Australia's National
Science Agency

GISERA | Gas Industry Social and Environmental Research Alliance

Progress report

Onshore gas water lifecycle management options framework

CSIRO | Australia Pacific LNG | QGC | origin | Santos | NSW Government | Australian Government Department of Industry, Science, Energy and Resources | Supported by Government of South Australia | Queensland Government | Northern Territory Government

Progress against project milestones

Progress against milestones/tasks are approved by the GISERA Director, acting with authority in accordance with the GISERA Alliance Agreement.

Progress against project milestones/tasks is indicated by two methods: Traffic light reports and descriptive Project schedule reports.

1. Traffic light reports in the Project Schedule Table below show progress using a simple colour code:

- **Green**:
  - Milestone fully met according to schedule.
  - Project is expected to continue to deliver according to plan.
  - Milestone payment is approved.
- **Amber**:
  - Milestone largely met according to schedule.
  - Project has experienced delays or difficulties that will be overcome by next milestone, enabling project to return to delivery according to plan by next milestone.
  - Milestone payment is withheld.
  - Milestone payment withheld for second of two successive amber lights; project review initiated and undertaken by GISERA Director.
- **Red**:
  - Milestone not met according to schedule.
  - Problems in meeting milestone are likely to impact subsequent project delivery, such that revisions to project timing, scope or budget must be considered.
  - Milestone payment is withheld.
  - Project review initiated by GISERA Director.

2. Progress Schedule Reports outline task objectives and outputs and describe, in the 'progress report' section, the means and extent to which progress towards tasks has been made.

Project schedule table

TASK NUMBER	TASK DESCRIPTION	SCHEDULED START	SCHEDULED FINISH	COMMENT
Task 1 Stage 1	Collate existing information in published sources, existing industry practices	Aug-20	Oct-20	Completed
Task 2 Stage 1	Stakeholder analysis and engagement plan, design and complete stakeholder survey and collate results	Aug-20	Nov-20	Completed
Task 3 Stage 2	Wastewater KPI development, link with Code of Practices, obtain stakeholder feedback	Dec-20	Mar-21	Completed
Task 4 Stage 2	Review treatment options, Address knowledge gaps, Develop optimisation criteria	Apr-21	Jul-21	Completed
Task 5 Stage 2	Conduct multi-criteria analysis and develop framework tool – application of holistic approach incorporating technical (treatment, reuse options), environmental (water quality and quantity), economic analysis (treatment costs, operational costs)	Jul-21	Sept-21	Completed
Stage Gate				
Task 6 Stage 3	Case Studies to test framework tool	Oct-21	Dec-22	
Task 7 Stage 4	Delivery of final report/handbook on operating guidelines and a key stakeholder briefing	Oct-21	Dec-22	

Project schedule report

STAGE 1 (TASKS 1 & 2): TECHNOLOGY, PROCESS AND STAKEHOLDER SCAN - 4 MONTHS

TASK 1: Collate existing technology and process information and stakeholder orientation

BACKGROUND

Task 1 will involve research and review of the published literature, science reviews, company EMPs and industry reports to determine.

- What can we learn from onshore gas operations in other states and internationally?
- What are the currently experienced wastewater qualities, process steps, treatment options, issues, disposal challenges, chemistry issues, examples of successful beneficial reuse?
- What examples can be found of diverting various waste streams at points in production and treatment process.

This task will also identify key stakeholders for the onshore gas industry in the Northern Territory, identify a stakeholder list, contact Industry, community and government stakeholders on project, introduce the project and orient in readiness for subsequent activities (survey), determine their areas of interest, knowledge and concerns, identify how they prefer to engage in project.

During this task the team intends to undertake an orientation site visit to a site of current shale gas development in the NT. Should travel restrictions prohibit the site visit at this stage in the project, then it will be conducted at the earliest available opportunity within travel and seasonal limitations.

TASK OBJECTIVES

1. Collate existing information based on literature searches and surveys.
2. Orientation site visit from research team (scheduled for earliest possible in project).
3. Conduct stakeholder analysis

TASK OUTPUTS AND SPECIFIC DELIVERABLES:

Literature Review and Stakeholder Analysis (will form relevant sections of final report).

PROGRESS REPORT

This milestone is now 100% complete. Objective 1 of a literature review of current wastewater treatment practices within Australia and internationally has been completed, identifying plausible options, considerations, and limitations.

Objective 2 of travel to the site for project team orientation has been impacted by travel restrictions and will be conducted under a future milestone when safe and appropriate during 2021. Objective 3 Stakeholder Analysis has been completed, identifying stakeholders for the project and likely interests through targeted stakeholder engagement. Both the literature review and stakeholder engagement will form chapters in the final project report.

TASK 2: Design and complete survey and collate results

BACKGROUND

During Task 2, the team will develop an industry survey/questionnaire to survey selected shale gas operator in Australia and ascertain current industry practices in water and wastewater relevant to the NT onshore gas development. The survey will determine all aspects of sources of wastewater within processes, treatment and reuse, beneficial use options and practices - including engagement with other industries on related practices. The key objectives for this survey will be to obtain baseline data on current practices used in the shale industry. It is anticipated that this initial survey would highlight knowledge gaps that would require more detailed follow up.

The survey target audience is intended to be regulators, industry proponents, related and proximal industries and key community stakeholders. The survey will include (but not limited to) the following:

- How are these industries' currently doing things/operating with wastewater?
- What should be included?
- What are current limitations and challenges?
- What the other industries are in the region?
- What existing treatment options are available and currently utilised?

TASK OBJECTIVES

1. Design of survey of industry stakeholders in NT.
2. Run industry survey with identified groups.
3. Collate survey results and identify key insights.

TASK OUTPUTS AND SPECIFIC DELIVERABLES

Technology, Process and Stakeholder Scan document (will become chapter in final report).

PROGRESS REPORT

This milestone is now 100% complete. Objectives have been completed – survey developed, and insights obtained from industry and government stakeholders on industries, treatment challenges and opportunities in the region. A summary has been developed which will form a chapter in the project final report

TASK 3: Wastewater KPI development, link with Code of Practices, obtain stakeholder feedback

BACKGROUND

The survey data will be used to quantify both typical values for key performance indicators (KPIs) and realistic target values (benchmarks). KPIs for technical, environmental, economic, and social aspect would provide a complete framework for water management. This lack of an overall framework was the gap identified. KPIs in relation to water use can include information on the sources of water for completions (hydraulic fracturing) at the operations by volume and percentage of total volume. Water quality as a KPI can include reporting frequency of pre- and post-drilling water testing by area of operations. KPIs for produced water and flowback water storage, treatment, and reuse will be developed in consultation with the stakeholders.

TASK OBJECTIVES

1. Develop water use, water quality, treatment, reuse KPIs. KPIs are to measure treatment, reuse, what can be more efficient. Holistic life cycle approach. Systematic approach to understanding what processes generate what waste and what options for management may be possible. This approach helps to gain industry and regulator trust, ownership and buy-in to KPIs, and gives industry an adaptive approach to managing WW – accessible approach.
2. Link KPIs with code of practices – ensure regulatory body has opportunity to test and input to KPIs. Workshop or direct input (more regulatory focus).
3. Stakeholder engagement to update stage 2 findings. (talk to all stakeholders for refining KPIs).

TASK OUTPUTS AND SPECIFIC DELIVERABLES

Document on KPIs for Wastewater Management in the NT (will become chapter in final report).

PROGRESS REPORT

This milestone is 100% complete. KPI development is complete and stakeholder input has been obtained. We aspire to greater stakeholder input which will be further sourced in Task 4. A summary has been developed which will form a chapter in the final report.

TASK 4: Review treatment options, Address knowledge gaps, Develop optimisation criteria

BACKGROUND

We will review the treatment technologies and determine the feasibility of their practical implementation, and an in depth understanding of features important to promote the adoption of treatment technologies by the shale oil and gas industry. The treatment of wastewaters produced in the shale gas production process poses a big challenge for the development of fracking industry. There is a need to understand the composition and time-evolution of flowback and produced waters in the different shale plays where hydraulic fracturing takes place. Once these effluents have been characterised, it will be possible to select and optimise the most appropriate treatment

technologies for each scenario. The general treatment process of the produced water includes the separation of oil and water, removing suspended solids and organic compounds including naturally occurring radioactive material, and the total dissolved solids (TDS) reduction. Especially, the removal of total suspended solids (TSS) and TDS is important for discharging or reuse of the produced water. It is because the high concentration of TSS and TDS in the produced water can cause scaling in the wells or contamination of adjacent water and soil. In the treatment process, segregating techniques such as a centrifuge, hydro-cyclones, or dissolved air flotation are firstly applied to separate oil and to remove TSS. Then, an individual or a combined water treatment technique such as membrane distillation (MD), reverse osmosis (RO), or evaporative crystallization (EC) is applied to reduce TDS. The selection of the most adequate technology for produced/ flowback wastewater treatment will ultimately depend on the specific properties and pollutants of the effluent considered as well as the volume of wastewater to be treated in a single unit.

The criteria used for assessment of different technologies will be based on the Table 1 (above). The results of literature review and technical assessment of treatment technologies will be used as basis in the development of the decision tool based on multicriteria analysis as proposed in Task 5.

TASK OBJECTIVES

We will review the treatment technologies and determine the feasibility of their practical implementation, and an in depth understanding of features important to promote the adoption of treatment technologies by the shale oil and gas industry:

1. Determine what treatment options are available to achieve the KPIs.
2. Conduct SWOT analyses of treatment options – including water use, cost for infrastructure, operational costs, energy consumption, social acceptability, sustainability, waste generated, water quantities. Centralised vs decentralised treatment approaches, single industry vs multi-industry approaches.
3. Documenting end use water quality specifications/requirements for categories of beneficial reuse. E.g. growers, cattlemen, likely industrial users e.g. where highly saline water or rich in chemicals, can we collect that potent water and then improve the wastewater quality.
4. Perform economic feasibility of the treatment technologies based on the infrastructure establishment and operational costs?
5. Identify major environmental and social the barriers for the implementation of the treatment technology.
6. If poor data availability, may need to address knowledge gaps.
7. Engage local NT engineering subcontractor support to ascertain infrastructure treatment costs for industry trajectories.
8. Incorporate monitoring for water quality and water quantity - at process level, treatment level.
9. Confirm local water qualities, through industry or contractor, collect new samples if necessary.

TASK OUTPUTS AND SPECIFIC DELIVERABLES

Document treatment options and criteria, i.e. Wastewater Options Analysis (document) (to be chapter in final report)

PROGRESS REPORT

This milestone is 100% completed. A range of wastewater options exist for treatment of wastewaters of the quality currently identified. However, water qualities from the few wells currently at appraisal stage are highly variable making some key criteria difficult to evaluate, or tending possible solutions towards uneconomic. If the water qualities and quantities can be

confirmed to be within acceptable ranges for the more favourable treatment options, there is potential for suitable end users in the region, particularly in the mining sector. This milestone report will form a chapter in the final report.

TASK 5: Conduct multi-criteria analysis and develop framework tool

BACKGROUND

Multi-criteria decision analysis (MCDA) is a structured approach for measuring the performance of alternatives that are based on multiple attributes. The different methods that fall within this category can support the decision analysis process for issues in which more than one criterion—also known as attribute—is simultaneously evaluated. These decision analysis tools enable the inclusion of relative importance, or weight, for each criterion. The weight is used to rank the performance of the alternatives to be implemented against the selected criteria. These methods have the potential impact of improving transparency, auditability, and analytical rigor of decision-making processes in complex contexts. Numerous MCDA techniques provide decision makers and analysts the opportunity to properly and effectively address decision problems. The selection criteria will include capital cost, operating and maintenance (O&M) costs, space (footprint) requirement, commercial availability, mobility, and energy demand. Based on the criteria selected and prioritised during TASK 2, a decision support framework that combines a large number of selection criteria will suggest efficient treatment trains capable of treating non-traditional waters to the target water quality required for beneficial use or discharge to the environment.

Determination of criterion weights is crucial in MCDA. The Analytical Hierarchy Process (AHP) is a popular mathematical method for this purpose when analysing complex decision problems. It derives the weights through pairwise comparisons of the relative importance between each two criteria. All weighted criteria can then be aggregated using a weighted combination method (e.g. ordered weighted averaging (OWA), or fuzzy OWA) to generate output ranking(s) from the decision support framework. These evaluation results will illustrate the usefulness/effectiveness of the proposed solution.

TASK OBJECTIVES

1. Develop a MCDA framework tool – an application of holistic approach incorporating technical (treatment, reuse options), environmental (water quality and quantity) and economic analysis (treatment costs, operational costs) with the consideration of balancing community/social benefits/outcomes (Duration: 4 weeks).
2. Analyse options against the KPIs and beneficial use and optimisation criteria requirements to develop decision support for wastewater management. This includes the selection of criteria and determination of their thresholds (Duration: 2 weeks).
3. Derive criteria weights using analytic hierarchy process (AHP). This includes the construction of various pairwise comparison matrixes and identification of relative importance between each pair of criteria (Duration: 2 weeks).
4. Aggregate multiple identified treatment options and wastewater reuse criteria. This includes a set of collective evaluation runs using different weighted criteria based on different prioritised options (Duration: 2 weeks).
5. Compare usefulness of treatment and reuse options and report writing (Duration: 2 weeks)

TASK OUTPUTS AND SPECIFIC DELIVERABLES

Document MCDA analysis and framework tool (to be chapter in final report)

PROGRESS REPORT

This milestone is 100% complete.

The team have completed development of the wastewater framework tool using MCDA methodology, obtained industry and government key stakeholder review, and drawn conclusions on the wastewater technical treatment options for the appraisal stage. We have included transport costs estimates by working with a related GISERA project team undertaking the transport volumes work (TRANSiT tool), to get accurate independent assessment of the transport costs. Objectives 1-5 are now complete, and a Northern Territory Research Advisory Committee discussion paper has been prepared for the Stage Gate, providing a summary of results to date and requesting authorisation for project to continue to following stages.

Variations to Project Order

Changes to research Project Orders are approved by the GISERA Director, acting with authority, in accordance with the GISERA Alliance Agreement. Any variations above the GISERA Director's delegation require the approval of the relevant GISERA Research Advisory Committee.

The table below details variations to research Project Order.

Register of changes to Research Project Order

DATE	ISSUE	ACTION	AUTHORISATION
16/07/2021	Unavailability of a key resource due to their relocation to another state, as well as a delay in the engagement with the engineering contractor due to the disruption of the relocation of this key project member.	Milestone 4 extended from end June 2021 to end July 2021.	
27/07/2022	Delays experienced during the stage gate approval process between stages 1&2 and 3&4.	Milestone 6 and 7 extended from end February 2022 to mid-December 2022.	

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GISERA is a collaboration between CSIRO, Commonwealth and state governments and industry established to undertake publicly-reported independent research. The purpose of GISERA is to provide quality assured scientific research and information to communities living in gas development regions focusing on social and environmental topics including: groundwater and surface water, greenhouse gas emissions, biodiversity, land management, the marine environment, and socio-economic impacts. The governance structure for GISERA is designed to provide for and protect research independence and transparency of research.