eChartered

ENGINEERING COMPETENCY REPORT

EXAMPLE D

13 January 2014

ENGINEERS AUSTRALIA

Table of Contents

About this example

This report is part of a set of example reports that is being developed to provide examples of Engineering Competency Claims and the Engineering Experience Record (EER). These Examples are for use by participants using the eChartered system to guide them.

Before reviewing the example reports, applicants should refer to the appropriate *2012 Australian Engineering Competency Standards Stage 2- Professional Engineer or Engineering Technologist or Engineering Associate* available in the Resources section of the eChartered website.

Participants should also refer to Section 5 of the Online Participant Guide, *Submission*, paying particular attention to Section 5.3. *Writing Engineering Competency Claims (ECCs).* The *Thought Starters for Preparing Engineering Competency Claims in eChartered* available in the Examples section also provides guidance and is recommended reading along with the example reports.

The following 16 example ECC reports were submitted by a civil engineer who successfully achieved Chartered Membership following their Professional Interview, as well as registration on the National Professional Engineers Register (NPER) and the Stage 2 Assessment for the application to become a Registered Professional Engineer of Queensland (RPEQ).

The author was prepared to meet the requirements of the *Australian Engineering Competency Standards Stage 2.* Each of their claims were verified by a responsible senior engineer.

Identifying information has been removed to protect the confidentiality of the author, their employers, their Verifiers, clients, and the projects covered. All verification has been removed for the purpose of maintaining confidentiality.

As the new eChartered process develops, Engineers Australia will be able to build a repository of examples. This example is from one of the first wave to use the eChartered system and successfully complete their Professional Interview.

Engineers Australia expresses its sincere thanks to the engineer who provided these reports to be used to assist others seeking Chartered Status and/or registration.

Claim 1. Deal with ethical issues

Between September 2009 to March 2010, I completed a secondment with a specialist marine contractor. The contractor was a small company and I got to know the owners and his employees in both professional and personal sense. During my time with the contractor I worked closely with a particular project manager in constructing a wharf structure on a major river. When I finished my secondment and returned to the office, I kept in contact with the project manager on a semi-regular basis.

When I got back to the office, I was responsible for completing detailed design drawings and tender documentation for a demolition project subsequent construction of a jetty finger in its place. The specialist marine contractor was one of four parties to bid for the contract. In order to be open and honest and avoid any conflicts of interest, I informed my client that I had completed a secondment with the particular contractor. Due to my secondment, the specialist marine contractor felt comfortable in contacting me with tender questions. During tender stage I was cognisant of the fact that I needed to behave ethically and ensure that no parties were put in an unfair disadvantage. For example, I ensured that confidential client information, such as the available client budget was not disclosed to any tenderer. As another example, I requested that all enquires during tender stage come via the client in the first instance. I would then disturb my associated responses back to the client for distribution to all tenderers.

From a team perspective, my intent is to always interact with my colleagues in an open and honest manner and act on the basis of a well-informed conscience, in line with the Engineers Australia *Code of Ethics*. I believe that these are critical elements to creating a positive team dynamic and ensuring successful project delivery. For example, I encouraged members of my team to complete their timesheets accurately, honestly and on time. My personal approach is to keep a daily diary of my time spent on project work and a description of the task/s I undertook. I do this in order to give an honest response when requested by my peers to provide explanation of time spent on specific project tasks. At all times, I encourage my team members to record their time accurately as opposed to charging unbudgeted hours to an overhead number. I always state to my colleagues that accurate recording of time gives greater insight into project performance and will not lead to repercussion.

I am now working for a major engineering consulting firm, which has an Integrity Management System (IMS) which has been designed to promote ethical business practices within the company. The company's Code of Conduct is one of its key IMS documents. The Code of Conduct has 3 imperative elements; Teamwork, Respect and Integrity which is analogous to the *Code of Ethics* provided by Engineers Australia. I reviewed and agreed to abide by the Code of Conduct when I signed my employment contract. For example, with regards to gifts, the Code of Conduct states 'refuse to accept gifts, financial payments, favours or benefits that are intended to, or are likely to, cause you to act in a biased manner in the course of your duties. 'I took particular notice of this clause as I am aware and have witnessed the offer of gifts by vendors and contractors within previous workplaces. I am aware that if I was offered a gift, that declaration to my company is the appropriate action. This ethical approach is in line with the Engineers Australia *Code of Ethics*.

I have engaged in ethical reflective practice by reviewing the Values Exchange provided by Engineers Australia. The case studies provided on the Values Exchange have helped me to develop my ethical judgement and decision making skills. This proved to be a great learning exercise and confirmed in my mind the importance of the *Code of Ethics* provided by Engineers Australia. In summary, I am aware that as an engineer practitioner, I am to use my knowledge and skills for the benefit of the community to create engineering solutions for a sustainable future. I am also aware that we as engineers are to serve the community ahead of other personal or sectional interests.

Claim 2. Practise competently

The maritime and coastal engineering industry is quite specialised and requires an appropriate skill set. Typically, maritime and coastal engineers complete designs based on empirical methods due to the lack of prescribed methods within available standards. When designing, I am heavily reliant on guidelines, conference papers, empirical methods, 'first-principals' approach, in lieu of published standards. This requires me to think critically to regularly assess my own competence and acquire new skills to ensure that my chosen approach is most applicable for design purposes. For example, I ensure that I stay abreast to latest developments within my industry.

My commitment to my professional development is long term and extends beyond project specific requirements. Since graduation for example, I have completed performance reviews every 12 months. The nominated reviewer and I assess my competence against a range of criteria and also determine areas where further skill development is required.

Training and development within the maritime and coastal engineering industry is generally quite scarce, however I recognise the importance of maintaining and updating my skills through the following avenues;

- Engineers Australia monthly magazine.

- Engineers Australia Queensland Water Panel provides presentations on an ad-hoc basis to which I have attended. The last presentation that I attended was by a past lecturer of mine and thesis supervisor., Tom Baldock from the University of Queensland. Tom's presentation was held November 2011 and was titled, 'Surf zone morphology, wave run-up, overtopping and sediment overwash.

- I am currently responsible for the organisation of monthly maritime technical presentations to my group.

- I am a Permanent International Association of Navigation Congresses (PIANC) member and read all the working group and 'on-course' quarterly magazines as part of my Continuing Professional Development (CPD). PIANC is the global organisation providing guidance for sustainable waterborne transport infrastructure for ports and waterways.

- I initiated the maritime group subscription to a Coastal Engineering Journal through my company's library service colleagues. This journal is extremely valuable as it combines practical application with modern technological and scientific achievements. I have downloaded papers such as, 'Wave height distributions on shallow foreshores' by Battjes and Groenendijk for example. At the time of my design work, this paper was at the forefront of industry knowledge and provided extreme value to my deliverables.

- I have entered all CPD events into the Engineers Australia (EA) website since graduation. Since 2006 I have exceeded 50 hours of CPD per year.

- I am an active member of Coastal List (http://www.coastal.udel.edu/coastal/coastal_list.html). Coastal list is a moderated email list for coastal engineers. It was established by the University of Delaware to provide approximately 1700 enrolled coastal engineers/scientists a means to communicate with each other so that items of interest for the community will be disseminated broadly.

I recently coordinated and was responsible for the delivery of a proposal for the Coastal Processes section of a regional Council Airport Expansion EIS. The Coastal Processes section of the EIS required a response to the draft terms of reference in the hydrodynamics, hydrology, marine sediments and water quality. I concluded that the latter 3 specialities were outside my level of experience and I therefore delegated these work packages to my company's specialists. Even though I had gained hydrological modelling experience as a cadet with a capital City Council I made conscience the decision that I was not sufficiently competent enough to provide hydrological advice.

I have and am still an active member of the in-house skills networks within both my previous and current company. I have posted many questions on the skills networks of my previous company. For example I posted questions on wave steepness limits for waves in shallow water and wind spectra definitions while working on the detailed design for a LNG project off the Australian east coast.

Claim 3. Responsibility for engineering activities

I started with my current company in early January 2012, and I was given the role of managing our sub consultant to undertake a dynamic mooring analysis for a confidential LNG project. This included passing ship simulations for a number of membrane and spherical LNG carriers (ranging from 125,000m3 to 217,000m3). The sub consultant's scope of works was determined during proposal stage, which occurred before I commenced my employment, and therefore was beyond my control.

The first action I undertook was to review the agreed scope of works included in my company's proposal. The proposal stated that a total of 40 simulations were required in order to complete the dynamic mooring analysis. Based on my experience of being responsible for the mooring analysis within the detailed design phase for a previous jetty construction project, I made the judgement that a total of 40 simulations were not adequate to meet client requirements. I agreed that client requirements were not clear as we were in Front End Engineering Design (FEED), however based on 5 vessels and the applicable environmental criteria, it was clear that a total of 40 simulations would not be sufficient. I immediately notified the project and design manager of this risk as the sub consultant was on a lump sum agreement.

The next action I undertook was to organise a teleconference with the sub-consultant to discuss the scope of works. I requested an explanation from the sub consultant as to how a total of 40 simulations would satisfy the client's requirements. After I referred our sub consultant to the Oil Companies International Marine Forum (OCIMF) standard environmental criteria, which in my experience is often exclusively referred to by the Oil and Gas majors, it was clear that a total of 40 simulations would be exceeded.

I recommended to our sub consultant that based on my experience, it was in our collective interests to complete a dynamic mooring analysis methodology document in the first instance for client review in order to mitigate the risk of scope creep and budget overspend. The sub consultant agreed to adopt my proposed approach. My intention for the methodology document was to state our approach, parameters adopted and a summary of the cases which we proposed to simulate. In my experience, this approach is both cost-effective and also provides clarity to the client and/or peer reviewer on the proposed design assumptions to be adopted within the simulations. I completed the methodology document based on information sent by the client and my company's internal library. Within the methodology document I highlighted the information gaps and proposed parameters required to complete the dynamic mooring analysis. For example, some of the parameters which I proposed for all vessel classes included:

- mooring line pretension values;
- mooring line diameters;
- mooring line tension limits (% strength);
- mooring line minimum breaking load;
- tail types;
- tail diameters;
- minimum tail breaking load.

In unison, I also completed the fender design for the breasting dolphins based on the *Code of practice for design of fendering and mooring systems* British Standard 6349 Part 4 - 1994 and the Permanent International Association of Navigation Congresses (PIANC) *Guidelines for the Design of Fender Systems*

(2002). I completed this in parallel with my senior structural engineering colleague who was designing the breasting dolphins. My senior colleague reviewed my design and I later refined my design based on his suggestions. I updated the methodology document with the appropriately designed and reviewed fender. I requested an internal review of the methodology document by the design manager. Finally, I requested that all values within my draft methodology document be either confirmed correct and/or updated by our sub consultant as they were the recognised author of the issued document.

Claim 4. Develop safe and sustainable solutions

Immediately after the January 2011 floods, my company was engaged on an emergency works basis. Flood waters had scoured a section of a major Creek and subsequent bridge embankment to such a distance that the road and bridge was at risk of subsidence. I assessed the creek and slope stability from a hydraulic / scour point of view and supervised the rehabilitation works.

Before going to site, I completed a Job Safety Analysis (JSA).Through the JSA, I logically identified, assessed and documented the hazards associated with my site visit in accordance with my company's Health and Safety policy. For example, I ensured that my colleague and I had the appropriate personnel protective equipment (PPE) before entering the site.

Once on site, the contractor had proposed a rock revetment solution along the scoured section of the Creek. Sketch drawings were provided to me.

I reviewed the contractor's design and supervised the emergency works on behalf of the state authority which was my client. As we were in an emergency works situation, I reacted promptly in the short term. I assessed the contractor's design and identified aspects of the design which were not structurally sound and informed my client that this would ultimately result in rework in the long term. I stated to my client that I appreciated the emergency situation, however correct and safe design was paramount. I proposed that site works be put on hold for 24 hours while I completed some preliminary calculations. I reinforced the fact that the contractor's design was neither cost effective nor a sustainable option. For example, the geotextile proposed did not have sufficient strength for the large armour rock and I concluded that the geotextile would puncture during construction. Also, the rock armour specified was not large enough for peak velocities up to 5 m/s, which I estimated based on Manning's equation. The revetment toe detail was not robust in my opinion and the risk of the rock slope failing in extreme events was high. I immediately requested that the procurement of materials be put on hold while I completed an alternative design. My client agreed with this approach.

I suggested to my client to broaden the extent of the works. I identified the high risk of scour due to highly mobile creek bed sediment particles and the expected flow separation behind the proposed works. I recommended extending the revetment structure by 50 metres upstream past the bend in the creek. By extending the structure, the cost to my client increased, however I reduced the risk of failure due to scour and therefore future rework was minimised considerably.

I designed the rock revetment using, '*CIRIA C551 Manual on Scour at Bridges & Other Hydraulic Structures*'. As per CIRIA C551, I initially calculated the rock size required for minimal maintenance. After discussion with my client and contractor, I deemed that this approach would be too costly to procure, construct and maintain by the state authority. I then calculated the rock size based on the fact that future maintenance may be required after large storm events. I recommended this approach to my client and they confirmed that the revetment would be placed on the yearly maintenance inspection programme. The contractor confirmed that my calculated rock armour size could be procured from the quarry on short notice. My approach was sustainable as I rationalised my solution on economic, risk, material resources and human effort criteria while providing for the safety of the workers.

I was present on site during construction in a near full time basis due to the nature of the emergency works. Access to the site was hazardous due to the poor ground conditions. I recommended to the foreman that he use the underlayer rock that I had specified as a working platform while completing works on the eroded slope. I identified that by placing rock armour at the crest, which is typical for coastal engineering projects, would pose a risk to the construction staff, future maintenance inspectors and the public. I detailed on the drawings the placement of underlayer rock within the voids of the rock armour. This provided a safe walking platform along the crest and mitigated the future risk of injury.

Claim 5. Engage with the relevant community and stakeholders

It was my responsibility to complete a flood risk assessment and determine an appropriate design flood level for a marina project on the banks of a major river in Ireland. My team leader and I were engaged by our client to carry out engineering design alongside an architect.

I identified, in consultation with my team leader which stakeholders needed to be consulted, to ensure that I had a clear understanding of their requirements for my design solution:

- The Office of Public Works (OPW);
- The applicable Hydro-electric Scheme;
- My company's office flood modelling team.

My investigations revealed that the governing body within the region where the assessment was taking place did not (at the time of the project – 2006/07) have formalised guidelines for proposed developments within the floodplain. I contacted the flood information officer within the OPW responsible for the region and confirmed a legislative gap within their requirements. Working ethically to negotiate acceptable outcomes for the community, I proposed to develop an appropriate design flood level for OPW review. I contacted my expert hydrologist colleague about best practice design flood levels for this type of development. The flood information officer agreed that a 1 in 100 year design flood level was appropriate and met their flood immunity requirements.

I stated that the impact of climate change on peak flood flows should be considered within my flood risk study as this would lead to higher peak flood levels. The flood information officer stated that their requirements on peak flows due to climate change were currently in draft format. I requested the flood information officer provide formal advice, to which they replied in letter format. I incorporated the formal advice of the OPW, which at the time stated that peak flood flows could increase by up to 20% due to climate change. After a thorough investigation of the catchment characteristics and a sensitivity analysis including increasing peak flood flows by 10, 15 and 20%, I recommended a 20% increase in flows was in line with best practice. I ensured that long term requirements set by others were considered to obtain a sustainable solution.

My investigations showed that no flood studies had been undertaken within the catchment. There was however recorded flows and recorded water levels in the vicinity of the proposed marina site. I organised a meeting with the chief engineer of the applicable Hydro-electric Scheme to discuss the operational procedures of the weir and its impact on upstream water levels. I listened carefully to the chief engineer explain operational procedures of the weir, both daily and in times of flood, as I knew this was critical to my analysis. As I listened, I took accurate notes as I knew his 30 years of experience was of immense value in lieu of published data.

I requested recorded flows and water levels from the chief engineer in order to determine a relationship between the two variables based on a statistical analysis. The chief engineer provided to me with 64 years of recorded flows (monthly maxima) and approximately 56 years of recorded daily water levels.

I contacted our local flood modelling team to perform the statistical analysis to produce the 1 in 100 year frequency curve as they had a licence to the appropriate software. At the end of my flood risk analysis I relied on my expert hydrologist colleagues within the Leeds office to review my report. I incorporated their comments before client issue.

I explained the basis of my preliminary 1 in 100 year flood level and the additional climate change and freeboard contingencies adopted, to the architect. The architect's conceptual scheme envisaged structures close to the river and my preliminary flood level became contrary to their design intentions. The architect challenged my approach. I stated that the design flood level was in line with the requirements of the OPW including their provisions for climate change. I stated that my colleagues provided formal review and confirmed that my work was in line with climate change best practice for preliminary design.

Two years later the OPW published their guidelines which confirmed that the assumptions I made were now minimum requirements for floodplain development planning application.

Claim 6. Identify, assess and manage risks

I was responsible for the production of detailed design drawings and specifications for a jetty structure. I was responsible for working with our senior planning engineer through the development assessment process to gain approval for the works. I was also responsible for tender documentation.

I proposed to my client, to complete our work in two stages. I suggested to my client that this was the most cost effective delivery mechanism for the project. Stage 1 included working with the client for local authority Development Approval (DA). As the time taken to approve the development and the requirements of the approval were outside of my control, I recommended that a Stage 2 proposal would be provided on the successful completion of Stage 1. The client was satisfied with my cost-effective approach and agreed to my proposal.

I proposed to my client that a dilapidation report be completed of the adjacent walkway and embankment before demolition of the existing wharf commenced. I recommended this risk based approach to my client as a way to mitigate against potential future claims of damage to the walkway and/or embankment during the demolition/construction phase. The client agreed with this approach. I informed my client that this work had not been allowed for in my proposal and I would seek approval for a variation. I stated my request within an email and provided an additional fee. The client replied to my email giving his approval. I documented this in my variation register in spread sheet form.

During the project I maintained my variation register. I found this extremely advantageous when it came to preparing monthly invoices. At project end, there were a total of 5 variations which in effect doubled our original proposal fee. This highlighted to me the importance of documenting variations and seeking prior client approval in writing before proceeding with additional works. By not seeking approval for variations to the agreed scope, I would have over-spent my budget and placed unacceptable financial risk upon my company.

I prepared a Gantt chart programme of works for all design activities. I used the programme as a reference on a near daily basis to assess project progress. The client specified a final milestone deliverable date where all drawings, specifications and contract documents were required. I proposed intermediate milestones within the programme. For example, I produced Issue For Review (IFR) drawings, specifications and contract documents. I provided these IFR deliverables in a 'drip-feed' approach to allow sufficient time for client review and input, thereby minimising the risk of running late on the final milestone date. I found that the 'drip-feed' approach was an extremely effective mechanism for achieving each agreed milestone. I felt that involving the client throughout the design process fostered a collaborative culture which in turn added value and reduced the risk of project delay.

On a weekly basis, I reviewed my budget against the collective hours spent and actual progress made. I informed my project director on a weekly basis on my progress with regards to budget spent, programme burnt, milestones met and any issues which had the potential to cause delay.

To document design change, I prepared a technical risk register in spread sheet form. Within the register I documented the changes to applicable codes, standards, local authority and concurrence agency's requirements against each design element and assessed the consequences to the existing design. The systematic approach that I took by creating the register provided a clear summary of changes and was extremely beneficial when reviewed by my senior colleague during the QA process.

Local authority DA approval stipulated that once the jetty structure was constructed, an 'on maintenance' period of one year would commence. For 'on-maintenance', the local authority required RPEQ signed 'as-constructed' drawings and certification of the works of the jetty structure. In order for my company to provide certification of the works, I negotiated with my client that some site supervision was required. I suggested to my client that site supervision would be completed on an hourly basis, capped to an upper limit amount. My approach provided my client with a mechanism to control and forecast project costs accurately.

Claim 7. Meet legal and regulatory requirements

I was responsible for working with our senior planning engineer through the development assessment process in order to gain approval for the works. I was also responsible for the production of the detailed design drawings, specifications and tender documentation for a jetty structure.

I proposed to work under the Consult Australia (2009) short form contract as this was my company's legal preference. For Stage 2, I proposed to work under the same signed Consult Australia (2009) short form contract as I successfully did for Stage 1. The client agreed with this approach. However, due to a later change in management, the client later proposed that I work under their preferred terms and conditions. I spoke with my legal colleagues with regards to our position and asked them to review the client's new terms and conditions. The client's terms and conditions were no more onerous on my company than the ACEA (2009) short form contract. Therefore, I proposed to continue working under the signed ACEA (2009) short form contract, to which the client agreed.

I worked alongside our senior planning engineer in order to satisfy the local authority planning approval and the Department of Environment and Resource Management (DERM) (now known as DEHP) prescribed tidal works approval application process. I provided approval drawings of the jetty structure. I showed on the approval drawings the jetty layout, proposed demolition of the existing timber wharf structure, proposed plan and typical cross-section of the proposed jetty structure.

The client stipulated that a timber flume which was part of the original structure, be retained before demolition and reused in conjunction with the new jetty works. I worked with the landscape architects to ensure that the timber flume was incorporated in their works. I designed the bracing and supports for the timber flume in accordance with Australian Standards (AS) 4100 Steel Structures and provided additional drawings to the landscape architects works package.

I was aware that I had a duty to comply with section 22 of the Work Place Health and Safety Act 2011 and ensure, so far as reasonably practicable, that the design is without risks to health and safety. I completed a safety in design risk register and Safety in Design (SiD) report for the project. In consultation with my client, I considered public health and safety and environmental consequences for all stages of the project from design, construction, maintenance, decommissioning and finally through to demolition. Within my risk register spread sheet, I identified the hazards and assessed the associated consequences in order to determine the risk level. I then highlighted the mitigation measures for which I took within the design in order to reduce the risk level to a level as low as reasonably practical, commonly known as ALARP.

The local authority Development Approval (DA) stipulated a list of compliance measures that needed to be adhered to during both design and construction. Lighting of the jetty was not included in the approval drawings. I highlighted this as a hazard and documented the fact that lighting of the jetty was a development approval condition. I engaged our electrical engineers to complete the lighting design as per the associated Australian Standards and with Registered Professional Engineers of Queensland (RPEQ) sign off.

I created tender documentation based on the general conditions of contract AS 2124 (1992). I amended the conditions of contract through the annexures, schedules and job specifications specific to the project requirements and local authority and concurrence agency requirements. For example, I ensured that the contractor prepare an erosion and sediment control program and provided demolition and construction methodologies thereby satisfying the construction environmental management plan, which was a requirement of the DA.

I ensured my company's intellectual property was protected at all times. For example, I ensured all deliverables such as drawings, reports, specifications, conditions of contract were always sent in pdf format and therefore unauthorised changes could not be made. I also ensured that appropriate disclaimers were added to issued reports. The disclaimers would generally state that the reports were prepared for my particular client and should only be relied upon by my client based on the agreed scope and stated limitations.

Claim 8. Communication

At my previous company, I worked alongside and was part of a group of predominantly bridge and structural engineers. A particular bridge which was peer assessed by others, found that a scour assessment during detailed design has not been completed.

I agreed to the request and completed a scour assessment of the bridge design. In order to work effectively, I requested from the bridge designer the amount of time required and available budget in order to complete the scour assessment. I worked with the bridge designer to collate the bridge design drawings and available geotechnical information of the river bed. In order to effectively complete my scour assessment in accordance with relevant guideline material, I interfaced between the bridge designer and flood modeller. I relied on my previous flood modelling experience to converse appropriately and build rapport with the flood modeller.

I was able to request vector plot diagrams at flood peak velocity as opposed to flood peak water level. This is a key point which was critical to the scour assessment as the magnitude and direction of the flow at both flood stages changed considerably. I completed a sensitivity analysis of both flood stages to improve the accuracy of my analysis.

I initiated informal design reviews with my senior colleague by having regular conversations on an adhoc basis. Based on my discussions, I ensured that I included a tidal velocity component within my calculations as this was not modelled within the flood study. I also recognised that the empirically based predictive methods given in the relevant guideline material are based on non-cohesive material and my analysis would therefore be considered conservative. To improve my analysis, I investigated applicable scour prediction methods for cohesive material by placing a post on my company's in-house skills network, reviewing the maritime library, completing searches on Google, Compendex and ScienceDirect, for example.

By successfully working with my colleagues and completing the scour assessment, I became the main point of contact within my group for all scour related project issues.

During my scour assessment, it became clear to me that there was a knowledge gap within the group on assessing waterway scour within the bridge design process. I exercised informal leadership by giving a presentation to my group's quarterly meeting, consisting of approximately 70 engineers and CAD technicians, on waterway scour mechanics.

I gave a 15 minute presentation to my group with the aid of PowerPoint slides. I started my presentation by explaining the importance of why scour needs to be considered and gave some illustrative examples on bridges around the world which have failed due to scour. I explained the predictive empirically based methods, namely general, constrictive and local scour equations provided in the relevant guideline material. I was able to highlight 'watch-its' and lessons learnt applicable to each predictive method.

I explained the importance of working with our flood modellers and geotechnical engineers in order to gain an understanding of peak velocity magnitude and direction and insitu river/creek bed conditions, respectively. I emphasised that the scour analysis should start at preliminary design stage and not retrospectively at the end of detailed design. I also emphasised that proposed bridge piers should be aligned with the flow of the river/creek where practical. I highlighted this point graphically by highlighting an increasing trend of predicted scour depth with an increasing incident flow angle. I also highlighted the dynamic nature of scour should be borne in mind when thinking of the scour process. I explained that as the flood velocity reduced from its peak, deposition within the scour hole is likely occur.

All of the above points were key concepts which I explained in detail through graphical means. My presentation was well received. It was clear that most people within my group were not aware of these key concepts when considering scour mechanics and prediction. I finished my presentation by recommending that any member of my team should come and see me with any questions that may have for future project work.

Claim 9. Performance

My client recently requested that I inspect a roll-on roll-off (RoRo) ramp for an LNG project situated within Australia. My company completed the ramp design, before I commenced my employment with them. The ramp was at risk of failure due to propeller wash during vessel operations.

I immediately went to site to gain a better understanding of the situation by having discussions with my client, and their transportation logistics business arm. Through my discussions on site, it was clear that during the berthing of a particular RoRo vessel, the rock armour protection was becoming unstable, leading to the scour of the core material beneath the concrete ramp. I informed my client that my immediate priorities were to complete a design review of the structure and secondly, propose some remediation options for review.

Once back in the office, I completed a design review of the ramp's rock protection. I concluded that the structure was being compromised due the operation of the large RoRo vessel's twin azimuth propeller thrusters at its stern. Each propeller utilised 1000 horse power or 736 kilowatts and I immediately highlighted to my design manager that the RoRo vessel was outside the bounds of the adopted design criteria. The design manager and I participated in teleconferences with representatives of the client and their transportation logistics arm and a sub-contractor to discuss both temporary and permanent solutions.

For the permanent solution, I recommended the use of a proprietary product to protect the existing structure from propeller scour.

I called the designer, to discuss with him his product and its potential application for the RoRo ramp. Over numerous phone calls, I built up a rapport with the designer. I spoke with my client and it was clear that there was some internal resistance to the use of the product, for various reasons. I exercised leadership by proposing that all concerned parties meet on site to discuss all aspects of the product.

My client agreed with my approach. The site visit and workshop was successfully completed as it allowed all parties to discuss the product and its expected performance for our particular application.

I exercised competence by creating a technical performance specification for the design and supply of the product. Within my technical performance specification, I provided the following information to ensure that the product was designed to provide the required performance;

- Design water levels, waves and currents for the RoRo ramp
- Design vessel parameters including propeller diameter, engine power and application of engine power to the propeller while berthing.
- Minimum propeller wash velocities at the seabed for the design vessel
- Construction drawings and specification of the RoRo ramp
- Existing hydrographic survey of the RoRo ramp berth pocket and approaches
- All available geotechnical information of the RoRo ramp and surrounding area
- Completed diver surveys of the RoRo ramp in its compromised state, to which I had commissioned.

I included a clause within my technical performance specification, to ensure that the provision of design calculations were mandatory for company review. I also suggested to my client that a request for a performance warranty should be made through the commercial contractual arrangement.

My technical performance specification ensured that my client was able to procure a correctly designed product for the particular RoRo ramp.

I added value by recommending that another hydrographic survey be undertaken with particular focus on the berth pocket. The client agreed and I was able to complete a delta plot comparing the new hydrographic survey to a baseline hydrographic survey to accurately determine propeller wash scour extents. To minimise any potential movement of the product and ensure performance, I proposed to bury the free end of the product 0.5 metres beyond my predicted scour depth. In addition, my request for additional hydrographical survey added value as I was able to optimise the product coverage extents.

Claim 10. Taking action

I managed, lead and was responsible for the delivery of a successful proposal to complete a structural condition assessment of a small town's convict built and heritage listed causeway and its exposed seawall.

After reviewing the request for tender documents, I contacted my structural, geotechnical and geophysical internal colleagues requesting their input into my proposal. I also engaged a sub consultant to provide heritage advice and services. I requested that they all review the tender and provide an estimate of their costs, proposed methodology, their CV's and any other supporting material which would help my team to win the project. I coordinated the bid process and integrated all material received into my proposal. I created a master spread sheet with an estimate of my company's collective cost to complete the works. I proposed a reduction in my company's charge-out rates to ensure my bid was competitive, to which my group manager agreed.

I wrote the proposal and was responsible for the proposed methodology. The client had requested Ground Penetrating Radar (GPR) geophysical testing in their tender request. After consulting with my colleagues, I made the decision to deviate from the client's request and recommend Multi-Analysis of Surface Waves (MASW) seismic testing. I highlighted within my proposal that it was both cost effective and technically advantageous to adopt the MASW seismic survey approach.

I requested, and was given permission by my group manager to complete a site inspection of the seawall during proposal stage. Although this involved an increased expense before potential contract award, I was able to add value to my bid document by demonstrating an improved knowledge of the seawall. For example, I was able to highlight within my bid document that the seawall had failed in a number of locations. I informed my client that one particular location of the seawall had failed and posed a risk to the health and safety of the public. I defined my proposed scope, clearly stated project specific qualifications and accurately estimated my company's fee.

My proposal was accepted and my company was awarded the contract. As per my proposal, I immediately organised an inception meeting with the local authority. I organised for our heritage sub consultant to join us in order to show my client that we came as a prepared and coordinated team. At the end of the meeting I asked my client to provide feedback on our proposal. They stated that my company was awarded the contract as my bid provided greatest value based on my proposed alternative methodology. The client stated that after reading my proposal they felt confident in our ability to successfully deliver the project.

Once the contract was officially awarded to my company, I set up a job number in my company's internal financial management system. I created sub job numbers and assigned them to the various internal groups who were working on the project. In line with my company's Quality Assurance (QA) policy, I created task sheets for all personnel working on the project. For each task sheet, I documented their brief, expected deliverables and budget. I requested each member of my team to review and once satisfied, sign their individual task sheet. In line with my company's policy and as the project manager, I felt comfortable in the fact that my team members were taking ownership of their individual tasks.

I checked and tracked actual incurred project costs against my budgeted amounts on a weekly basis.

Following the inception meeting, I ensured that I adhered to my company's management systems and processes. These included but were not limited to;

- Ensuring that our heritage sub consultant signed my company's standard sub consultancy agreement.
- Completing a 15% project review with my project director.
- I kept my company's QA electronic job management system updated at all times. As the project manager, I was aware that I needed to do this to ensure that my company adhered to the ISO 9001 Quality Assurance, AS/NZS 4801:2001 Occupational Health and Safety and ISO 14001 Environmental accreditation.
- I kept my company's electronic financial job management systems updated at all times. This included recording all agreed variations and invoicing for works completed by agreed milestone dates.

Claim 11. Judgment

I managed, lead and was responsible for successful delivery of a structural condition assessment of a convict built and heritage listed causeway and its exposed seawall. My client was a local government authority. I was responsible for supervising, monitoring and evaluating the work of a multi-disciplinary team made up of structural, geotechnical and geophysical engineers and a heritage sub-consultant.

I supervised and monitored the Multi-Channel Analysis of Surface Waves (MASW) geophysical survey on site, which was completed by my internal colleagues. I worked with the MASW geophysical survey team on site and due to time constraints; I recommended that their scope of works be amended to ensure that the critical components of the causeway fill were analysed. My client requested that the preliminary MASW results be sent to them for their review. I evaluated the MASW results to ensure that my client's requirements were met. I ensured that the P and S-wave velocity tomograms made direct reference to the soil reference threshold values, thereby providing clear interpretation of the identified weak zones behind the seawall.

While on site, it became clear that the local Lands Council Aboriginal Corporation representative, who was there to represent the views of traditional owners of the region, had not been informed of our planned activities. I took it upon myself to immediately introduce myself to the representative and inform him of our planned activities which included a condition assessment of the seawall and Multi-Channel Analysis of Surface Waves (MASW) geophysical survey of the causeway fill behind the seawall. My decisive approach helped to resolve a situation which could have led to a temporary cessation of our works.

At the end of all investigations by all parties, I had received reports in various formats written by different authors. I made the judgement that it was imperative that I combine all text into one master report, where the findings were linked and the conclusions flowed accordingly. I spent some additional time producing a consolidated report, however my judgement ensured that our technical conclusions were clear and concise.

I reviewed and evaluated the geotechnical borehole data and the MASW geophysical survey with respect to the structural integrity of the seawall. The geotechnical borehole logs showed that the material behind the full height of the seawall was made up of a clayey sand matrix. The MASW geophysical survey confirmed a consistent clayey sand matrix along the entire seawall length. I made the engineering judgement that within my structural condition assessment report, a section titled 'failure mechanism' was required. I surmised that due to the lack of an appropriate filter layer, which I was able to confirm during the condition assessment, there was a high risk of causeway material being washed out due to both tidal variation and wave action. Within this section of the report, I explained how this failure mechanism was leading to road subsidence and loss of structural interlock within the seawall rock face.

I consulted with my Project Director. I suggested to the Project Director that based on the evidence found during the investigation and the subsequent assessment of risk; closing the traffic lane immediately adjacent to the seawall should be one of the key recommendations of my report. My report conclusively showed that failure of the seawall and adjacent roadway was high due to its assessed condition and its deficient performance. My Project Director reviewed my report, provided feedback and gave his support to this conclusion.

In my final structural condition assessment report, I exercised sound engineering judgement by providing 5 remediation options for client review. I stated that the 5 options were prepared at concept level only due to limitation of available information. Due to scope limitation, I made the decision to suggest to my client that an options assessment based on predefined criteria, such as financial, environment, cultural, heritage, economic etc. should be completed in future stages to ensure that all interests pertinent to the seawall are given due consideration.

My report, including the engineering judgements that I made, were accepted by my client.

Claim 12. Advanced Engineering Knowledge (PE) Knowledge of Standardised Practices (EA) Knowledge of Technology (ET)

I was asked by an internal colleague to complete a mooring analysis of 6 different vessel class types and predict vessel motion envelopes for a conceptual port in open water off the coast of Western Australia. My port planning colleague asked that I complete the analysis as he knew I was competent with a proprietary mooring analysis software package, and requested that a few 'quick calculations' would be sufficient.

Initially, it became clear to me that I needed to provide further explanation of the engineering fundamentals to my port planning colleague. I wrote a technical note explaining the theory and fundamentals of vessel motion and included a section on the accuracies and limitations of the current commercial numerical modelling software packages.

I stated that in the first instance, it is paramount to have an understanding of the metocean conditions of the site, including wind, wave and current components. I explained that it is also paramount to complete an initial investigation into the susceptibility of the site to long period waves. I went on to explain that most commercial models do not accurately predict vessel motions due to long period waves, contrary to the software proprietors claim.

I explained that vessel motion is typically made up to both static and dynamic components. I clarified that static motions are predominantly due to wind, current and wave-drift force acting on a vessel. I emphasised that the current proprietary mooring software version procured by our company was only suitable for static analysis.

I then went on to explain that dynamic vessel motions due to wind gusting and/or incident wave components acting on the vessel are required to be modelled in the time domain. I explained that the software package has the capacity to calculate 'quasi-dynamic' vessel motions through the use of their Hydrodynamic Coefficient Files (HCF). I explained that the HCF files comprises a set of 6 degrees of freedom hydrodynamic data which has been generated by an independent tested program called AQWA, which is accepted industry standard. I explained that the proprietary mooring software refers to the HCF data to calculate the relevant response amplitude operators (ROA's) for a particular water depth, vessel size, draft, trim metacentric height (GM) and selected roll damping.

My technical note stated that the static only software model considers the wave height and period within the frequency domain and not the time domain. I explained that the software proprietors claim that the use of HCF files equates to a fully dynamic model. Based on fundamental theory, I advised my colleague that the use of the HCF files equates to a 'quasidynamic' model only and careful consideration needs to be given to the various definitions. I advised my colleague that I have previously utilised the 'quasi-dynamic' models for a detailed design of a LNG jetty.

I made the recommendation that to simulate the true dynamic component of vessel motion, a model which captures wave height and period in the time domain is required. I advised my colleague that our current version of the software did not, at the time, have this capability. I contacted the software proprietors, and they informed me that they were currently working to upgrade their software to include wave height and period in the time domain. In addition, I contacted our in-house wave modellors, and they confirmed that the site is susceptible to long period waves.

Based on these facts, I gave my recommendation within my technical note that I did not have the capacity with the current tools at hand to accurately predict vessel motions. I provided details of known commercial numerical models provided by others which had the capacity to model long period waves and therefore predict vessel motions accurately.

Claim 13. Local knowledge

I was responsible for the conceptual design of a rock revetment solution for a beachfront property in Queensland, Australia. I firstly consulted my company's library and determined that the following local documents provided the most relevant information in describing the coastal processes at the local area:

- *Hervey Bay Beaches* by the Beach Protection Authority Queensland (1989).
- *Queensland Climate Change and Community Vulnerability to Tropical*
- *Cyclones: Ocean Hazards Assessment Stages 2 and 3,* by the Marine Modelling Unit of James Cook University (2004). I ensured that my conceptual design adhered to the following legislation and standards;

I ensured that my technical design adhered to the following legislation and standards;

- *Queensland Coastal Plan* (2012) (recently revoked) which replaced the State Management Coastal
- Plan (2001) and associated regional coastal management plans.
- *The Operational Policy, building and engineering standards for tidal works* under the Coastal Protection and Management Act (1995). The policy provides the minimum building and engineering criteria for tidal works approved under the Sustainable Planning Act (2009).
- Australian Standard (AS) 4997 (2005) *Guidelines for the design of maritime structures*
- British Standard (BS) 6349 (2000) *Maritime Structures Part 1*
- *The Rock Manual,* CIRIA C683 (2007)
- *Coastal Engineering Manual* (CEM) (2006) by US Army Corp
- *Random Seas and the Design of Maritime Structures* (2000) by Goda

All aforementioned documents subsequently formed my design basis. My design basis consisted of the following adopted parameters;

- I adopted a 50 year storm event as defined in the operational policy, building and engineering standards for tidal works under the Coastal Protection and Management Act (1995).
- Tidal planes (2004) within the James Cook University studies were adopted. I noted that the 2012 HAT level was 90 mm higher than the 2004 level adopted within the published study. In line with good practice for the design of coastal structures, I added the difference to my design storm tide level.
- Extreme wave heights and periods were provided in both the *Hervey Bay Beaches* and James Cook studies. I determined that the James Cook studies provided the most relevant offshore 200 year wave height and period with a corresponding depth for wave transformation purposes.
- The *Queensland Coastal Plan* (2012) recommended 0.4 m of sea level rise until the year of 2060 which exceeds the 50 year value of 200 mm given within AS4997. I adopted the *Queensland Coastal Plan* (2012) sea level rise value as I deemed it as most appropriate for the project site.
- I referred to the *The Rock Manual* for guidelines on overtopping values and associated damage levels. I adopted a conservative limit in line with the *Operational policy, building and engineering standards for tidal works*.
- I adopted a beach slope from the survey provided in The *Hervey Bay Beaches* document as no other bathymetry was available.
- I adopted a rock revetment 'damage factor' and rock toe level of LAT in accordance with the *Operational policy, building and engineering standards for tidal works*.

I utilised the Coastal and River Engineering Support System (CRESS) program to complete wave transformation calculations and corresponding wave height estimates within the surf zone. The CRESS program utilises the composite Weibull distribution of wave heights in shallow water based on Battjes and Groenendijk (2000). As reference, I read through Battjes and Groenendijk (2000) paper to ensure that I understood the assumptions and limitation of their given approach.

I concluded that the predicted significant wave height within the surf zone would break before reaching the structure toe due to depth limitation. I then created a spread sheet and calculated the depth limited wave height based on *Random Seas and the Design of Maritime Structures* by Goda.

I read the applicable sections on rock armour hydraulic stability under wave action within *The Rock Manual*. I applied the Van der Meer Van Gent (2004) equation as the revetment was within the wave breaking zone. I graded the rock amour and underlayer based on the filter rules given in the *CEM*. I completed a check of my design with the commercial software called, Breakwat, produced by Delft Deltares and found that my design calculations were correct.

Claim 14. Problem analysis

In 2010, I was responsible for the delivery of the static and dynamic mooring analysis, including the effects of passing ship, for six LNG design vessels.

My client had specified that the a proprietary mooring software package was to be used to conduct the analysis. I had no experience with the software prior to award of detailed design of the LNG jetty. My first action was to post a thread on my company's in-house skills network in order to determine if there was anyone within my company who had a high level of experience with the software. The resounding response was that there was no one within my company who had experience with it, let alone was competent with utilising the software. I determined that my company had a software licence in an overseas office, however it had not been used for some time. I organised with my colleagues in this office to gain access to their stand-alone computer which had the software installed. This proved quick and efficient and more cost effective than sending the dongle via airmail.

I then applied for internal funding where I proposed to replicate the software results of a reference mooring analysis that was provided by my client during tender design stage. I also proposed to complete a technical discussion paper at the end of my works to document my understanding of the software package and the information gaps that I identified. I provided a business case and budget to complete my study. Funding was subsequently approved.

In the process of completing the modelling replication, I read through the software user manual and found this most beneficial to my learning's. My replicated results were within 3 and 5% for fender and mooring line loads, respectively, compared to the reference mooring analysis results provided by the client. I concluded that the percentage difference in results was due to the fact that I was utilising a static only approach within the software. The reference design took a quasi-static approach through the use of hydrodynamic coefficient files (HCF) which model wave induced vessel motions within the frequency domain. I immediately identified that the procurement of HCF files was critical to the mooring analysis and I recommended the procurement of the correct HCF files based on the design vessels.

At the conclusion of my investigation, I progressed to having a basic understanding of how to use the software. I was able to define the major componentry of the software, and was apt at carrying out future investigations. For example, the reference design report provided by my client was title, '*dynamic mooring analysis*'. I was able to highlight that technically this was not accurate, as waves are not modelled within the time domain. I suggested to my colleagues that the report should have been named 'quasi-dynamic mooring analysis' as the software at the time modelled waves within the frequency domain only. This fundamental understanding was obtained by my research and replication of previously modelled scenarios by others.

I sent my technical discussion paper to my peers within the maritime group, the maritime design lead for the LNG jetty, and finally the executive-level design team for their review. I concluded my investigation by making recommendations on how best to proceed with the mooring analysis once detailed design had been officially awarded. This included;

- Documenting the version of the software required for myself and my team to complete the mooring analysis in order to complete detailed design phase as per client requirements.
- I also provided a budgeted estimate for the software which was confirmed by quotation from the supplier.

- Setting up a sub-consultancy agreement with the supplier, Tension Technology, to act in a checking and review role of my simulations due to a lack of in-house expertise. I concluded my discussion paper by recommending that training by the supplier was required in order to obtain a thorough and clear understanding of the technical issues associated with the software.

I concluded my discussion paper by recommending that training by the supplier was required in order to obtain a thorough and clear understanding of the technical issues associated with the proprietary mooring software.

Claim 15. Creativity and Innovation / Advanced Operation / Predictable Operation

During 2012, I was responsible for the conceptual design of a rock revetment solution for a beachfront property.

I sketched 4 structurally sound and economic conceptual design options for both a typical rock and one layer cube solution, for my client's review. In order to compare the revetment footprint and therefore overall cost, I provided revetment solutions based on a 1 in 2 and 1 in 1.5 slope.

By providing a 1 in 1.5 slope solution I was able to show an overall reduction in the revetment footprint and thereby provide value due to a reduce rock volume. However, I clearly highlighted on my sketch drawings that the D_{50} (median rock size defined as the size for which 50% by weight of the material is finer) increased from 550 kilogram for a 1 in 2 slope to 800 kilogram for 1 in 1.5 slope. I highlighted to my client that the increase in armour size was based on a first principal's approach, by explaining that the wave energy dissipation provided by the structure would be less for a steeper slope. I created value by suggesting to my client that a cost-benefit analysis based on local quarry rates would be required in order to determine which solution was most cost effective.

I concluded that the predicted significant wave height within the surf zone would break before reaching the structure toe due to depth limitation. I created a spread sheet and calculated the depth limited wave height based on *Random Seas and the Design of Maritime Structures* by Goda. I tested a range of values for each parameter to check the sensitivity of Goda's equation. For example, I investigated wave breaker heights at the structure for storm tide, HAT and LAT. Due to the low topography of the property, it was clear that breaking waves would overtop the proposed crest at storm tide and HAT water levels. I rationalised my solution (i.e. by reducing the design breaking wave height on the structure and consequently reducing the rock armour size) by concluding that the design wave for this particular structure would be depth limited. I created value by concluding that the design wave height would be limited by the revetment crest level.

My client had constructed a 'quasi' revetment wall out of 450 one tonne (approximately) concrete blocks. The revetment wall subsequently failed, hence my design. I considered the reuse of the existing 450 one tonne (approximately) concrete blocks in a single layer armour solution. I referred to *The Rock Manual* in the first instance and found that design experience with single layered cubes was very limited. Due to the conceptual nature of my work and the potential to save the client a substantial sum of capital expenditure, I deemed it appropriate that single layer cube solution should be investigated at a conceptual level for client review. I read the paper by the author, J.W. Van der Meer, for which the guidance given in *The Rock Manual* is based. I did this to ensure that my design was within the validity bounds and fundamental principles of the experiments performed by Van deer Meer. My calculations showed that 'breaking' the concrete blocks in halve had some feasibility. Through my investigations and provision of sketch drawings to my client, I was able to create value from both a sustainability and cost point of view.

I provided value to my client by implementing a risk-based design approach. The Van der Meer equation which I utilised allows the size of the rock armour to change in proportion to the selected 'damage factor'. As part of my design basis, I allowed an 'initial' damage factor equivalent to 'few units being displaced' during the design storm event. I informed my client that by accepting my design approach, some maintenance may be required after a storm event. With my client accepting some potential maintenance requirements of the structure, I was able to provide a substantial capital expenditure saving by reducing the size of the rock and the rock layer thickness.

Claim 16. Evaluation

I was requested to complete an inspection and evaluate the construction of a test panel for a rock causeway structure for an LNG project. A test panel is a demonstration of correct rock underlayer and armour placement and most importantly provides a baseline for acceptable construction practice.

I immediately reviewed the rock armour specification and I concluded that the specification did not provide sufficient detail on how to conduct a test panel. I concluded that further explanation of how a test panel should be performed was required. I also stated to my client that correct completion of the test panel alone did not constitute certification of the works.

Before arriving on site, I read the relevant sections of the The Rock Manual, CIRIA C683 (2007) with regards to test panels in order to ensure that my advice was correct and would not adversely impact the works. Once I was on site, I requested a toolbox talk with the client and contractor where I explained the importance of a test panel and its relevance as a reference point during construction.

I stated to all parties that the following criteria would be adopted:

- The test panel would be completed for the rock armour layer only as the underlayer had been already constructed;
- A 5 metre section would need to be marked out on site with spray paint or similar approved by myself;
- A weighing mechanism and appropriate recording documentation of the rock armour was required on site;
- The rock amour to be used in the test panel would need to be separately stockpiled to allow time for my inspection and approval;
- The test panel was to commence at low tide to maximise visual inspection of the built structure;
- Provision of 'as-constructed' survey of the core, underlayer and rock armour layers as per the specification;
- An expected rock armour placement density of 1.6 to 1.7 tonne / m3.

I provided this additional criterion as my review of the rock armour specification deemed it necessary. I also spoke to the excavator operator and confirmed that the following criteria were applicable to his operations:

- 'Bottom-up' placement of rock armour from the toe was expected to ensure adequate interlock;
- Placed rock armour must have three point of contact to ensure adequate interlock;
- The face of the rock amour should be irregular in nature. This was contrary to the operator's view of rock armour placement so I gave a theoretical explanation in layman's terms on the reasoning behind this criterion.

I firstly inspected the weight scale within the front-end loader and deemed this a sufficient mechanism to weigh the rock armour. I deemed the use of a front-end loader was appropriate as opposed to the use of alternative methods such as weighing each individual armour rock, thereby causing minimal impact on the works programme.

I confirmed that the marked up section for the test panel was sufficient. I spoke with the surveyor and confirmed that 'as-constructed' levels were available for the core and underlayer as per the specification. I then inspected the stockpiled rock armour and approved its quality against the specification. I also retained a copy of the rock armour weight receipt.

At low tide I approved the commencement of the test panel. I positioned myself on site where I could best view the placement of rock armour. After watching the excavator operator for some time, I confirmed that bucket placement of rock armour was satisfactory as opposed to 'grab' placement, which had been suggested to me as an alternative. When the test panel concluded, I requested the excavator operator to take GPS levels at the toe and crest of the structure. Based on the weighted tonnage of rock armour, preliminary levels taken with the excavator and my visual inspection, I was able to complete some preliminary calculations and evaluate the test panel as satisfactory. I made the point on site that my evaluation was preliminary only and was subject to further checks once 'as-constructed' survey was complete.

My evaluation ensured overall quality assurance was met as per the specification and minimal impact on the works programme was achieved.

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