Australia's National
Science Agency

GISERA | Gas Industry Social and Environmental Research Alliance

Progress report

Environmental baseline characterisation of the springs in Hot Springs Valley, NT

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
1	Stakeholder consultation, access and permission (landowners & TO)	01 Sept 2023	31 Jan 2025	Completed
2	Hydrogeological architecture/fluid flow path models	01 Sept 2023	06 June 2024	Completed
3	Field geology mapping & sampling	01 Jul 2024	31 July 2025	Completed
4	GHG survey, analysis & interpretation	01 May 2024	30 Aug 2025	
5	Water Sampling, laboratory analysis and interpretation	01 May 2024	30 Aug 2025	
6	Terrestrial ecology survey, analysis & interpretation	01 May 2024	30 Aug 2025	
7	Data integration and conceptual model development	01 Sept 2024	30 Aug 2025	
8	Project reporting	01 Sept 2023	31 Oct 2025	
9	Communicate findings to stakeholders	01 Sept 2023	30 Nov 2025	

Project schedule report

TASK 1: Stakeholder consultation, access, and permission (landowners & TO)

BACKGROUND

The areas around the Hot Springs Valley has been under a pastoral lease ownership for the past four decades. Further, the area holds significant historical and cultural significance. Therefore, consultation with the relevant stakeholders is an important first step before the research work can commence. Engagement with the current pastoral lease owners to enable access to the areas to be studied is essential. The project team will also obtain any necessary permits or approvals from traditional owners and representative bodies (such as AAPA and the NLC). Communicating the goals and objectives of the research with community stakeholders is of high importance. Engagement with local Aboriginal communities will be undertaken where welcomed. This will enable some knowledge sharing and allow the project team to undertake their research in a culturally sensitive way. This will also assist CSIRO's understanding of the cultural and historical significance of the area, which will help to inform the environmental data collection and interpretation process.

TASK OBJECTIVES

The objectives of this task are

- Obtain relevant ethics approvals, if required,
- To gain necessary approvals, permits and certificates to access the Hot Springs Valley area and conduct the planned field activities from land holders and traditional owners; and,
- Engage with traditional owners to understand the cultural and historical significance of the Hot Springs Valley and to share information about the objectives of this project.

TASK OUTPUTS AND SPECIFIC DELIVERABLES:

- All necessary approvals, permits and certificates to access the study site and to complete the planned field work.
- An understanding of the traditional owners the Hot Springs Valley.

PROGRESS REPORT

This milestone is complete.

We engaged with the Northern Land Council (NLC) from the start of the project. NLC officers consulted with and engaged broadly with the indigenous community associated with the Hot Springs Valley (HSV) to obtain approval for accessing the area. Prior to the commencement of the field work, two NLC officers managed and facilitated a 2-day site visit and meeting between CSIRO researchers and six traditional owners at the HSV. Approval was granted by the four elders prior to commencement of the field work. The extensive field campaign was conducted from 19-30 August 2024 after Welcome to Country were performed at the sites.

TASK 2: Hydrogeological architecture/conceptual fluid flow paths model

BACKGROUND

The Hot Spring Valley is located along the northern part of the major fault systems of the OT Downs fault zone that is bounding the northern part of the eastern Beetaloo Sub-basin. These regional fault systems are likely to have accommodated episodes of fluid flow as old as 1645-1640 My and are targeted for mineral exploration as potential fluid pathways for ascending metalliferous brines.

They are likely to have been reactivated through the more recent tectonic history of the region with current hot springs such as Lagoon Creek springs and Beauty Creek springs (Frery et al., 2022). There are existing geological, geophysical and hydrogeological data that can be compiled and interpreted in a desktop study to develop conceptual models that allow for targeted field data collection. There is existing knowledge with Northern Territory Government about the Hot Springs Valley.

TASK OBJECTIVES

Conduct a desktop study to develop more comprehensive hydrogeological architecture/fluid flow path models integrating existing geological, geophysical, satellite remote sensing & other associated relevant data as to define the field work zones of interest. This task will also involve compilation of all existing Hot Springs Valley data (e.g., hydrogeology and hydrochemistry) and

engagement with Northern Territory Government staff to capture as much existing information as possible.

TASK OUTPUTS AND SPECIFIC DELIVERABLES

- Compiled dataset and hydrogeological architecture/fluid flow path conceptual model for the springs of the Hot Spring Valley.
- Field work plan for additional data collection.

PROGRESS REPORT

This milestone is complete, the compilation of the datasets has been completed and the field work plan for additional data collection has been made, with fieldwork scheduled to start on 10 August 2024 for 7-10 days.

TASK 3: Field geology mapping, sampling and rock analysis

BACKGROUND

Mapping the geology around the springs will allow the geological setting to be constrained through understanding the stratigraphy and structural history (faulting and fracturing) associated with the springs. Carbonate rock concessions associated with fossil seeps are records of paleoclimatic and paleotectonic events (Altunel and Hancock, 1993; Frery et al., 2017). These rocks, called travertines are calcium carbonate agglomerates known to be built under near ambient

conditions in continental areas (Capezzuoli et al.,2014). They can be studied to unravel the source of the paleo-leaky gas and fluids (stable isotopes) and well as the timing of circulation (absolute dating).

TASK OBJECTIVES

Document the geology of the Hot Springs Valley area, the current geological setting of the springs and the natural evolution of structural controls on circulation to provide a baseline understanding of the natural fluctuations with time and space.

TASK OUTPUTS AND SPECIFIC DELIVERABLES

- Interpreted geological map of the Hot Springs Valley area.
- Laboratory characterisation of rocks sampled in the mapped zones, the characterisation method will be defined based on the characteristics of the rock sample recovered in the field.

PROGRESS REPORT

The sampling work was completed during the field trip in August 2024. Laboratory analysis of 28 samples, including microscopic mineralogical analysis with a micro XRD, elemental mapping using a micro XRF, and isotope ratios with an MC ICP-MS, have now been completed. A draft report discussing the interpretation of the result of the laboratory analysis of the samples has been completed and is under review. It is envisaged that the work from this task will contribute to and be reported in Task 7.

TASK 4: GHG survey, analysis & interpretation

BACKGROUND

The results of a recently completed SREBA project indicated elevated and correlated methane and ethane concentration above the bubbles at the Hot Spring near Clints Gorge. While the presence and correlated nature of methane and ethane does not necessarily indicate that the source is thermogenic, as biogenic methane and ethane may also be possible, irrespective of its origin, the quantification of the natural emissions pre-development is essential benchmark. The work conducted for SREBA was limited due to the limited access and time hence there remains a gap in baseline emissions for the Hot Springs Valley. Specifically, only one hot spring was visited and sampling limited to the small area where bubbles were found. In addition, no emission rate measurement were collected.

TASK OBJECTIVES

The objectives of this task are

- Comprehensive characterisation of the atmospheric methane and ethane (where relevant & within detection limit) concentration surrounding up to 5 hot springs;
- Comprehensive characterisation of emission rates at bubble locations for up to 5 hot springs;

TASK OUTPUTS AND SPECIFIC DELIVERABLES

- Baseline atmospheric methane and ethane (where relevant & within detection limit) vector maps for each hot springs visited;
- Baseline emission rates vector maps for each hot springs visited.

PROGRESS REPORT

This task will be completed in August 2025.

TASK 5: Water Sampling, laboratory analysis and interpretation

BACKGROUND

Previous water and dissolved gas sampling programmes in the Beetaloo Sub-basin region focussed on the characterisation of groundwater within the Cambrian Limestone Aquifer (CLA) and the characterisation of the source of the Mataranka springs (e.g., Deslandes et al. 2019; Lamontagne et al. 2021). However, only a limited understanding of the source aquifer of geothermal springs in the Hot Spring Valley and their connections to, or isolation from, gas reservoirs exist at present (e.g., ELA, 2022; Frery et al., 2022). The groundwater sampling in this project focusses on closing these important knowledge gaps through the collection and analysis of spring samples for a wide range of hydrochemical, gaseous and isotopic parameters from Hot Springs valley. This will provide an important baseline data set to benchmark the present state to help track any changes should they occur. This will also help to better understand the origin of gas and hydrogeological

connectivity pathways. We will compare the existing and newly collected analytical results from Hot Springs Valley with those of Mataranka Springs and other spring systems in the Beetaloo Sub-basin as a useful reference point for the baseline of the different spring complexes in this region.

Upon completion of the field sampling campaign, spring water and gas samples will be analysed at well-established national and international laboratories. For example, stable noble gases will be analysed at the CSIRO Environmental Tracer laboratory in Adelaide, whereas samples for other hydrochemical and isotopic parameters will be analysed at commercial laboratories in Australia and overseas (e.g., Canada, United States of America and New Zealand).

TASK OBJECTIVES

The first objective of this task is the collection of samples from up to 5 groundwater springs in Hot Spring Valley. Samples will be collected for a wide set of parameters, including:

- Major, minor and rare earth element chemistry
- Isotopes (stable isotopes (H, O and C), $^{87}Sr/^{86}Sr$, Li-6/Li-7, boron isotopes)
- Hydrocarbon concentrations
- Headspace and dissolved gas analysis: this includes N_2, CO_2, O_2, Ar, H_2, He, CH_4, C_2H_6, C_3H_8, i-C_4H_{10}, n-C_4H_{10}, i-C_5H_{12}, n-C_5H_{12} and C^{6+} (all in headspace), and quantification of CH_4 (methane), C_2H_6 (Ethane) and C_3H_8 (propane) dissolved in water, as well as ^{2}H and $^{13}C/^{12}C$ analysis of methane, ethane and propane isotopes (if present), ^{13}C and ^{18}O of CO_2 and dissolved hydrogen sulphide (H_2S).
- Stable noble gases concentrations and isotope ratios (He, Ne, Ar, Kr, Xe)
- Age tracers (e.g., tritium, carbon-14 and ^{36}Cl)
- Radioactive noble gases (^{39}Ar, ^{81}Kr, ^{85}Kr)
- 16S rDNA microbial community profiling

The second objective of this task is to complete the analysis of spring water samples in Hot Springs Valley. Once the results have been supplied by laboratories, the new data will be integrated with results from previous investigations using multiple complementary graphical and statistical techniques to characterise the source of gas and the origin of water in the assessed spring complexes. The analysis of the different parameters will allow to refine the understanding of hydrogeological connectivity pathways.

TASK OUTPUTS AND SPECIFIC DELIVERABLES

- Samples are collected from up to 5 springs for a wide range of baseline hydrochemical, gas and isotope parameters from springs in Hot Springs Valley;
- Baseline hydrochemistry and environmental tracer data sets for the parameters listed above; and,
- Interpretation of hydrochemical and tracer data to characterise source aquifer of springs, differentiate between gas source and determine hydrogeological connectivity pathways.

- Interpretation of microbial community data to examine linkages between spring samples, microbial community descriptive statistics and descriptions of the dominant microbial processes that occur in the springs.

PROGRESS REPORT

This task will be completed in August 2025.

TASK 6: Terrestrial ecology survey, analysis & interpretation

BACKGROUND

The GBA BESA and SREBA studies conducted aquatic ecology surveys at Clint's Gorge in the Hot Springs Valley area. Terrestrial ecology has not been studied in as much detail. Documenting the terrestrial species that rely on the springs is an important component of the baseline assessment.

TASK OBJECTIVES

The objectives of this task are:

- Summary of existing ecological baseline data; and
- Conduct a terrestrial ecology survey to determine the water-dependent terrestrial species that occur in the region.

TASK OUTPUTS AND SPECIFIC DELIVERABLES

- Baseline of ecological data for the Hot Springs Valley area focussing on species that rely on the springs.

PROGRESS REPORT

This task will be completed in August 2025.

TASK 7: Data integration and conceptual model development

BACKGROUND

Conceptual models form the basis of groundwater management and numerical models developed for impact predictions in resource development projects. The development of reliable conceptual hydrogeological models of potential hydrogeological connectivity pathways relies on the integration of multiple lines of evidence. This includes for example integration of geological and geophysical methods that characterise the geometry of the subsurface with chemical, hydrochemical, microbiological and environmental tracer data that provide an understanding of the composition of atmospheric and dissolved gases and groundwater. Although previous water and gas sampling has been conducted on springs in the Beetaloo Sub-basin region, most of this work has focussed on the Mataranka Springs and only limited data are available for springs in Hot Springs Valley.

TASK OBJECTIVES

The data and knowledge from previous studies and Tasks 1 to 5 of this project will be integrated to develop and test conceptual models of hydrogeological connectivity pathways between deeper formations and the springs in the Beetaloo Sub-basin. The integration of data from multiple lines of evidence (atmospheric survey data, geophysics, geology (including surface mapping and rock characterisation), hydrochemistry and environmental tracers) will provide valuable insights into connectivity pathways and source aquifer (or aquifers) of groundwater and gas (methane and ethane) in Hot Springs Valley. Options for monitoring of the springs and their water sources will also be considered. Monitoring could include periodic observation, flow gauges or monitoring bores.

TASK OUTPUTS AND SPECIFIC DELIVERABLES

Conceptual hydrogeological models (e.g., via annotated cross-sections, maps and simple 3D block diagrams) of springs and connectivity pathways in Hot Springs Valley based on the integrated datasets from this study and previous studies. The project output will increase the confidence in the understanding of hydrogeological dynamics of the region and in particular the interaction between deep and shallow formations. As currently only limited deep borehole infrastructure is available to hydrochemically characterise different aquifers and gas reservoirs, this assessment may not be able to resolve all knowledge gaps; however, it will provide critical baseline data and through identification of on-going data and knowledge gaps will help to support groundwater management and monitoring, future groundwater infrastructure decisions, and greenhouse gas monitoring programs.

PROGRESS REPORT

This task will be completed in August 2025.

TASK 8: Project Reporting

BACKGROUND

Information from this project is to be made publicly available after completion of standard CSIRO publication and review processes.

TASK OBJECTIVES

To ensure that the information generated by this project is documented and published after thorough CSIRO internal review.

TASK OUTPUTS AND SPECIFIC DELIVERABLES

1. Preparation of a final report outlining the scope, methodology and findings;
2. Preparation of datasets for publication through CSIRO's data portal;
3. Following CSIRO ePublish review, the report will be submitted to the GISERA Director for final approval; and
4. Provide 6 monthly progress updates to GISERA office.

PROGRESS REPORT

This task will be completed in October 2025.

TASK 9: Communicate project objectives, progress and findings to stakeholders

BACKGROUND

Communication of GISERA research is an important component of all projects. The dissemination of project objectives, key findings and deliverables to relevant and diverse audiences allows discourse and decision making within and across multiple stakeholder groups.

Specific communication and engagement activities will be undertaken with local community stakeholders to address their communication needs and interests. These are likely to include visits to local communities and development of targeted communication materials.

TASK OBJECTIVES

Communicate project objectives, progress and findings to stakeholders through meetings, knowledge transfer session, fact sheets and journal articles, in collaboration with GISERA Communication officers.

TASK OUTPUTS AND SPECIFIC DELIVERABLES

Communicate project objectives, progress and results to GISERA stakeholders according to standard GISERA project procedures which may include, but not limited to:

1. Engagement with an established technical reference group.
2. Two project fact sheets: One developed at the commencement of the project, and another that will include peer-reviewed results and implications at completion of the project. Both will be hosted on the GISERA website.
3. Project reporting
4. Knowledge Transfer session with Government/Gas Industry
5. Presentation of findings to community stakeholders such as business and/or community groups in a community forum (virtual or face-to-face) to learn of research results.
6. Preparation of article for the GISERA newsletter and other media outlets as advised by GISERA's communication team
7. Peer reviewed scientific manuscript ready for submission to relevant journal

PROGRESS REPORT

This task will be completed in November 2025.

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
19/10/2024	Delays in obtaining necessary approvals, permits and certificates to access the Hot Springs Valley and conduct field campaign.	Milestone 3 extended from 31 May 2025 to 31 July 2025. Milestones 4-7 extended from 31 March 2025 to 30 August 2025. Milestone 8 extended from 31 May 2025 to 31 October 2025 Milestone 9 extended from 30 June 2025 to 30 November 2025.	
25/02/2025	Field trip contingent with researchers, NTG and TOs was significantly larger than anticipated during proposal development. Additional funds required for base camp, catering and mobilisation costs for the field campaign conducted in August 2024.	An additional $38,520 allocated to overall budget.	

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Contact us

1300 363 400
+61 3 9545 2176
csiro.au/contact
csiro.au

For further information

1300 363 400
gisera.csiro.au

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.