Setting a new benchmark for erosion and sediment control in Queensland

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Environmental Excellence

BRUCE HIGHWAY UPGRADE – CALOUNDRA ROAD TO SUNSHINE MOTORWAY (CR2SM)

FULTON HOGAN SEYMOUR WHYTE JOINT VENTURE

CR2SM Caloundra Road to Sunshine Motorway

A Fulton Hogan Seymour Whyte Joint Venture

Fulton Hogan

SEYMOUR WHYTE

Queensland Government

The Fulton Hogan Seymour Whyte Joint Venture (FHSWJV) is delivering the $812.95 million Bruce Highway Upgrade – Caloundra Road to Sunshine Motorway (CR2SM) on behalf of the Queensland Department of Transport and Main Roads (TMR).

Located on Queensland's Sunshine Coast and adjacent to sensitive areas of State and National Environmental Significance, the team is using innovative and cost-effective solutions for erosion and sediment controls (ESC) to manage land and water contamination.

A proactive, transparent approach to environmental management has earned accolades from the Department of Environment and Science (DES). The Regulator described the planning and execution of ESC on the project to be of a high standard in environmental performance and representative of best practice.

By actively sharing and promoting their results at forums, site tours and education sessions for industry, community groups, local and state government departments, CR2SM is positively contributing to the broader ESC industry.

The innovation adopted by the projects' construction joint venture partners (Fulton Hogan and Seymour Whyte) is setting a new benchmark for large scale civil transport infrastructure projects delivered in Queensland.

We are honoured to be considered as an industry leader and are pleased to submit this nomination for the 2019 IECA Environmental Excellence Awards.

Brad Thompson
Project Director
Fulton Hogan Seymour Whyte Joint Venture

Trevor Land
Project Director
Department of Transport and Main Roads

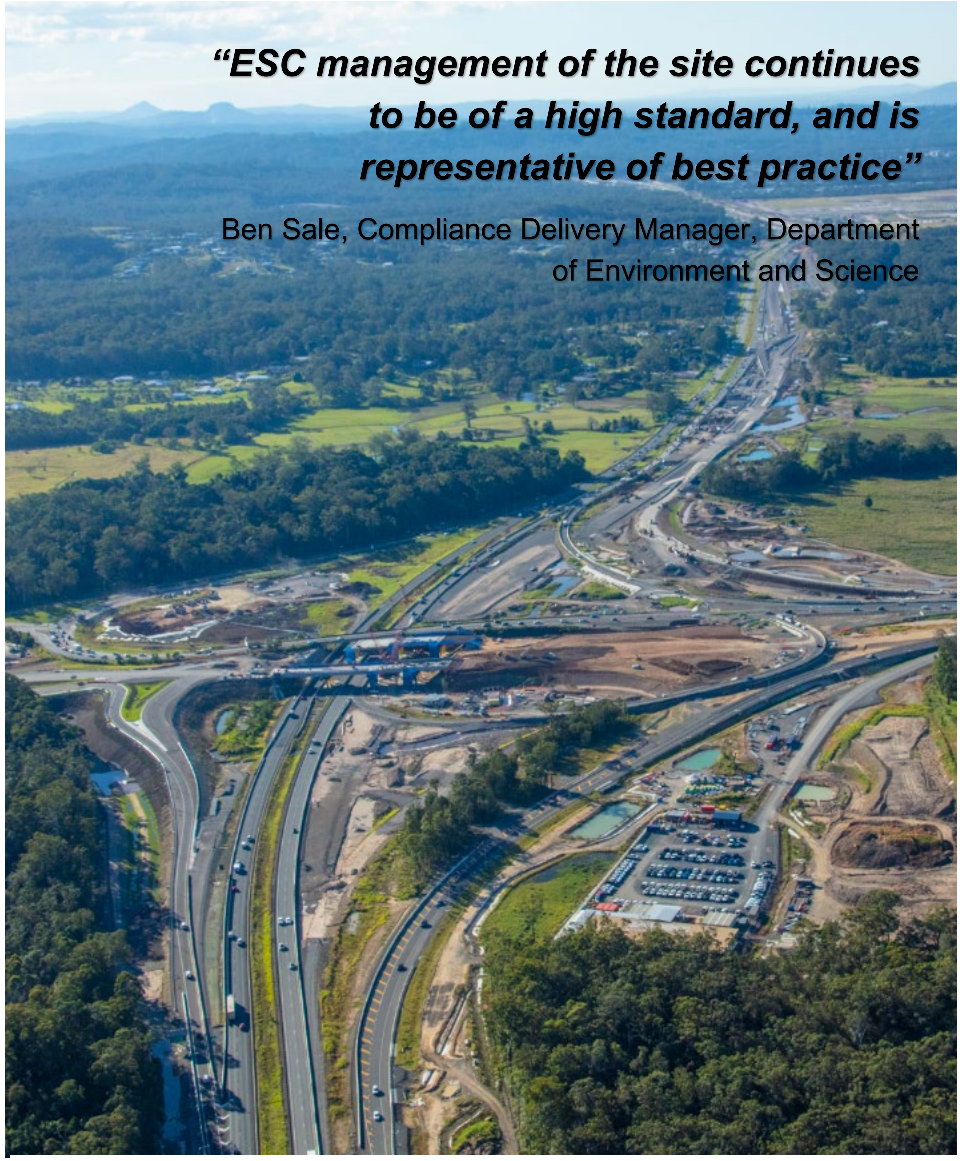


Figure 1 An aerial view of the Caloundra Road interchange, looking north up the Bruce Highway and towards the Sunshine Motorway

1 Entry description

The Bruce Highway Upgrade – Caloundra Road to Sunshine Motorway (CR2SM) involves upgrading the Bruce Highway from four to six lanes, including major upgrades to both interchanges and a western service road for local traffic travelling between Steve Irwin Way and Tanawha Tourist Drive.

The Sunshine Coast is renowned for high rainfall. The area has received above average rainfall since 2017, leading the CR2SM team to develop innovative and cost-effective solutions for use of High Efficiency Sediment (HES) basins to manage the erosion and sediment control (ESC) and land contamination risk profile of the site.

Surrounded by the Mooloolah River National Park (formerly the Beerwah State Forest) and Palmview Conservation Park, major waterways including the Mooloolah River and Sippy Creek traverse the site. These waterways are home to Matters of State and National Environmental Significance including Threatened Ecological Communities (TEC) protected under the *Environmental Protection and Biodiversity Act 1999 (EPBC).* The waterways also have stringent Water Quality Objectives outlined in Queensland legislation and hold significant cultural heritage value to the Kabi Kabi First Nation People.

During construction, the team has continually demonstrated a proactive and innovative approach to managing exposed areas including dispersive and acid sulfate soils (ASS) as well as contaminated land and waters to protect sensitive downstream environments. This includes strategic planning of temporary instream works during construction of 11 major bridges that span over sensitive waterways.

HES basins were installed across the site to not only remove sediment but also remove contaminants such as E.coli from upstream sources. A system for treating water 24 hours a day was devised by combining multiple sub-catchments throughout the site and retrofitting several traditional type D sediment basins to include solar powered in-line dosing units. This provided significant cost savings, minimised environmental and legislative risk and optimised return to work timeframes after large rain events.

The team has shared the success of using HES basins for managing ESC on a large civil transport infrastructure project at environmental forums. This has also been promoted via local and state government authorities, educational sessions and site tours for local university and high school students.

The diligent application of ESC on site has seen the project receive two letters of commendation from the Department of Environment and Science (DES) following post rainfall inspections. This confirmed the ESC standard was representative of best practice and the planning and execution of ESC was of very high standard.

Figure 2 An innovative application of HES basins on site has managed ESC in challenging site conditions and effectively treated large volumes of contaminated water from upstream sources.

2 Location and key milestones

Located on Queensland's Sunshine Coast, about 75km north of Brisbane, the project is set between 65km of beaches on the east coast and surrounding tropical rainforest and woody hinterland to the west. There is a mixture of urban centres and rural hinterland communities—all of which place a high value on the protection of environmental values.

The upgrade is vital for the continued development of the Sunshine Coast and with its increased capacity, the highway will provide safer and more efficient travel for commuters along this stretch. It also includes construction of an Australian-first Diverging Diamond Interchange (DDI) at Caloundra Road. This innovative design was chosen for its ability to minimise impact to the Beerwah State Forest while tackling congestion and providing enhanced capacity, safety and active transport connections.

Below is a list of the unique environmental features of the project:

- The Mooloolah River National Park (formerly Beerwah State Forest) and Palmview Conservation Park located adjacent to major construction areas.
- The original project design required a 35-hectare portion of the former Beerwah State Forest vegetation be cleared. The continued refinements to the design has reduced the impact on the forest to approximately 6 hectares and a reduction of areas exposed to ESC.
- Major waterways traverse the site with Mooloolah River and Sippy Creek home to Commonwealth and State protected ecological communities. These waterways hold significant cultural heritage values for the traditional owners.
- High-risk in-stream works with 11 of the 22 major structures spanning sensitive waterways and drainage flow paths.
- Water contamination, including E.Coli and high sediment load from upstream water sources.
- The proximity of the upstream Ewan Maddock Dam—a major, ungated dam that has extended overflows during periods of rainfall.
- Dispersive ASS, potential ASS (PASS) and contaminated soils in low-lying areas.

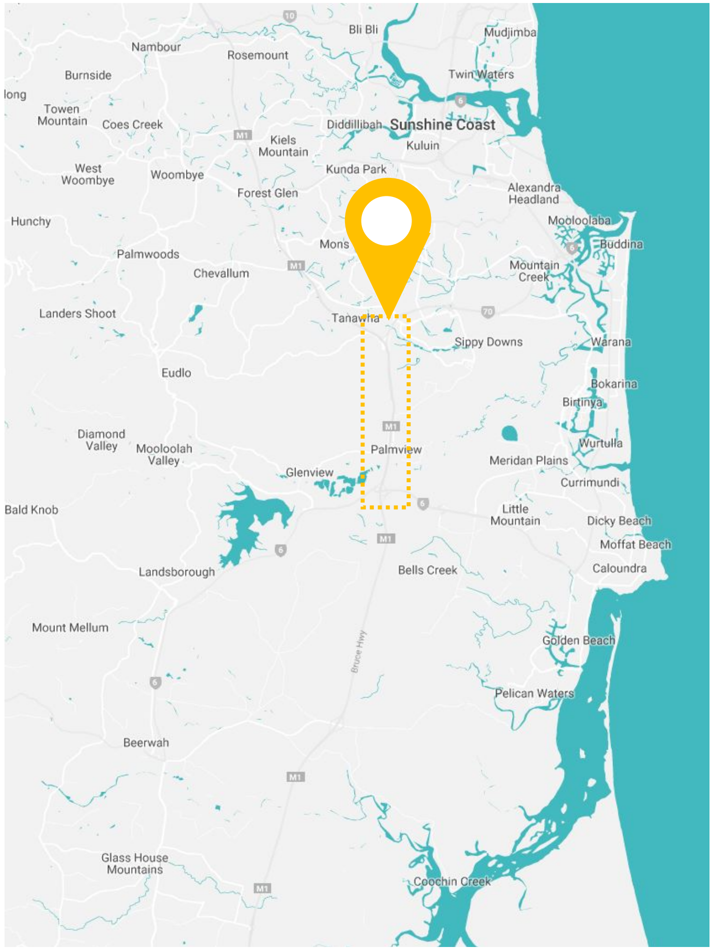


Figure 3 The project, located on the Sunshine Coast, involves upgrading the Bruce Highway and transforming two interchanges at Caloundra Road and the Sunshine Motorway

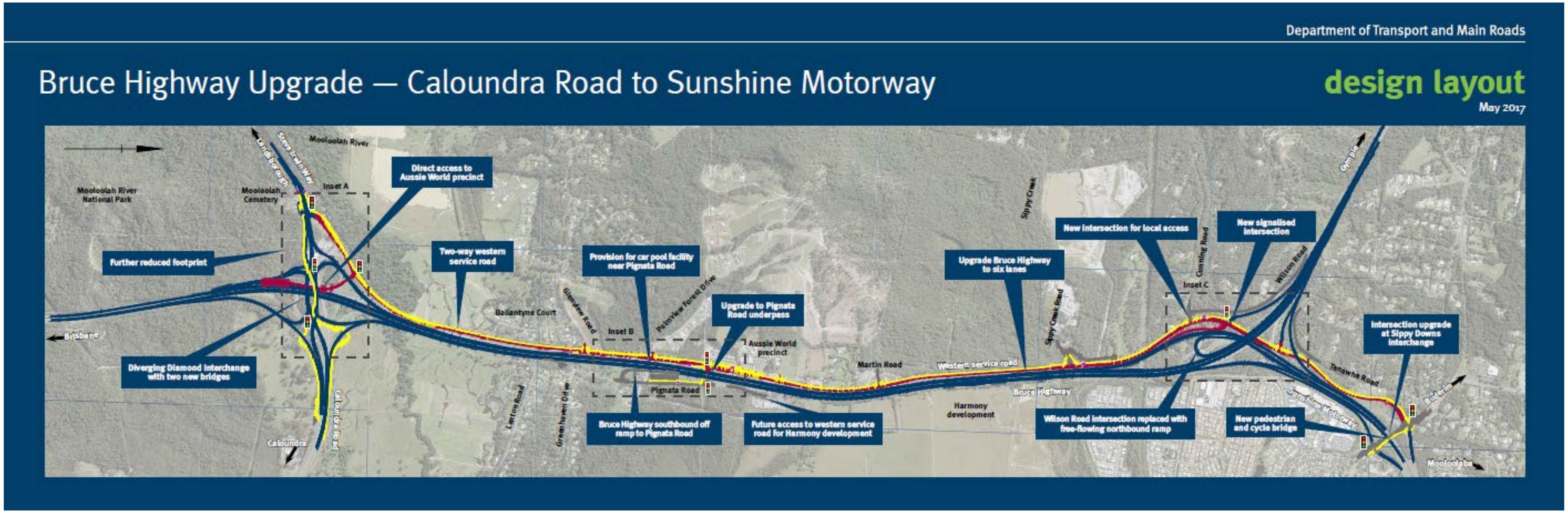


Figure 4 Project design layout showing the scope and extent of work

Figure 5 The project timeline design layout and timeline showing the start and expected duration of construction

Key milestones

In September 2016, the Fulton Hogan Seymour Whyte Joint Venture (FHSW JV) was awarded the contract to finalise detailed design and construct the upgrade. The FHSW JV comprises a construction joint venture (CJV) between Seymour Whyte and Fulton Hogan and a design joint venture between Arup and Jacobs (DJV).

Preliminary construction activities began in late 2016 with major construction commencing in May 2017. During 2018-19, major construction continued across two work zones with multiple work fronts. Construction is expected to be complete in late 2020.

3 Challenges and unique aspects

Design process for temporary ESC

Due to the high-risk environmental profile of the project and the sensitivity of the downstream environments, a four-gate review process was implemented for each stage of construction. Temporary ESC plans were designed by CJV and reviewed by TMR for each stage.

The four-gate review process (shown in Figure 6) was applied for each major construction stage (clear and grub, initial earthworks, final earthworks and revegetation). Previously this type of review was only implemented for permanent works. Using this process for temporary ESC works added additional layers of technical review during the planning and development of the progressive Erosion and Sediment Control Plans (ESCPs) with the key objective of providing better than usual environmental outcomes.

At the completion of the four-gate review process, the plan and drawings related to each ESCP were Issued for Use (IFU) and Issued for Construction (IFC) respectively. At each stage, the CJV submitted an ESC package that contained the relevant drawings, management plans, calculations and typical details. TMR's onsite Certified Professional in Erosion and Sediment Control (CPESC) reviewed and provided comments on the submission for CJV to address. Other various TMR environmental personnel also provided observations which the CJV addressed as warranted.

As required under the contract, it was mandated that at least one CJV environmental team member was a CPESC. Any changes to the ESCPs required sign-off from the CJV (via their CPESC) and the project's Independent Verifier (IV) CPESC via a specified 'Red Line Mark Up' process.

Figure 6 Each ESC plan and drawings is subject to a four-gate design review process for each progressive stage of construction

Key Performance Indicators for ESC

Due to the high level of environmental risk on the project, TMR and the CJV developed specific Key Performance Indicators (KPIs) proportionate to the risk profile of the works.

The Environmental and Sustainability Key Result Area (KRA) comprised of three KPIs, in which 75% of the overall score rating was related to the management of ESC onsite. The objective of this scoring system was to ultimately drive performance and achieve good environmental outcomes.

The KPIs for the Environmental and Sustainability KRA were as follows:

- Erosion and sediment control performance in external audits (50%)
- Closing out ESC corrective actions within appropriate timeframes (25%)
- Ecological value - minimise impact on EPBC Act protected matters (25%):
    - areas of critical koala habitat
    - areas lowland rainforest of subtropical Australia (threatened ecological communities).

Challenges

Since major construction began in 2017, the project has received above average rainfall, providing many challenges in the planning and implementation of works. The project has managed land and water contamination issues including E.coli contaminated waters from upstream sources. This resulted in the reconfiguration of the overarching ESC strategy in the northern zone (near the Sunshine Motorway).

This reconfiguration of the ESC strategy required diligent planning and a collaborative approach between the CJV and TMR.

This collaborative decision-making resulted in a change to the drainage design. The sediment-laden water from several upstream catchments within the construction footprint were managed via a downstream HES basin. These initiatives reduced the risk of surface water interacting with known contaminated material and allowed dewatering of work areas to be expedited and return to work timeframes optimised post rain events.

One of the key challenges was managing piling and excavation works in and around sensitive waterways including EPBC protected ecological communities with stringent water quality objectives.

Another significant challenge was the redesign of permanent and temporary works including changes to temporary traffic ramps, the realignment of two waterways and construction of three bridges over the Mooloolah River and floodplain during unpredictable weather patterns. These design changes required additional mitigation measures as contingency to build resilience and minimise the environmental risk profile.

Key achievements

Despite these challenges, the team has continually demonstrated a proactive and innovative approach to managing exposed areas and downstream environments. These initiatives have included research, development trials and knowledge sharing to a range of stakeholders, resulting in excellent environmental outcomes. Some of the key achievements include:

- Installation of HES basins and trials of a variety of flocculants to not only remove sediment but also remove contaminants such as E.coli (entering site from upstream sources). This has proved highly successful and learnings have been shared with industry groups located in Queensland and New South Wales.
- Following post-rainfall site inspections with representatives from the Regulator, DES (Sunshine Coast Branch), a commendation letter was received on three occasions describing the planning and execution of ESC to be of a high standard. (Refer Attachment 1, 2 and 3).
- The project has combined a number of sub-catchments throughout the site and retrofitted several traditional type D sediment basins to include solar powered in-line dosing units allowing treatment of water 24 hours a day. This provided significant cost savings for the project, minimised environmental and legislative risk and facilitated construction commencement in areas which otherwise would not have been accessible post rainfall. The return to work timeframes has provided sound commercial outcomes for the project and mitigated downtime.
- To date, the project has met its General Environmental Duty as per requirements of the *Environmental Protection Act 1994.*with no breaches or significant environmental incidents occurring during critical construction phases.

HES basin dewatering innovations

A large portion of the project is to be constructed in low-lying flood plains. The project team has been consistently challenged to achieve stringent local water quality objectives to mitigate harm to the environment.

With complex, low-lying sub catchments hosting over 50 type D sediment basins, it was evident that these systems were often performing inefficiently. By challenging traditional construction and water management methods and incorporating cost efficient water treatment systems, the team was able to gain significant time and cost savings.

Using their learnings and expert knowledge, the team has developed a suite of recommendations for future site application of these adapted basins, along with new standard operating procedures and training packages.

Development incentives

There were a number of driving factors that generated the need to develop more sophisticated, technology-based site stormwater management practices:

- Potential extensive delays to the construction program due to dewatering requirements after rainfall, particularly across the Mooloolah River floodplains and other low-lying areas.
- Potential significant costs incurred for flocculants to discharge more than 50 traditional batch treatment sediment basins across the site.
- The time-intensive resources and logistics involved with testing and issuing dewatering permits to construction crews.
- The challenges associated with monitoring discharged water quality parameters across multiple sites, in line with the project's environmental requirements and safety expectations.
- Safety consideration for workers applying flocculants and manual handling around liquids.
- Allocation of site resources to manually treat captured waters.
- Delays in treating turbid groundwater during excavation activities.

Creating a solution to these issues was critical, enabling the team to find the balance between construction progress, sound commercial outcomes and the need to minimise environmental harm.

Constraints

Adopting a forward-thinking solution for managing ESC on site was not without its own challenges. Some of the constraints experienced by the team included:

- Historical reluctance to approve aluminium-based products that allow for rapid flocculation of sediment-laden stormwater. Concerns raised about not being able to control influences on pH and aluminium toxicity in the receiving environment.
- Confidence that the flow-through method of water treatment delivers water of an acceptable quality to the receiving environment at all times, particularly when unsupervised.
- Developing an understanding within the project team that value for money means more than the price paid and benefits can be both direct and indirect.

Environmental outcomes

HES basins were designed for flow-through dosing of the incoming turbid water with aluminium chlorohydrate (ACH) during weather events, or direct pumping from dewatering.

One of the main risks that these flow-through treatment train methods present is the residual aluminium becoming available in the downstream environments. The team proposed using ACH products and conducting water quality laboratory sampling at both the inlet and outlet of the treatment train to determine if residual aluminium was being discharged off site at a trial basin on the northern floodplain.

The ecological risk of metals downstream (aluminium in particular), where specific dosing and monitoring was being undertaken, were below Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines.

Results have shown a significant reduction available iron, zinc, coliforms and less available aluminium on the outflow after dosing. After receiving these results, the team installed eight modified HES basins and dosing systems across the project at critical points to increase discharge rates post rainfall and during subsurface dewatering operations.

Figure 7 , 8 and 9 shows the modified turkey nest within the Mooloolah River floodplain, which was used to treat all sub-catchments within the Caloundra Road interchange.

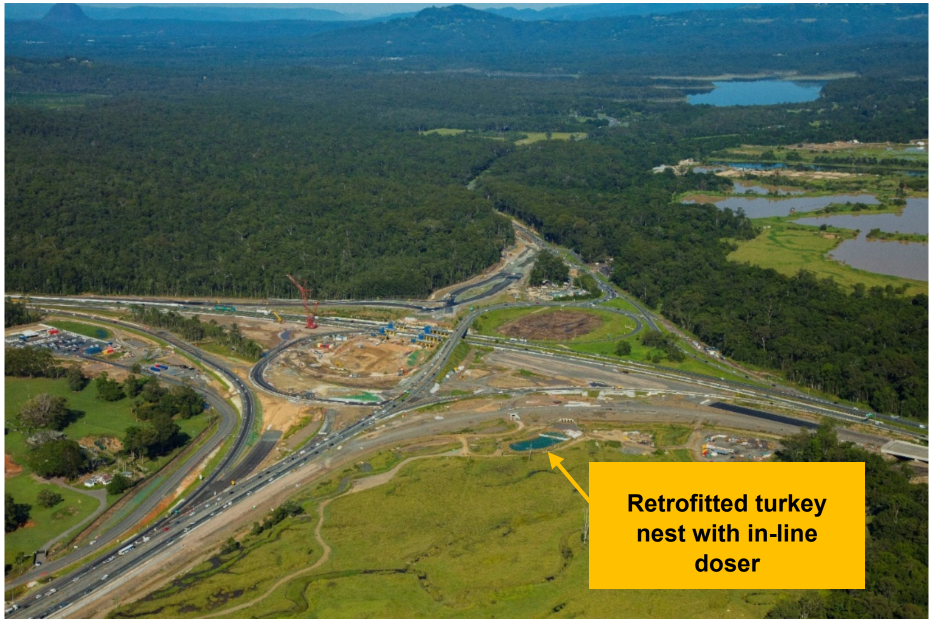


Figure 7 An aerial view of the Caloundra Road interchange showing the extent of the sub-catchment areas.

Figure 8 A modified turkey nest arrangement at the Caloundra Road interchange, shown here from above, captures and treats all sub-catchments within the interchange work area.

Figure 9 A ground perspective of the retrofitted turkey nest and inset showing the inside of the solar powered in-line dosing unit.

The HES has proved to be a highly efficient treatment device within the Mooloolah River floodplain work area. Figure 10 and Figure 11 show the location and scale of this device.

Overleaf, Figure 12 and Figure 13 provide a visual demonstration of the improvement of water quality flowing to the EPBC protected Mooloolah River during a 150mm rain event.

Figure 10 Another turkey nest HES basin installed in the northern Mooloolah River floodplain for dewatering and treatment of contaminated water from upstream sources.

Figure 11 An aerial view showing the location of the HES basin in relation to the project works.

Figure 12 The upstream water quality of Mooloolah River

Figure 13 Water being discharged from the construction site shows following a 150mm rain event into the sensitive Mooloolah River catchment a distinct improvement after being treated in the HES basin.

Positive feedback from the Regulator

Ben Sale, Compliance Manager from DES' Sunshine Coast branch conducted a site inspection in October and December 2018 in response to CR2SM proactively providing water quality results after a rain event (refer Attachment 1 and 2).

The inspection included a review of the site ESC and drainage staging as the wet season approached. The department took samples of the discharged water leaving site, with results confirming all water leaving site was lawful and above design.

Feedback from the department's team was extremely positive with Ben Sale describing CR2SM as a high performing site in the ESC space and openly commending the team (refer Attachment 1).

The CR2SM team continued to grow a strong relationship with the department and subsequently received a third letter of commendation in May 2019 (refer Attachment 3). The team was commended for their innovative use of HES basins in optimising return to work timeframes after high rainfall events.

Figure 14 The HES basin in the northern work zone manages water received from multiple sub-catchments

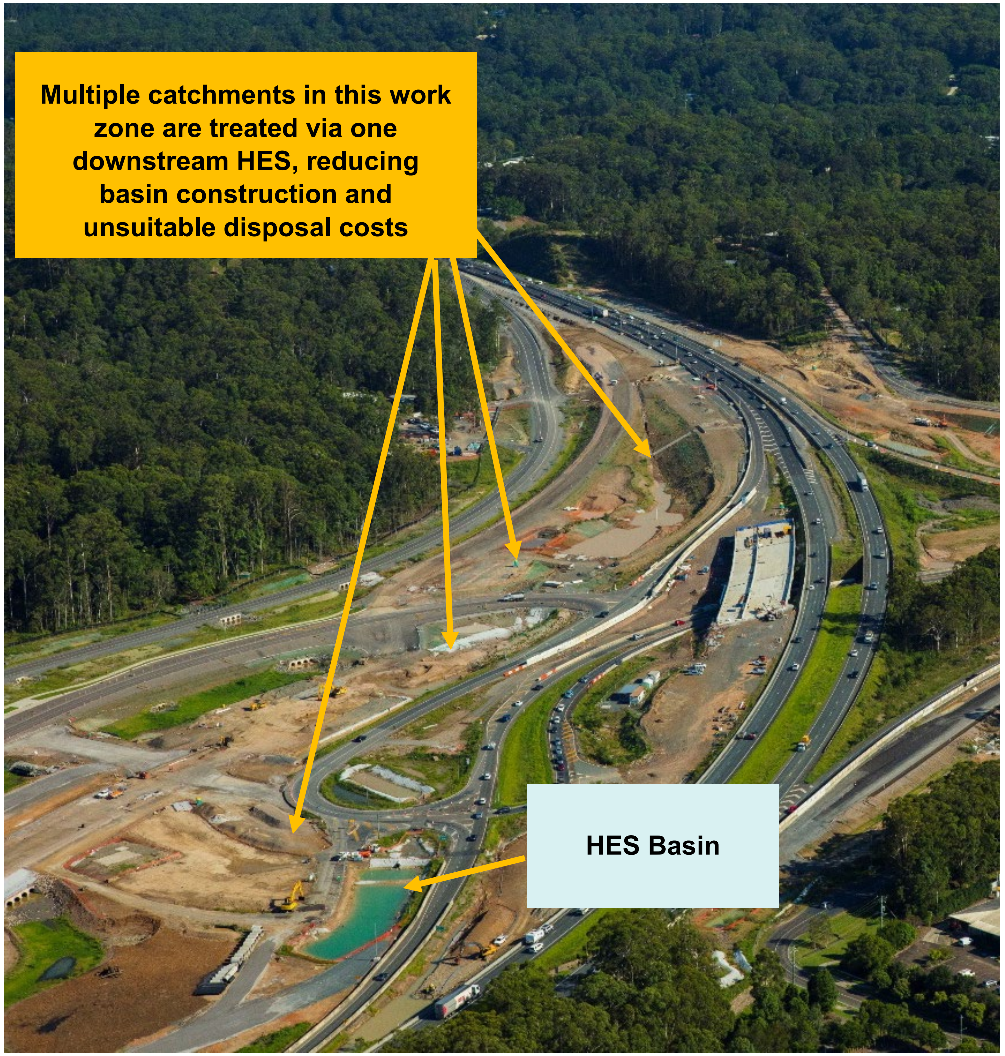


Figure 15 An aerial image showing the project's northern work zone at the Sunshine Motorway interchange and the location of the HES basin in this area

Other initiatives for stockpile and haul road management

A long-term stockpile and haul road through the floodplains provided an opportunity to trial the use of dustbloc to aid with soil stabilisation.

CK88 fertilizer was added to the hydromulch with a seed mix of rye and millet as the cover crop with couch for longer term ground cover. Dustbloc was mixed into the road material with the use of a grader and water cart for soil stabilisation on the haul road.

A trial using dustbloc treated soil (left) submerged in water against a quality control soil sample from the site demonstrated its effectiveness in haul road management.

Figure 16 A trial using Dustbloc demonstrated the effectiveness of this simple solution.

Figure 17 Dustbloc is used on site as an effective way of aiding soil stablisation.

4 Community, industry and organisational benefits

Benefits to the environment

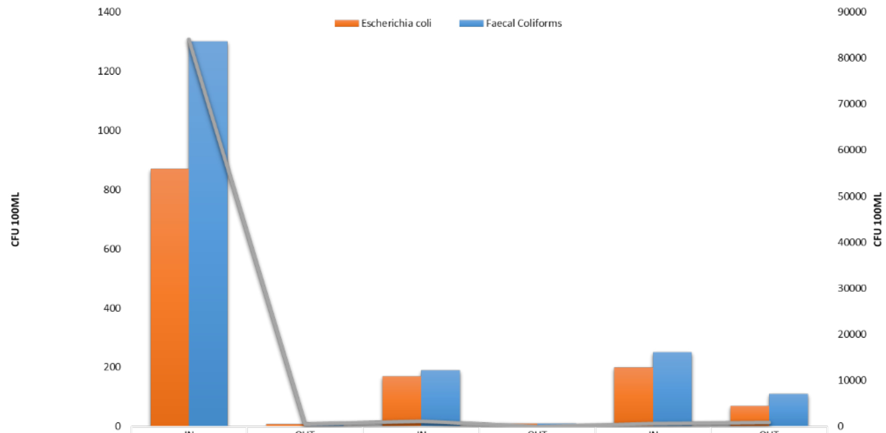
The project has observed a large reduction in E.coli and turbidity levels from upstream to downstream and trialled a number of different flocculants and coagulants to optimise this environmental outcome. The redesign of permanent and temporary clean and dirty water diversion drains around contaminated areas has minimised sub-surface water interaction with contaminants.

The use of soil binder has greatly reduced waste impacts with a large quantity of waste (geofabric and sediment fencing) and unsuitable waste quantities being sent to landfill.

Mulch sourced from tree-clearing work on the project is being reused for temporary ESC landscaping activities. This is a great project outcome as the alternative is for the mulch to be disposed of to landfill.

E.coli and total coliform reduction

Bacterial samples were taken during sampling at the basin site. The results during each sampling event recorded significant reductions in bacterial levels and consistently lower on outflow than inflow locations as seen in Figure 18. The primary contact levels under ANZECC guidelines for faecal coliforms (150cfu/100ml) was on average reduced by 98.1%. Total average reduction for total coliforms and E.coli was 99.3% and 98.6% respectively.



	29/05/2018 IN	29/05/2018 OUT	03/07/2018 IN	03/07/2018 OUT	31/07/2018 IN	31/07/2018 OUT
Escherichia coli	870	7	170	10	200	70
Faecal Coliforms	1300	15	190	10	250	110
Coliforms	84000	570	1200	12	600	960

Figure 18 Reduction of bacterial contamination through HES treatment

Reduction in total and dissolved aluminium

Total aluminium results compared with Total Suspended Solids (TSS) are shown in Figure 19. Each sampling event resulted in lower Aluminium and TSS on downstream. An average 88% reduction over the study period was observed on total aluminium levels.

Significant reductions in dissolved aluminium were observed during the sampling. An average 77% reduction was recorded when minimum limit of reporting levels was used (0.005mg/L).

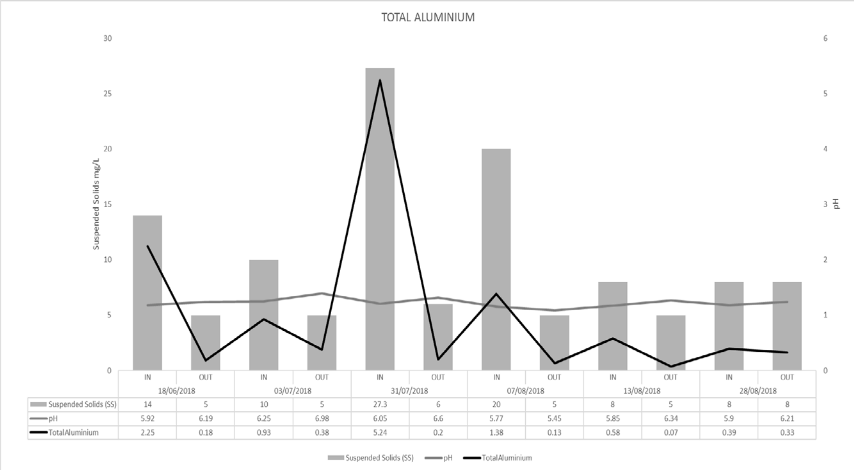


Figure 19 Reduction of in total and dissolved aluminum through HES treatment

Benefits to the community

CR2SM has encouraged and promoted wider knowledge sharing by holding educational sessions and site tours for local university and high school students currently studying or interested in ESC. The project team has also been in consultation with local environmental stakeholder groups and the Kabi Kabi First Nation People.

The water quality objectives have been managed well to maintain the recreational use characteristics of the surrounding waterways and downstream environments, including the Sippy Downs lakes area.

The team has reduced the environmental noise nuisance aspect of dewatering with the successful implementation of HES flow-through systems and traditional sediment basins with syphon outlet arrangements.

The project team have invited community members to become involved in project revegetation and offset tree planting days since 2018.

Below is a list of the community information sessions and tours in which the project has held to communicate and knowledge share our ESC initiatives.

- CSQ Try A Trade – August 2018
- University of the Sunshine Coast (USC) enviro site visit – October 2018
- Power of engineering – November 2018
- USC site tour – March 2018
- USC site tour – April 2018
- Japanese site tour – March 2019
- USC site tour – April 2019
- Engineers Australia – May 2019
- CCF – April 2019
- South Queensland Land Rehabilitation Group (SQLRG) tour – April 2019
- Landcare – ongoing every third Sunday of the month.

Benefits to the industry

The project has provided work experience to environmental management, science and engineering students looking for a career in the industry and utilised local suppliers and consultants in the implementation of the site initiatives.

The team has presented and hosted a site tour for revegetation contractors as part of the South Queensland Land Rehabilitation Group Conference 2019 to discuss topsoil management and alternate revegetation techniques.

The lessons learned from the project initiatives have been shared externally to parties within the ESC industry for Roads and Maritime Services (NSW) and TMR (QLD).

Benefits to the organisation

The project team have developed innovative and cost-effective solutions to manage the ESC and land contamination risks - to treat sediment and manage the overall environmental/commercial and reputational risk profile of the high-risk works. These initiatives have been shared with TMR and both parent construction companies (Fulton Hogan and Seymour Whyte) to demonstrate how efficient soil and water management techniques can provide sound commercial outcomes and optimise return to work timeframes.

Cost

Sediment basin design and construction costs are comparable between typical type D and type A or type B. Whilst decanting structures and low flow pipes may add an additional $250-$400 to the build cost, they offer significant pump cost savings by gravity feed discharge. They are however limited to areas with suitable fall or spillway construction.

As shown in Figure 20, the cost comparison of different products and associated activities was calculated.

Application via a subcontractor involved loading of product onto a hydromulch truck, mixing, drive to site and broadcast spray application. All sub-contractor costs were at hourly rate with product costs to project. Site staff were required for setting up pumps and hoses for dewatering activities.

Self-performance costs involved loading of product into site application trailer by site staff, mixing, drive to site and broadcast spray application. Site staff were required for setting up pumps and hoses for dewatering activities where low flow valves were unable to be utilised.

HES costs involved supply and delivery of product to the dosing unit. Costs not included were the purchase or monthly hire of the units of $11,000 and $1,100/ month respectively. Purchase or hire is based on location, catchment and expected basin time requirement. Efficiencies in designing cascading of basins, or modifications in drainage lines, has also significant time and cost savings where overflows from smaller basins, outlet into a larger catchment area where a dosing unit has been installed.

On below cost estimates, catchments requiring approximately 2ML of water to be discharged post rainfall is cost neutral in one year of operation. This is based on business as usual dewatering cost on average amount of discharges required annually. Smaller catchments and basin requirements do not offer the cost saving to purchase or rent the dosing unit. Cost savings were realised where there was modified catchments, instead of numerous basins under 1,000m3, several catchments cascaded and drained into a final structure with a dosing unit.

Product comparison	Chitosan 1000L	Hydra gypsum 1000L	TS3 1000L	ACH 1000L	Powdered Gypsum	HES ACH
Cost $	1500	1600	2187.5	2950	700	2950
PPM	500	150	150	100	350	100
Cost per MEG	886.25	376.25	464.375	431.25	381.25	295
Application method	Dose and mix	Broadcast	Broadcast	Dose and mix	Broadcast	Direct Dose

Figure 20 Cost comparison of treatment option

Time

A key component to this work is the speed of the process. The modified turkey nest basins on the flood plain has the ability to handle 3x150mm pumps at 12,600L per minute. Continuously dewatering can achieve 20ML in 24 hours. Included with the real time telemetry, monitoring of the pH and turbidity with alarms sending text messages if discharge parameters are nearing exceedances.

These innovations resulted in 80% of the sites 50 sediment basins dewatered within three days of significant rainfall. Ponded areas were dewatered efficiently and crews returned back to work significantly faster than anticipated.

Areas of shallow ponded water can be dewatered into a HES basin immediately after rainfall, compared with waiting until the onsite sediment basins are flocked and discharged in typical batch treating methodology.

For future work, there is the potential to set up pumps during rain events to prevent ponding. This will allow for treating and dewatering activities to be undertaken as the rain event is occurring. This has not occurred to date on site, but the opportunity may be presented as the project progresses.

Safety

Exposure to products and manual handling has been significantly reduced, particularly the use of dry powder gypsum, traditionally used in water treatment. Automatic dosing directly from a container allows secure set up, isolated from other works and minimising transport and logistical risks. This activity requires a Safe Operating Procedure (SOP) and trained personnel, therefore the risk of untrained or inexperienced staff undertaking the activity is removed.

The reduction in labour time and risk involved in flocculation and dewatering operations have been observed. Due to the methodology of dosing and sampling, the overall exposure hours to the sediment basins and risk of drowning have been considerably reduced both from field staff and from environmental teams undertaking the sampling and testing.