and responsibilities, not limited to:
  - the owner of monitoring network assets
  - the manager of monitoring network assets and results
  - the party (or parties) undertaking monitoring (prior to construction, during construction and for five years following opening).

The requirements of the WMMP are considered to be appropriate given the nature of the predicted impacts of the project.

Since the wetlands are demonstrated to be overwhelmingly sustained by surface water run-off from local urban areas, the need for setting groundwater specific EPRs is not considered warranted. Further, it is noted that the reference design of the proposed Mordialloc Bypass does not require the excavation of
trench structures requiring the dewatering of aquifers which would give rise to significant impacts to the aquifers intersected by the trench. Therefore, direct comparisons to groundwater EPRs developed for the LXRA Edithvale-Bonbeach EES cannot be made. The negligible impacts to groundwater predicted by the numerical groundwater model is considered to be of high confidence due to its inherent conservatism, and therefore, the requirement for additional groundwater EPRs outside the development of the WMMP is not considered to be warranted.

**Impacts to groundwater - Water Level Monitoring**

The majority of the groundwater monitoring bore network has groundwater level loggers installed allowing for the ongoing groundwater level monitoring at 6 hour intervals. Depending on the bore, this data logging commenced in August 2017 after the installation of the initial monitoring bores. Additional level loggers were added as the monitoring network was progressively expanded.

A complete inspection of the groundwater monitoring bore network was completed in January 2019 to assess the operational status of the water level loggers and download water level obtained since June 2018. This data has been appended to the existing hydrographs (originally found in Section 5.6.5 of the GWIA). Figure 1 and Figure 2, presented below shows the latest groundwater monitoring data. Distinct seasonal patterns can be observed between winter and summer months and major rainfall events.

The addition of new groundwater level data supports conclusions made in the GWIA and EES on the natural variability of groundwater levels observed within the Study Area.

![Figure 1 Quaternary Aquifer Groundwater Levels (mAHD)](image)
Figure 2 UTAF Aquifer Groundwater Levels (mAHD)

**Impacts to groundwater - Water Quality Sampling**

A number of submission raise concerns in regards to water quality.

A strong understanding of the groundwater quality setting for the project area was investigated in order to substantiate the key factors influencing the water quality in the wetlands be they influenced by urban run-off, rainfall evaporative salinisation and/or sea water intrusion into aquifers connected to Port Phillip Bay. Changing groundwater flow and flux to the wetlands by the project was investigated to evaluate likely impacts. The monitoring program was therefore designed to determine the water quality conditions of the various key wetlands and groundwater aquifers as a means of establishing the baseline setting for the project.

Quarterly groundwater and surface water quality sampling was undertaken over a period of 12 month to capture seasonal variability in water quality and to obtain baseline water quality data. Details of groundwater and surface water sampling are provided in Section 4.3.2.3 of the GWIA.

Water samples were collected from 35 groundwater monitoring bores and 17 surface water locations as shown in Figure 4.1 of the GWIA. Groundwater samples were also collected from 7 LXRA groundwater monitoring bores and Port Phillip Bay to supplement the GWIA, support groundwater source fingerprinting, and support the cumulative impact assessment. Water samples were submitted to NATA accredited labs for the following analysis:

- Physico-chemical parameters (pH, EC, TDS)
- Major Ions (Ca, Cl, HCO3, Mg, K, Na, NO3, SO4, Br, F)
- Dissolved Metals (Al, As, Ba, Be, B, Cd, Cr, Co, Hg, Pb, Mn, Ni, Se, V, Zn)
- TRH/TPH & BTEXN
- Pesticides (First sampling event only)

The water level and water quality data forms the groundwater existing baseline data for the project and is to be used in the development of the WMMP (EPR W5) as outlined above. The quarterly sampling and
ongoing water level monitoring is sufficient in capturing seasonal variability of groundwater quality and levels within the groundwater systems.

**Cumulative impacts to sensitive receptors arising from both the proposed Mordialloc Band LXRA Edithvale – Bonbeach project**

The LXRA Edithvale and Bonbeach and Mordialloc Bypass projects share a similar geographical region with the Edithvale level crossing removal approximately 2.5 km to the west of the project alignment within the same hydrogeological regime.

Whilst the Mordialloc Bypass does not involve the excavation of trench structures (as does the LXRA project), it does involve the placement of elevated embankments (conceived as potentially posing a risk to groundwater flow conditions through aquifer loading and compaction), both projects identified the Edithvale portion of the Edithvale-Seaford Wetlands as a sensitive receptor to potential cumulative project-related impacts. As such MRPV and LXRA established a data sharing and cooperative arrangement allowing MRPV access to LXRA groundwater bores and water quality data. This has allowed the incorporation of select LXRA monitoring bores into the project groundwater monitoring network. The data obtained to date has assisted in the development and calibration of the project’s own numerical groundwater model.

The numerical groundwater model provides the basis for the groundwater impact assessment for the Mordialloc Bypass and includes data obtained by LXRA with several references to LXRA groundwater bores and the LXRA Edithvale Wetlands site investigation program. To maintain consistency between projects, MRPV has engaged the same independent third party reviewer (CDM Smith).

As described above, the numerical modelling completed for the Mordialloc Bypass shows that the slight changes to the groundwater level do not reach beyond the embankments themselves and will not impact groundwater levels adjacent to the wetland, nor will they meaningfully change the rate of groundwater discharge to the wetlands.

The LXRA report findings indicate that changes to the water table elevation as a result of that project will not extend eastwards as far as the Edithvale Wetlands. As such, no cumulative impacts to the wetland are expected as a result of both the Mordialloc Bypass and the Edithvale – Bonbeach LXRA projects.

It is important to note that the Edithvale wetlands experience large seasonal variation in water level and are managed by Melbourne Water in accordance with the Edithvale-Seaford Wetlands Ramsar Wetland Site Management Plan (Ecology Australia, 29-9-2016).

For more details see Section 7.3 of the Groundwater Impact Assessment (GWIA) and Section 4.4 of the Groundwater Modelling Report (Appendix C of the GWIA).

**Groundwater – surface water interaction, and groundwater dependant ecosystems**

Groundwater / surface water interactions and, in particular, the interaction between groundwater and the local and regional wetlands has been one of the primary focus’ of the GWIA.

To determine the risk and understand the potential impacts, the GWIA included a comprehensive literature review, groundwater and surface water sampling, geochemical and isotopic analysis, water balance modelling and the development of a numerical groundwater model.

The findings of the GWIA supported previous investigations in identifying wetland cells with groundwater dependence and those relying on surface water. Anthropogenic wetlands, such as the Waterways, were constructed with a clay liner to minimise loss to groundwater recharge and to prevent intrusion of more saline groundwater.

Sections 5.4 in the GWIA describes the surface water features including the Edithvale-Seaford Wetlands (Edithvale portion only), Braeside Park, Woodlands Estate and Waterways Estate wetlands, Mordialloc Creek and several anthropogenic drains within the Study area.
Section 5.8 of the GWIA details the findings of the water sampling and monitoring including water quality (Section 5.8.1 & 5.8.2) and the detailed geochemical analysis (Section 5.8.2.1).

The geochemical analysis compared the major ion composition to ‘fingerprint’ water types, chloride and bromide ratios to determine the causes of groundwater salinisation and stable isotope analysis to determine recharge sources to groundwater dependant wetlands.

The characterisation of groundwater – surface water interaction between the wetlands and groundwater dependant ecosystems supported numerous previous technical investigations including statements on groundwater dependence within Melbourne Water’s Edithvale-Seafood Wetlands Ramsar Site Management Plan (Ecology Australia 2016).

**Groundwater Recharge**

There are two relevant hydrostratigraphic units (HSUs) within the study area being the Quaternary Aquifer (QA) and Upper Tertiary Aquifer Fluvial (UTAF see section 5.6 for more details on these HSUs) within the Study area.

These HSUs are geographically extensive throughout the South East of Melbourne with outcropping units found north of Essendon, Pakenham in the East and the Mornington Peninsula in the south.

Direct and indirect rainfall infiltration is the primary recharge mechanism to both the QA and UTAF aquifers with recharge zones corresponding to the outcropping HSUs. The change of land use through construction of embankments and hardstands as part of the project is very unlikely to impact recharge to the aquifers as the direct area impact is minimal when compared to the recharge zone of the HSUs.

Typical runoff drainage designs deliver water from hardstand to vegetated drainage lines / swales that encourage infiltration to groundwater.

Groundwater recharge mechanisms are detailed in section 5.6.3 within the GWIA.

**Climate change.**

Impacts of climate change were assessed as part of the uncertainty analysis and is discussed in Section 4.5.1 of the Groundwater Modelling Report. Current CSIRO climate models indicate a reduction of rainfall and changes in rainfall intensity and duration is likely over the next 50 years. The recommended approach for assessing the effects of climate change on regional unconfined aquifers is to factor the groundwater recharge by a percentage as determined from climate modelling by Petheram (2002). This approach and was adopted for assessing climate change as part of the uncertainty analysis using DELWP climate change rainfall predictions.

In this study, the assessment of climate change was carried out as part of the uncertainty analysis, whereby the expected range in rainfall in 2065 (from climate modelling) is incorporated into the range in rainfall recharge applied on the uncertainty (Monte-Carlo) analysis described in Section 4.5 of the Groundwater Modelling Report. It is concluded that groundwater impact to the Edithvale Wetlands as a result of the embankments is unlikely to be meaningful under the currently accepted climate change scenarios.

**Environment Performance Requirements**

Ongoing monitoring will be included in the Water Management and Monitoring Plan (WMMP) (EPR reference W5), a requirement of the Project Environmental Management Framework. The WMMP is to be prepared in consultation with EPA Victoria and relevant water authorities, and is required to be implemented prior to construction, during construction and for five years following opening the project to the public. The WMMP must incorporate both surface and groundwater monitoring. In my opinion no further EPR are required to manage groundwater impacts to the project.
Declaration

I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Inquiry and Advisory Committee.

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Signed

Date: [insert]
Appendix A  Matters Raised by PPV’s Guide to Expert Evidence

(a) The name and address of the expert

Raymond Keith Hatley, Senior Principal Hydrogeologist, WSP Australia, Level 27, 680 George Street, Sydney 2000 NSW.

(b) The expert’s qualifications and experience

<table>
<thead>
<tr>
<th>SIGNIFICANT CONTRIBUTORS</th>
<th>PROFILE</th>
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</table>
| Ray Hatley – Capability executive – Hydrogeology | Ray has 34 years’ experience providing geological, hydrogeological, geotechnical and environmental services to road, rail and tunnel infrastructure projects, mining, energy, industrial, land development, construction, state and federal government clients in project director, project manager, coordinator, advisory or technical review, and Independent Certifier roles. He has completed work covering major Victorian, NSW, and Queensland transport infrastructure projects. Work Ray undertook included groundwater related inflow and dewatering assessments for road and rail tunnels, caverns and dive structures; road and rail cutting/embankment pore pressure assessments, dewatering monitoring and management; environmental impact of road and rail alignments on groundwater users, vulnerable ecological communities and GDE’s, risk assessment (review, methodology development and management/mitigation decision-making); acid sulphate soil, metals and nutrient runoff management; contaminant mobilisation assessment, monitoring and management; and design evaluation, input and adequacy review. Key transport infrastructure projects Ray has had substantial involvement in include:

— LXRA Cheltenham and Mentone;
— Beaufort Bypass;
— MRPA – Suburban Road Upgrades;
— EastLink Freeway;
— WestConnex (NSW);
— M5 East Motorway (NSW);
— Pacific Highway Upgrade - Tintenbar to Ewingsdale (T2E)(NSW);
— Pacific Highway Upgrade - Warrell Creek - Nambucca Heads – Urunga (NSW); and
— Toowoomba Second Range Crossing (Qld);

Other works completed cover water resources, water supply schemes, and groundwater works for water conveyance, defence, industrial, commercial and petrochemical facilities (contaminated land assessment and remediation), oil and gas projects, and mining and mineral process operations. |

Raymond’s CV is located in Appendix B

(c) A statement identifying the expert’s area of expertise to make the report
(Raymond’s area of expertise is hydrogeology and hydrogeochemistry)

Raymond’s CV is located in Appendix B.

(d) A statement identifying any other significant contributors to the report and where necessary outlining their expertise

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<thead>
<tr>
<th>SIGNIFICANT CONTRIBUTORS</th>
<th>PROFILE</th>
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<tbody>
<tr>
<td>Ellen Kwantes – Senior Hydrogeologist</td>
<td>Ellen is a senior hydrogeologist and an accredited Registered Professional Geoscientist in the field of Hydrogeology. Ellen has 11 years’ experience in groundwater investigations, with specific expertise in groundwater modelling, environmental assessments, environmental monitoring programs, geochemistry, groundwater-surface water interaction, drilling supervision and surface water assessments.</td>
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<tr>
<td>Wendy Mclean – Principal Hydrogeochemist</td>
<td>Wendy is a Hydrogeochemist and Hydrogeologist, and is an accredited Registered Professional Geoscientist in the fields of hydrogeology and hydrogeochemistry. She has a background in Earth Science and over 16 years’ experience in environmental studies and hydrogeology, with a focus on hydrogeochemical, environmental isotope and applied tracer techniques in hydrogeology. Wendy has undertaken groundwater and surface water investigations in a range of hydrogeological environments throughout Australia and internationally, and has been involved in many projects investigating water quality, groundwater contamination, salinity, coal seam gas development, longwall mining and other mining related hydrogeological issues, groundwater-surface water linkages, groundwater dependent ecosystems and water resource supply. Wendy was awarded an ARC Fellowship and was a key researcher in an ARC Linkage Project trialling novel isotopic methods for assessing aquifer and surface water linkages.</td>
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<tr>
<td>Alistair Stewart – Senior Hydrogeologist</td>
<td>Alistair is a senior hydrogeologist with over nine years’ professional experience in groundwater investigations across Australia. Alistair has specific expertise in groundwater impact assessments and groundwater characterisation. Alistair also has extensive site based experience including drilling supervision, aquifer / pump testing, baseline investigations, and groundwater/surface water sampling. His project experience includes several large groundwater impact assessments for both greenfield and brown field resource projects, linear infrastructure projects, and large water resource infrastructure projects.</td>
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(e) All instructions that define the scope of the report (original and supplementary and whether in writing or oral)

The Groundwater Impact Assessment and EES chapter was prepared to address the key issues pertaining to groundwater outline within the Scoping Requirements for the Mordialloc Bypass Environment Effects Statement (DELWP 2018).

Instruction to produce this Groundwater Expert Report was made by Clayton Utz

(f) The identity of the person who carried out any tests or experiments upon which the expert has relied on and the qualifications of that person
• Water quality analysis by Australian Laboratory Services Pty Ltd (ALS) – Nata accreditation number: 825
• Isotopic analysis by University of California – Davis (UC Davis) Stable Isotope Facility

(g) A statement setting out any questions falling outside the expert's expertise

The work covered by the GWIA is considered to be, in its entirety, to be within the Raymond’s area of expertise

(h) A statement setting out any key assumptions made in preparing the report

The groundwater impact assessment is based on previous technical investigation, scientific literature, site data and analysis. The impacts were assessed by the development of a numerical groundwater model which independently reviewed and deemed to meet industry standard with appropriate assumptions and inputs.

(i) A statement indicating whether the report is incomplete or inaccurate in any respect

The report is considered complete and fit for purpose having assessed the potential risks to groundwater and the local and regionally located wetlands using industry best standard methods and multiple lines of evidence.
Appendix B   CV
RAY HATLEY  
Capability Executive - Hydrogeology

PROFILE
Ray has 34 years’ experience providing geological, hydrogeological and environmental services to transport, infrastructure and land development, construction, mining, energy, industrial, state and federal government clients and community groups. He has worked on projects for these clients in Australia, Africa, China, South America, the USA, Indonesia and Papua New Guinea in project director, project management, coordinator, advisory or review roles.

He has completed work covering major Victorian, NSW, and Queensland transport infrastructure projects. Work Ray undertook included groundwater related inflow and dewatering assessments for road and rail tunnels, caverns and dive structures; road and rail cutting/embankment pore pressure assessments, dewatering monitoring and management; environmental impact of road and rail alignments on groundwater users, vulnerable ecological communities and GDE’s, risk assessment (review, methodology development and management/mitigation decision-making); acid sulphate soil, metals and nutrient runoff management; contaminant mobilisation assessment, monitoring and management; and design evaluation, input and adequacy review.

EDUCATION
BSc (Geology and Chemistry), University of Natal, Durban, South Africa (1974)

BSc(Hon) (Geology), University of Natal, Durban, South Africa (1975)

Grad. Course in Engineering Geology (Hydrogeology), University of NSW, Sydney, Australia (1985)

PROFESSIONAL ASSOCIATIONS
Australasian Institute of Mining and Metallurgy  
AusIMM

International Association of Hydrogeologists  
IAH

International Mine Water Association  
IMWA

PROFESSIONAL EXPERIENCE
Infrastructure and Water Resources
Focussed Summary of Experience
Development, Planning for Industrial and Infrastructure Water Management and Mitigation & Environmental Impact Assessments Project experience  
Victoria, NSW, WA, and Queensland:

- Project task management, project directorship, review and technical advice, and Independent Certifier roles in medium to large infrastructure projects
- These have included office based and field environmental and engineering investigations for road, rail and tunnelling projects.
- Groundwater impact assessment, testing, resource modelling and planning/permitting, acid sulphate soils investigations, contamination, risk assessments and groundwater dependant ecosystems (GDE) impact evaluations.
- Development of conceptual geological and hydrogeological models for road and rail alignments, underground tunnels, mining and deep quarry projects, dam performance and subsurface excavation.
- Geological and hydrogeological assessment, monitoring, impact prediction modelling oversight and mitigation/management of seepage inflows to voids.
Ray Hatley  
Capability Executive - Hydrogeology

including tunnels, underground workings, quarry pits, and infrastructure excavation (rail and road cuttings, tunnels and buildings).

- Assessment of groundwater baseline conditions and groundwater types. Development of conceptual groundwater flow and hydrogeochemical models. Assessment of the long-term quantity and quality implications of resource exploitation and aquifer interference for road-rail-tunnel infrastructure, land development, mining, commercial and agricultural clients.

- Assessment of geotechnical implications and impacts on groundwater regimes arising from infrastructure (road/rail/tunnel) projects – including those effects caused by cutting, embankments, structures and tunnels.

- Aquifer vulnerability, aquifer interference policy (AIP) and groundwater dependant ecosystems assessments, accounting and licencing.

- Aquifer storage and recovery, injection and reinjection, and sewer mining projects, including impact assessment, GDE protection, and technology assessment, design and implementation.

- Design of the field investigations for groundwater monitoring (monitoring well, standpipe piezometer, vibrating wire piezometer facilities), hydraulic parameter field and laboratory testing supervision and data analysis (well testing, packer testing and tracer tests).

- Geological and hydrogeological, groundwater conceptualisation, assessment, monitoring, impact prediction modelling oversight and mitigation/management of seepage inflows to voids: including tunnels, underground workings, quarry pits, and infrastructure excavation (rail and road cuttings, tunnels and buildings).

- Groundwater flow and contamination impacting on or arising from road and rail alignments, buildings, manufacturing, dams and landfill facilities: design criteria, construction phase, operation phase, monitoring, closure/post-closure, and associated permitting and rehabilitation/remediation.

- Assessment of groundwater baseline conditions and groundwater types. Development of conceptual geochemical models. Assessment of the long term quantity and quality implications of resource exploitation for remote communities and agricultural clients.

Pertinent Project Experience

Groundwater Impact Assessments for the North, West and South East packages of the Major Road Projects Victoria (formerly, Outer Suburban Arterial Roads (OSAR)) program with particular focus on the Mordialloc Bypass Project (2017 to current), Lead Hydrogeologist.

Client: VicRoads  
Role: Technical Adviser / Groundwater Task Manager – Baseline conditions reporting, Groundwater Impacts Assessment for Existing Conditions Reporting, EPBC Referral groundwater impacts reporting and Environmental Effectives Statement Reporting.

Key achievements:
- Peer reviewer and technical advice for the Existing Conditions – groundwater and hydrogeological regime – reporting for the various SRU project alignments.
- Identification of direct and indirect impacts associated with the construction and operational phases of the project and related to embankment compaction related groundwater disruption effects (potential impacts on groundwater levels, quality and sensitive receptors). Developed practical measures to avoid or mitigate impacts identified and designed ongoing monitoring and assessment.
- Technical manager and adviser for the groundwater water impacts portion of the referral under the Environmental Protection and Biodiversity Conservation Act (EPBC, 1999).
— Supervision and technical advice into the groundwater related impact assessment required as part of the Victorian Environment Effects Statement (EES) process – involving assessment of the likely significant effects the project proposal might have on the surface water and groundwater systems which contribute to the health and habitat quality of adjacent and nearby wetlands, including the Ramsar-listed Edithvale wetland.

— Supervision of the numerical groundwater modelling tasks related to quantifying groundwater impacts, including standalone, cumulative and climate change effects.

**Groundwater Existing Conditions and EES Impact Assessments for the Beaufort Bypass programme (2017 to current), Lead Hydrogeologist.**

Client: VicRoads / Roads Corporation of Victoria

Role: Technical Adviser / Groundwater Task Manager – Groundwater Inflow and Impacts

Key achievements:

— provided technical advice and peer review for the existing conditions (hydrogeological regime) along the various bypass project alignment options. Identified potential impacts on groundwater levels, quality and sensitive receptors. Identified direct and indirect impacts associated with the construction and operational phases of the project.

— Technical adviser and reviewer for the preparation of the groundwater components of the Environmental Effects Statement (EES) including the groundwater investigations, data assessment and prediction of groundwater impacts to environmental values (users and GDEs), risk assessment and design of practical measures to avoid or mitigate impacts identified, and design of a verification monitoring well network.

— Assessment of the potential groundwater impacts arising from the road cuttings in bedrock fracture aquifers (though groundwater flow diversion and removal of sustaining flows to ecological receptors and water users), and embankment surcharging likely to effect groundwater flow conditions on the alluvial aquifer systems, related to each of the proposed design elements for the various alignment options.

**Groundwater Mitcham to Frankston Freeway – Melbourne, Victoria, Australia (2006-2007)**

Client: Beca (Leighton/Abigroup/Transurban/ Deutsche Bank Consortium)

Role: Technical Review

Key achievements:

— Provision of groundwater technical input to the Mitcham to Frankston Freeway team - involving the assessment of the hydrogeological risks and potential impacts, and inflow mitigation advice/implementation for the tunnel design and construction phase of the project. Client: Consortium of Banks financing the Leighton/Abigroup/Transurban/ Deutsche Bank Consortium tender bid (for Beca).


Client: RMS

Role: Technical Advisor Groundwater lead – Groundwater related design and Impacts input

Key achievements:

— Groundwater related input to the Clients Technical Advisor involving oversight of the two main contractor’s groundwater investigation and monitoring system installations for the projects. Design of groundwater related scope, services brief definition, oversight of investigation contractors, advisor to RMS on suitability of project investigations and monitoring system assessments. Preparation of design related reporting (Bronze, Silver and Gold Reference Design groundwater input), groundwater inflow prediction estimates, definition of high risk groundwater zones related to major structural defect, dykes (and other zones of potential high rock mass permeability risk inflow), paleo-valley structures and shallow alluvium occurrences; impact of saline and contaminated groundwater; potential impacts to the...
groundwater systems and likely inflow contaminant loading; tunnel liner groundwater pressure assessment; and review of proposed mitigation methods and management. Provision of data to the Environmental Assessment team preparing the Project EIS.

Toowoomba Second Range Crossing (TSRC) - Pavement Sub-Surface Drainage Modelling

**Lead Hydrogeologist (2015–2018).**

**Client:** Nexus Infrastructure and QLD Department Main Roads  
**Role:** Technical Adviser / Peer Review – seepage modelling, drain design and water supply  
**Key achievements:**  
Advice, assessment and review of:

— Planning of groundwater monitoring infrastructure’s integrated within geotechnical field investigations. Interpretation of groundwater level data for variations in climatic conditions. Determined maximum groundwater level rise expected within strata types along the alignment to be applied in Cut design. Assessed potential drawdown impacts on stakeholder water supplies and sensitive ecosystems. Contributed to geotechnical interpreted reporting.

— Groundwater issues and piezometric levels in proposed road cuttings. Analytical and numerical groundwater modelling for prediction of inflows into the proposed Toowoomba Range twin tunnels and extent of drawdown.

— Conducted road pavement seepage assessment using SEEP/W modelling tool and provision of sub-surface drainage recommendations. Including the application of cut-off (formation) drains to manage subsurface drainage beneath the road pavement of cuts in the eastern section of the TSRC. Prediction of maximum regional groundwater levels in the location of the Cuts were used to provide a worst case of groundwater head and seepage rate. The two-dimensional finite element modelling package Seep/W was used to simulate groundwater levels and flux beneath the road pavement and flux within cut-off drains.

— Groundwater resource assessment of construction water supplies

— Planning of groundwater monitoring infrastructure and its integration into the project geotechnical field investigations. Interpretation of groundwater level data for variations in climatic conditions. Calculation of maximum groundwater level rise expected within strata types along the alignment to be applied in Cut design.

— Assessment of potential drawdown impacts on stakeholder water supplies and sensitive ecosystems. Contributed to geotechnical interpreted reporting. Conducted road pavement seepage assessment using SEEP/W modelling tool and provision of sub-surface drainage recommendations.

**Assessment of existing groundwater conditions and predictions of groundwater impacts for a proposed railway alignment (2016–2018):**

**Client:** Australian Rail Track Corporation (ARTC)  
**Role:** Technical Adviser / Peer Review  
**Key achievements:**

— Technical advice and review of the assessment of existing groundwater conditions and predictions of groundwater impacts for the preferred alignment for the Inland Rail line between Illabo and Stockinbingal (I2S).
Groundwater impacts assessment for the Woolgoolga to Ballina (W2B) section of the Pacific Highway Upgrade (2016-2017):
Client: Pacific Complete for RMS
Role: Technical Adviser / Peer Review
Key achievements:
— Technical advice and review of the assessment of road construction (embankment compaction induced impacts) on local alluvial plane environments and design of mitigation measure to minimise waterlogging and groundwater flow disruption
— Assessment of borrow pit (quarries) development of existing groundwater conditions, impacts of local environmental values (groundwater users and ecological receptors) and design of mitigation measures and verification monitoring well networks.

Client: RTA NSW (now RMS)
Role: Project Manager – Groundwater Impacts Assessment
Key achievements:
— Project managed the assessment study of groundwater impacts arising from the proposed upgrade works to the Pacific Highway between Tintenbar and Ewingsdale, NSW Far North Coast (arising from the Director Generals requirement statement). The study included a field investigations, data assessment and numerical modelling of the local and regional impacts (though groundwater drawdown and recharges water diversion) on the various groundwater systems of the road cuttings and tunnel, where these impacts might affect spring flow, water well production, groundwater quality, groundwater recharge, groundwater dependant ecosystems and the water sharing plan allocations.
— Assessment and ranking of road cuts penetrating into the existing groundwater table and their likelihood of capturing groundwater flow, diverting them to the surface water drainage system associated with each cut and out of the local groundwater system which may feed local springs and creeks
— Development of an innovative method of groundwater modelling and risk ranking of road cut types based on penetration of the groundwater systems and their down-gradient receptors. The various road cuts were risk ranks and inferred impacts predicted. Mitigation measured were then deigned and applied to those cuts deemed likely to cause non-negligible impacts. A construction and operation phase verification monitoring program was developed to manage future impact effects.

Client: RTA NSW (now RMS)
Role: Project Manager – Groundwater Impacts Assessment
Key achievements:
— Review of preliminary assessment of impacts to groundwater systems from proposed road cuttings along the proposed alternative route a section of the Pacific Highway from Warrell Creek to Urunga. The desktop assessment focused on potential impacts to the groundwater systems caused by road cuttings along the preliminary route, considering the probability of impacting near-by environmental ecosystems and creeks, and, groundwater users and structures located along the proposed route. An investigation and monitoring program was proposed to quantify likely impacts. Possible mitigation options are also presented.

Independent Certifier work verification - Groundwater Inflow Impacts – WestConnex, NSW, Australia (2015-present)
Client: RMS
Role: Technical Expert / Independent Certifier – Groundwater Inflow and Impacts
Key achievements:
Groundwater related input into the Independent Certifier work verification process involving a review of the contractor’s predictive groundwater model and input into work verification record keeping and associated meetings. Review assessments focussing on investigation methodologies employed and used in the model; modelled inflow predictions, their location and association with major structural defect, dykes (and other zones of potential high rock mass permeability risk inflow), paleo-valley structures and shallow alluvium occurrences; impact of saline and contaminated groundwater; potential impacts to the groundwater systems and likely inflow contaminant loading; tunnel liner groundwater pressure assessment; and review of proposed mitigation methods and management.

Client: RTA NSW (now RMS)
Role: Hydrogeologist
Key achievements:
— Provision of technical advice to the M5 alliance project team - involving the assessment of the hydrogeological risks associated with potential groundwater inflow to tunnel sections of the alignment, pumping test design/implementation oversight, assessment of potential impacts arising from inflows, and inflow mitigation advice for the tunnel design phase of the project.

Client: RTA NSW (now RMS)
Role: Project Manager – Groundwater Impacts Assessment
Key achievements:
— Project managed the assessment study of groundwater impacts arising from the proposed upgrade works to the Pacific Highway between Tintenbar and Ewingsdale, NSW Far North Coast (arising from the Director Generals requirement statement). The study included a field investigations, data assessment and numerical modelling of the local and regional impacts (though groundwater drawdown and recharge water diversion) on the various groundwater systems of the road cuttings and tunnel, where these impacts might affect spring flow, water well production, groundwater quality, groundwater recharge, groundwater dependant ecosystems and the water sharing plan allocations.

Groundwater Impact Review – M5 East Motorway Sydney NSW
Client: RTA NSW (now RMS)
Role: Hydrogeologist
Key achievements:
— Provision of technical advice to the M5 alliance project team - involving the assessment of the hydrogeological risks associated with potential groundwater inflow to tunnel sections of the alignment, pumping test design/implementation oversight, assessment of potential impacts arising from inflows, and inflow mitigation advice for the tunnel design phase of the project.

Groundwater Impact Review – Confidential Cross City Tunnel Project Sydney NSW
Client: RMS
Role: Technical Advisor - Hydrogeology
Key achievements:
— Provision of technical advice to RMS project team - involving developing groundwater investigation works requirements, the assessment of the hydrogeological risks associated with potential groundwater inflow to tunnel sections of the alignment, investigation design/implementation oversight, assessment of potential impacts arising from inflows, and inflow mitigation advice for the tunnel design phase of the project.
Homebush Bay - State Sport Centre Landfill, NSW, Australia (1998-2000)
Client: SOPA
Role: Project management
Key achievements:
— Project managed the investigation of the groundwater hydrogeological conditions related to the failure of a leachate collection system associated with a closed landfill at the State Sport Centre Landfill (Olympics 2000 Site at Homebush). Developed the remedial action plan (RAP) for the rectification works required to improve leachate management and reduce leachate production. This has involved the remodelling (relocation of wastes within the landfill) and the recapping of the new landfill profile. The latter has involved innovative stormwater drainage management designs, incorporating wetland features and sedimentation ponds.

Inflow Impact Assessment – Central Pool Augmentation Project. Los Angeles, California, USA (1990)
Client: Los Angeles Metropolitan Water District
Role: Hydrogeologist / Groundwater Modeller
Key achievements:
— Provision of expertise technical input to the hydrogeological characterisation of the study area, detailed analysis on the background groundwater regime, groundwater inflow analyses, development of project groundwater monitoring program and provision of peer review services for the groundwater study aspects of the Metropolitan Water District of Southern California tunnel project. Development of finite difference computer modelling procedures for the evaluation of the implications of tunnel construction inflows on the local groundwater regime. Assessment of likely environmental risks and impacts, and remedial options for impact mitigation. Presentations of pre-feasibility and feasibility stage concepts and design implication to local regulatory authorities.

Hydrogeological Impact Investigations – Water Conveyance Tunnel, Inland Feeder Project. Los Angeles, California, USA (1990)
Client: Los Angeles Metropolitan Water District
Role: Hydrogeologist / Groundwater Modeller
Key achievements:
— Project management of hydrogeological investigation team of expertise and provision of advice on the hydrogeological characterisation of the study area, detailed analysis on the background groundwater regime, groundwater inflow analyses, development of project groundwater monitoring program and provision of peer review services for the groundwater study aspects of the tunnel project. Development of finite difference computer modelling procedures for the evaluation of the implications of tunnel construction inflows on the local groundwater regime. Assessment of likely environmental risks and impacts, and remedial options for impact mitigation. Liaison with and presentations to local regulatory authorities. Client: Metropolitan Water District of Southern California.

Various Australian Department of Defence Sites NSW, Australia (2005-2007)
Client: Australian Department of Defence
Role: Project Director - Environmental Hydrogeological Advice
Key achievements:
— Site Assessment, Remediation PM and Specialist Advisor, Various Australian Department of Defence Sites NSW, Australia - Provided ESA project management and specialist advice regarding hydrocarbon-metals-halogenated hydrocarbon and asbestos impacted soils and groundwaters at a number of Defence sites in NSW:
— Shoalhaven Naval bases (Stage 2 Environmental Investigations at HMAS ALBATROSS, HMAS CRESWELL and Jervis Bay Range Facility) – see below;
— Shoalhaven Naval bases (Stage 3 Remediation/management works at HMAS ALBATROSS, HMAS CRESWELL and Jervis Bay Range Facility) – see below;
RAY HATLEY  
Capability Executive - Hydrogeology

- Shoalhaven Naval bases (Water Quality Management Strategy and Plans for HMAS ALBATROSS, HMAS CRESWELL, Beecroft Weapons Range and Jervis Bay Range Facility)
- Newington Armament Depot (groundwater impact assessment)
- Woolwich (groundwater impact assessment and modelling, risk assessment)
- Cockatoo Island (groundwater impact assessment and contaminant modelling, groundwater management)
- Zetland (groundwater matters encountered in the site assessment, risk assessment, remediation)
- Mulwala (groundwater impact assessment).

PROFESSIONAL HISTORY

WSP | Parsons Brinckerhoff 2015–Present
Arrow Energy  2015
SKM-Jacobs  2013 - 2015
RPS-Aquaterra  2012 - 2013
Golder Associates  2001 - 2012
URS Corporation/Woodward-Clyde  1989 - 2000
Australian Groundwater Consultants (AGC)  1986 - 1989
Earth Resources Foundation, Sydney University  1985 - 1986
CRA Exploration  1981 - 1983
Tsumeb Corporation  1979 - 1981
Union Corporation  1977 - 1979

AWARD

Best Paper Award  2006
Australian Geomechanics Society biannual conference and the International Association of Hydrogeologists, 2004

PUBLICATIONS AND PRESENTATIONS

Publications

Presentations
ALISTAIR STEWART
Senior Hydrogeologist

PROFILE
Alistair is a senior hydrogeologist with over nine years’ professional experience in groundwater investigations across Australia. Alistair has provided hydrogeological and environmental consulting across a number of industry sectors including linear infrastructure, resources (mining and CSG), water resource management, and to State and Commonwealth government agencies. The experience Alistair has gained in scoping and delivering projects to a diversified range of clients has placed him a strong position to understand the needs and challenges facing groundwater resources across Australia.

Alistair has specific capability in groundwater characterisation and conceptualisation, groundwater impact assessments, hydrogeochemical analysis, contaminant hydrogeology and statistical analysis. Alistair has also extensive site based experience including drilling supervision, aquifer / pump testing, baseline investigations, and groundwater/surface water sampling. His project experience includes several large groundwater impact assessments for both greenfield and brown field resource and infrastructure projects, compliance reporting and hydrogeochemical investigations.

Working closely with clients and stakeholders Alistair has successfully managed and contributed to the successful delivery of a broad range of hydrogeological, hydrology and environmental projects particularly relating to linear infrastructure, coal, and hard rock mining, providing quality solutions that are in line with current legislative requirements and satisfy client expectations.

EDUCATION
Bachelor of Engineering (Environmental) Royal Melbourne Institute of Technology

PROFESSIONAL ASSOCIATIONS
International Associations of Hydrogeologist – Member
Australian Institute of Geoscientists – Member

PROFESSIONAL EXPERIENCE
Infrastructure Projects
- **Inland Rail – Illabo to Stockinbingal, NSW (2018-Current): ARTC, Senior Hydrogeologist**
  EIS groundwater impact assessment of the proposed rail alignment including 37 km of new rail track, several deep excavation cuts, and embankment overpasses over waterways and roads. The alignment has several sensitive receptors including waterways and groundwater dependent ecosystems.
- **Level Crossing Removal - Cheltenham & Mentone (2019): Southern Program Alliance, Senior Hydrogeologist**
  Early works package in planning and implementing field studies to assist in dewatering design for both stations.
- **Mordialloc Bypass, VIC (2017-Current): MRPV, Senior Hydrogeologist**
  EES groundwater impact assessment of proposed road design that included several significant embankment structures potentially compacting alluvial material and impacting on regional groundwater flow to Ramsar protected wetlands.
ALISTAIR STEWART
Senior Hydrogeologist

— **Beaufort Bypass, VIC (2017-Current): Vic Roads, Senior Hydrogeologist**
  EES groundwater impact assessment of proposed road design that included several deep cuts through current landform and compaction of alluvial material through embankment structures.

— **Major Roads Project Upgrades, VIC (2017-2018): MRPV, Senior Hydrogeologist**
  Desktop impact assessment for several proposed road designs across northern and south eastern Melbourne.

**Water Resources**

— **Catchment Baseline Investigation, Northern NSW (2017): DPI Water, Hydrogeologist**
  Surface water quality data review and statistical analysis for 13 coastal and inland catchments in Northern NSW to establish baseline water quality parameters.

  Hydrogeological drilling, monitoring bore installation and development, aquifer testing, reporting.

— **Nathan Dam Supplementary EIS, Taroom, QLD (2013): SunWater**
  EIS groundwater investigations including GDE mapping and sampling, artesian bore licensing and design.

**Mining Projects**

— **Cannington Mine, Hydrogeological Investigation, SE Mt Isa, QLD (2018): South 32, Project manager & Senior Hydrogeologist**
  Data analysis and gap analysis of existing and historical groundwater data. Development of targeted field program to address data gaps to improve dewatering strategy.

— **Mount Isa Mines Groundwater Monitoring Network Review & Trigger Level development, Mount Isa, QLD (2016-17): Glencore, Hydrogeologist**
  Historical groundwater data review, aquifer characterisation, groundwater monitoring network assessment, statistical analysis, trigger level development and compliance reporting.

— **Lady Loretta Mine Environmental Authority Compliance Report, Lady Loretta Mine, QLD (2017): Glencore, Project Manager & Hydrogeologist**
  Annual groundwater quality review and compliance reporting as required under the mine Environmental Authority.

  Historical groundwater data review, aquifer characterisation, groundwater monitoring network assessment, statistical analysis, trigger level development and compliance reporting.

— **Whitehaven Coal Water Quality Review, Gunnedah Basin, NSW (2016): Whitehaven Coal, Project Manager & Hydrogeologist**
  Desktop groundwater / surface water quality review and hydrogeochemical analysis of coal contact water at all Whitehaven mines. This lead to the development of a targeted water sampling and analysis plan to satisfy NSW EPA requirements.
— Carrapateena Project, Gawler Craton, SA (2016): Oz Minerals, Field Hydrogeologist
Drilling supervision, water supply bore installation and development, pump test supervision and groundwater.

Groundwater conceptualisation, desktop groundwater review and data gap analysis to support approvals process for mine expansion.

Desktop groundwater and surface water quality review, statistical analysis, mass balance calculation and mitigation option investigation.

Annual groundwater quality review and compliance reporting as required under the mine Environmental Authority.

— Project Bravo, Bowen Basin, QLD (2015): Queensland Coal Investments, Field Hydrogeologist
Drilling supervision and installation of groundwater monitoring bore and vibrating wire piezometer network.

— Baralaba South and North Projects, Bowen Basin, Qld (2012-2013): Cockatoo Coal, Field Hydrogeologist
EIS groundwater studies for three two greenfield coal projects including baseline investigations, the design, drilling, installation, sampling, and aquifer testing of the groundwater monitoring and vibrating wire piezometer network.

— North Surat – Taroom, Collingwood and Woori Coal Projects, Surat Basin, QLD (2010-2012): Cockatoo Coal, Field Hydrogeologist
EIS groundwater studies for three major greenfield coal projects including baseline investigations, the design, drilling, installation, sampling, and aquifer testing of the groundwater monitoring and vibrating wire piezometer network.

Drilling supervision, installation and aquifer testing and sampling of groundwater monitoring network

— North Surat – Taroom, Collingwood and Woori Coal Projects, Surat Basin, QLD (2010-2012): Cockatoo Coal, Field Hydrogeologist
EIS groundwater studies for three major greenfield coal projects including baseline investigations, the design, drilling, installation, sampling, and aquifer testing of the groundwater monitoring and vibrating wire piezometer network.

Coal Seam Gas Experience

— Narrabri Gas Project EIS, Gunnedah Basin NSW (2017): Santos, Project Manager & Hydrogeologist
EIS support and response to submissions. Updating and data quality review of supporting water quality baseline report.

Drilling supervision and installation of petroleum spec groundwater monitoring bores, pump testing and groundwater sampling.

- Hydrogeochemistry of PEL238, Gunnedah Basin, NSW (2014): Santos, Hydrogeologist
  Groundwater sampling, pump installation design, hydrogeochemical data analysis

  Groundwater dependant ecosystem (GDE) sampling/mapping and conceptualisation.

  Logistics coordination, groundwater dependant ecosystem (GDE) sampling/mapping and reporting.

- Farm Bore Baseline Assessments, Surat Basin, QLD (2011): QGC, Hydrogeologist
  Farm bore baseline assessments of landholder bores throughout QGC’s North Surat leases.

  Drilling supervision and monitoring bore installation around Arrow Energy operations

**Defence Experience**

- RAAF Base Tindal PFAS Remediation, Northern Territory (2018): Department of Defence, Senior Hydrogeologist
  Drilling supervision and diamond coring of extraction and injection bores for groundwater remediation.

- North Queensland Water Quality Sampling, North Queensland (2015-2016): Department of Defence, Project Manager and Lead Hydrogeologist
  Logistic planning, defence permitting, groundwater sampling of over 200 groundwater monitoring bores, data interpretation, trigger level assessment and compliance reporting

  Drilling supervision, monitoring bore installation, soil and groundwater sampling

**Local Government**

- Groundwater Characterisation Scoping Study, Gold Coast, QLD (2014): City of Gold Coast, Project manager & Hydrogeologist
  Groundwater scoping study assisting the development of a new flood code for the City Plan. Conceptual models of regional aquifers and potential impact and risk of sea level rise within the City Region

- Hydraulic Study – Drainage Diversion, Gold Coast, QLD (2013): Gold Coast Airport Pty Ltd, Hydrogeologist
  Literature review and analytical model predicating groundwater inflows and impacts to groundwater levels along proposed drainage diversion.

**PROFESSIONAL DEVELOPMENT**

Australian Groundwater School, National Centre for Groundwater Research and Training 2012
ALISTAIR STEWART
Senior Hydrogeologist

PROFESSIONAL HISTORY

WSP 2017 – Present
Eco Logical Australia 2016 – 2017
Jacobs (formerly SKM) 2011 – 2016
Compass Environmental 2009 – 2011

PUBLICATIONS AND PRESENTATIONS

Publications