Project Order, Variations and Research Progress

Project Title: Ambient air quality, Surat Basin, Queensland

This document contains three sections. Click on the relevant section for more information.

1 Original Project Order

Project Order

Proforma 2016

1. Short Project Title (less than 15 words)

Ambient air quality, Surat Basin, Queensland

Long Project Title	Assessing ambient air quality in the Surat Basin, Queensland: observations and modeling
GISERA Project Number	G.3
Proposed Start Date	15 February 2016
Proposed End Date	15 April 2018
Project Leader	Sarah Lawson

2. GISERA Region

☒ Queensland ☐ New South Wales ☐ Northern Territory

3. GISERA Research Program

☐ Biodiversity Research ☐ Marine Research ☐ Agricultural Land Management Research

☐ Water Research ☒ GHG Research ☐ Social & Economic Research

4. Research Leader, Title and Organisation

(Include time commitment to project by the Research Leader)

Sarah Lawson Senior Research Scientist CSIRO Oceans and Atmosphere Aspendale, Victoria, 3195 Time commitment in 2015-18 will be 0.73 FTE

5. Project Description

The research proposed will provide the first comprehensive assessment of air quality in the Surat Basin Queensland using an air quality observation network and detailed air quality chemical transport modelling. This study will inform industry, community and government about the impact of CSG production on a variety of key air quality parameters in the Surat Basin.

The proposed research would incorporate and build on outputs from the existing Surat Basin Ambient Air Monitoring Program (SBAMP) which was commissioned by APLNG/Origin Energy in early 2015. CSIRO are directing the design, implementation and management of SBAMP and will undertake data interpretation and reporting.

The existing SBAMP includes the following activities:

- Monitoring of ambient air quality parameters at 3 sites within the Undulla Nose
- Monitoring of Volatile Organic Compounds (VOCs), aldehydes and H_2S via a passive sampler network of 10 sites in and around the Undulla Nose
- VOC method inter-comparison study (CSIRO)
- Detailed characterisation of potential emission sources (third party consultants)
- Production of quarterly reports compiling and summarising quality assured third party data (CSIRO)
- Air quality modelling (CSIRO) which will investigate a) the spatial distribution of air quality parameters (and validate siting of Undulla Nose ambient air sites) and b) determine impact of CSG production activities on air quality.

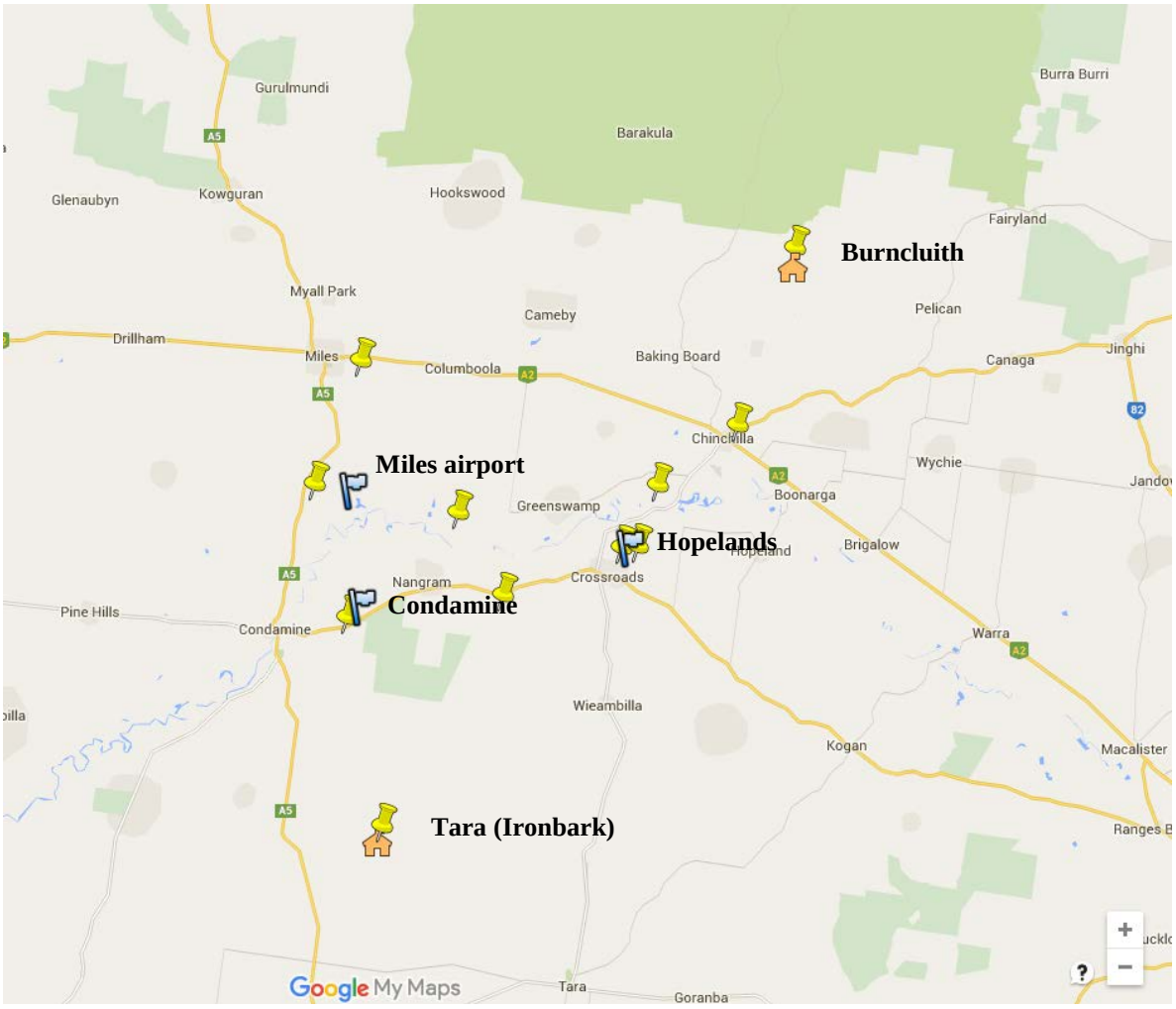
Data and outputs from the existing SBAMP would feed into and be available within GISERA. It is proposed the program be expanded within GISERA by undertaking the following additional activities:

- Addition of air quality instrumentation in CSIRO GISERA greenhouse gas ambient air sites at Origin's Ironbark property (Tara region) and at McConnachie farm (Burncluith) for 2 years (see Figure below). These stations have been deployed as part of GISERA Project number GAS1315 "Characterisation of Regional Fluxes of Methane in the Surat Basin, Queensland". Air quality measurements at these two greenhouse gas sites will greatly strengthen the SBAMP and will provide valuable data to the Methane Flux project.
- Interpretation and reporting of air quality data from the Tara and Burncluith sites
- Expansion of air quality modelling work to include detailed QGC emissions. The incorporation of robust emission estimates from QGC CSG production activities will provide more reliable model output and a realistic assessment of air quality impacts.

In October 2015, stakeholders from DSITIA, DEHP, Qld Health and DNRM recommended the program be further expanded within GISERA to incorporate two additional components.

Additional Component 1 would involve the live streaming of hourly data from the Surat Basin Ambient air monitoring sites to the DEHP ambient air website http://www.ehp.qld.gov.au/air/data/search.php. This would make air quality data accessible to community, industry and government in real time and would provide a large degree of transparency to concerned communities.

Additional Component 2 would comprise CSIRO undertaking a particulate matter (PM) validation study at one site to ensure the data produced from deployed PM instrumentation is equivalent to Australian Standard Methods. Having a high degree of confidence in the quality of ambient PM measurements will be very important if air quality objectives are approached or exceeded.



Location of existing SBAMP stations at Miles Airport, Hopelands and Condamine (blue flags) and proposed new air quality stations at Tara (Ironbark) and Burncluith (orange house). Passive VOC sites are shown by yellow pins.

6a. Budget Summary (for tasks 1, 2 and 3)

Expenditure	2015/16	2016/17	2017/18	2018/19	Total
Labour	79,177	64,878	32,524	-	176,579
Operating	8,000	8,000	8,000	-	24,000
Subcontractors	57,000	45,000	36,000	-	138,000
Total Expenditure	**144,177**	**117,878**	**76,524**	-	**338,579**

Expenditure per Task	2015/16	2016/17	2017/18	2018/19	Total
Task 1	78,312	44,000	44,000	-	166,312
Task 2	16,734	31,583	32,524	-	80,841
Task 3	49,131	42,295	-	-	91,426
Task 4	-	-	-	-	-
Task 5	-	-	-	-	-
Total Expenditure	**144,177**	**117,878**	**76,524**	-	**338,579**

Source of Cash Contributions	2015/16	2016/17	2017/18	2018/19	Total
GISERA (70%)	100,924	82,515	53,567	-	237,006
- APLNG (35%)	50,462	41,257.50	26,783.50	-	118,503
- QGC (35%)	50,462	41,257.50	26,783.50	-	118,503
Total Cash Contributions	**100,924**	**82,515**	**53,567**	-	**237,006**

In-Kind Contribution from Partners	2015/16	2016/17	2017/18	2018/19	Total
CSIRO (30%)	43,253	35,363	22,957	-	101,573
Total In-Kind Contribution from Partners	**43,253**	**35,363**	**22,957**	-	**101,573**

	Total funding over all years	Percentage of Total Budget
GISERA Investment	$237,006	70%
CSIRO Investment	$101,573	30%
Total Other Investment		
TOTAL	**$338,579**	

6b. Budget Summary – additional component 1 (for task 4)

Expenditure	2015/16	2016/17	2017/18	2018/19	Total
Labour	48,102	38,048	27,351	-	113,501
Operating	10,000	10,000	10,000	-	30,000
Subcontractors	-	-	-	-	-
Total Expenditure	**58,102**	**48,048**	**37,351**	-	**143,501**

Expenditure per Task	2015/16	2016/17	2017/18	2018/19	Total
Task 1	-	-	-	-	-
Task 2	-	-	-	-	-
Task 3	-	-	-	-	-
Task 4	58,102	48,048	37,351	-	143,501
Task 5	-	-	-	-	-
Total Expenditure	**58,102**	**48,048**	**37,351**	-	**143,501**

Source of Cash Contributions	2015/16	2016/17	2017/18	2018/19	Total
GISERA (70%)	40,672	33,634	26,146	-	100,452
- APLNG (35%)	20,336	16,817	13,073	-	50,226
- QGC (35%)	20,336	16,817	13,073	-	50,226
Total Cash Contributions	**40,672**	**33,634**	**26,146**	-	**100,452**

In-Kind Contribution from Partners	2015/16	2016/17	2017/18	2018/19	Total
CSIRO (30%)	17,430	14,414	11,205	-	43,049
Total In-Kind Contribution from Partners	**17,430**	**14,414**	**11,205**	-	**43,049**

	Total funding over all years	Percentage of Total Budget
GISERA Investment	100,452	70%
CSIRO Investment	43,049	30%
Total Other Investment		
TOTAL	**143,501**	

6c. Budget Summary – additional component 2 (for task 5)

Expenditure	2015/16	2016/17	2017/18	2018/19	Total
Labour	16,105	16,585	-	-	32,690
Operating	13,500	13,500		-	27,000
Subcontractors	-	-	-	-	
Total Expenditure	**29,605**	**30,085**	**-**	-	**59,690**

Expenditure per Task	2015/16	2016/17	2017/18	2018/19	Total
Task 1	-	-	-	-	-
Task 2	-	-	-	-	-
Task 3	-	-	-	-	-
Task 4	-	-	-	-	-
Task 5	29,605	30,085	-	-	59,690
Total Expenditure	**29,605**	**30,085**	**-**	-	**59,690**

Source of Cash Contributions	2015/16	2016/17	2017/18	2018/19	Total
GISERA (70%)	20,723.50	21,059.50	-	-	41,783
- APLNG (35%)	10,361.75	10,529.75	-	-	20,891.50
- QGC (35%)	10,361.75	10,529.75	-	-	20,891.50
Total Cash Contributions	**20,723.50**	**21,059.50**	**-**	-	**41,783**

In-Kind Contribution from Partners	2015/16	2016/17	2017/18	2018/19	Total
CSIRO (30%)	8,881.50	9,025.50	-	-	17,907
Total In-Kind Contribution from Partners	**8,881.50**	**9,025.50**	**-**	-	**17,907**

	Total funding over all years	Percentage of Total Budget
GISERA Investment	41,783	70%
CSIRO Investment	17,907	30%
Total Other Investment		
TOTAL	**59,690**	

Task	Milestone Number	Milestone Description	Funded by	Start Date	Delivery Date	Fiscal Year	Fiscal Quarter	Payment $
Task 1	1.1	Integrate air quality measurements at GHG sites	GISERA	02/2016	2/2018	2017/18	3	$116,418
Task 2	2.1	Data reporting and interpretation	GISERA	02/2016	4/2018	2017/18	4	$56,589
Task 3	3.1	Modelling study	GISERA	02/2016	12/2016	2016/17	2	$63,998
Task 4	4.1	Additional component 1 – streaming of live data	GISERA	02/2016	2/2018	2017/18	3	$100,451
Task 5	5.1	Additional component 2 – particulate validation study	GISERA	02/2016	02/2017	2016/17	3	$41,783

7. Other Researchers (include organisations)

Researcher	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Sarah Lawson	0.73	Air quality measurements and interpretation	14	CSIRO
Martin Cope	0.13	Air quality modelling	>20	CSIRO
Nada Derek	0.20	Data processing and reporting	>20	CSIRO
Jennifer Powell	0.24	Air quality measurements and reporting	>20	CSIRO
Paul Selleck	0.14	Air quality measurements	>20	CSIRO
James Harnwell	0.04	Field technician	>20	CSIRO

8. Subcontractors

Subcontractors (clause 9.5(a)(i))	**Subcontractor**	**Role**
	EcoTech Pty Ltd	• Instrumentation installation • Routine calibration and maintenance • Provision of data to CSIRO
	Katestone Environmental Consulting	Construction of detailed emissions inventory including QGC CSG emissions for modelling work

9. Project Objectives and Outputs

It is proposed that the SBAMP be expanded within GISERA to incorporate the following additional activities:

- Addition of air quality instrumentation in CSIRO GISERA greenhouse gas ambient air sites at Origin's Ironbark property (Tara region) and at McConnachie farm (Burncluith). These stations have been deployed as part of GISERA Project number GAS1315 "Characterisation of Regional Fluxes of Methane in the Surat Basin, Queensland" (Day et al. 2015) Air quality measurements at these two greenhouse gas sites will greatly strengthen the SBAMP by providing an upwind and downwind regional average of air quality parameters, in contrast to the three Undulla Nose sites which are situated in the area of highest CSG production. These additional measurements will also strengthen the Methane Flux project by providing additional combustion tracer measurements for identification of methane sources.
- Expansion of existing air quality modelling work to include detailed QGC emissions estimates in the model emissions inventory, and provision of QGC ambient air quality and source data (where available). The incorporation of robust emission estimates from

QGC CSG production activities and air quality data will provide more reliable model output and a realistic assessment of air quality impacts.

Two additional components recommended by Queensland Government Stakeholders are as follows:

- Additional Component 1. Hourly data from the SBAMP sites would be streamed live to the DEHP website. Data would be streamed and displayed in the same format as current stations in the Queensland ambient air quality network, and allocated an hourly air quality index value - see http://www.ehp.qld.gov.au/air/data/search.php. DEHP have indicated their willingness to host the data and DSITIA have indicated their support in facilitating the live streaming. Monthly validated data would also be made available via the DEHP website.
- Additional Component 2. CSIRO would undertake a particulate matter (PM) validation study at one site to ensure the PM data collected at the Undulla Nose sites is equivalent to data obtained by Australian Standard Methods.

The researchers will participate in GISERA community information sessions to explain results of this study.

10. GISERA Objectives Addressed

Carrying out of research and improving and extending knowledge of social and environmental impacts and opportunities of unconventional gas projects for the benefit of the Gas Industry, the relevant community and the broader public.

Informing government, regulators and policy-makers on key issues regarding policy and legislative framework for the Gas Industry.

11. Project Development (1 page max.)

In early 2015 APLNG commissioned a two year ambient air monitoring program to validate its Environmental Impact Statement (EIS). The ambient air monitoring program is focussed on the highly productive Undulla Nose region within the Surat Basin. This area incorporates the townships of Miles, Condamine, Chinchilla and Tara. This area has one of the highest CSG production rates within Queensland. Specific objectives of the Surat Basin Ambient Air Monitoring Program (SBAMP) are to:

- Update emission signatures of CSG production activities based on existing and new data
- Implement a risk based ambient air monitoring program. Collect high quality ambient air monitoring data and integrate with existing internal/ external ambient air programs
- Communicate interpreted and contextualised monitoring data to internal and external stakeholders

In April 2015 Origin Energy engaged CSIRO Oceans and Atmosphere (O&A) to provide direction on the design, implementation and ongoing management of SBAMP for two years.

CSIRO's involvement began with the review (Lawson et al. 2015a) of the Hopelands Pastoral Ambient Air Monitoring Program draft report (Katestone Environmental 2015). The Hopelands Pastoral Ambient Air Monitoring report is part of the first (design) phase of the Hopelands Pastoral Ambient Air Monitoring Program and provides a summary of relevant CSG activities and emission sources in the Orana gas field. CSIRO utilised the information summarised in the Hopelands report, along with background information provided by Origin Energy, to develop draft recommendations for the SBAMP.

CSIRO has provided recommendations on selection of ambient air monitoring sites and identification of measurement parameters, and has recommended additional activities that will strengthen and expand the existing program, including a method intercomparison study for passive volatile organic compound (VOC) measurements, and an air quality modelling study.

The SBAMP currently includes the following activities:

- Monitoring of ambient air quality parameters at 3 sites within the Undulla Nose (Hopelands, Miles Airport (Wilgas property) and Condamine (Pinehurst property) until February 2017, August 2017 and February 2018 respectively (measurements made by Ecotech Pty Ltd)
- Monitoring of VOCs, aldehydes and H_2S via a passive sampler network of 10 sites in and around the Undulla Nose via passive Radiello samplers until January 2016 (measurements made by SGS Leeder)
- A CSIRO-led intercomparison study between passive Radiello samplers (SGS Leeder) and an alternative VOC method based on EPA method TO17, using active sampling
- Detailed source characterisation including wellhead, inlet and sales gas, feed pond water, gas fired compressors and engines (measurements made by third party consultants)
- Production of quarterly reports (CSIRO) compiling and summarising quality assured third party data. Reports will include an objective and independent review of data, including assessment of concentrations against air quality objectives
- Air quality modelling (CSIRO) which will investigate a) the spatial distribution of air quality parameters (and validate siting of Undulla Nose ambient air sites) and b) determine the impact of CSG production activities of CSG production on air quality in this region. A detailed emissions inventory for the Surat Basin (required for the modelling) is being developed by Katestone Environmental (in conjunction with CSIRO). Origin Energy have provided detailed emissions estimates for the inventory including emissions associated from wells, gas plants, ponds and water gathering stations, gathering network, ancillary activities and drilling.

CSIRO presented the planned activities for SBAMP described above to key government stakeholders (DSITIA, Queensland Health, DEHP, DNRM) in October 2015. CSIRO also

presented the proposed expansion of the program within GISERA (described below in tasks 1,2 and 3) which was enthusiastically supported by stakeholders. Furthermore, two Additional Components were strongly recommended by stakeholders (described below in tasks 4 and 5).

12. Project Plan

The proposed work involves assessing the impact of CSG production on air quality in the Surat Basin, using an air quality measurement network and a detailed air quality modelling study. CSIRO has well-developed capability in design and implementation of air quality monitoring and modelling studies, both in urban and rural areas. This proposed work will strengthen collaboration with existing GISERA Project number GAS1315 "Characterisation of Regional Fluxes of Methane in the Surat Basin, Queensland", by promoting sharing of data and capability between projects.

12.1 Project Schedule

ID	Task Title	Task Leader	Scheduled Start	Scheduled Finish	Predecessor
Task 1	Integrate air quality at GHG sites	Sarah Lawson	02/2016	2/2018	
Task 2	Data reporting and interpretation	Sarah Lawson	02/2016	4/2018	
Task 3	Modelling study	Sarah Lawson	02/2016	12/2016	
Task 4	Additional component 1 – streaming of live data	Sarah Lawson	02/2016	2/2018	
Task 5	Additional component 2 – particulate validation study	Sarah Lawson	02/2016	2/2017	

Task	2016				2017				2018	
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
1										
2										
3										
4										
5										

Task 1

TASK NAME: Integrate air quality measurements at GHG sites

TASK LEADER: Sarah Lawson

OVERALL TIMEFRAME: Propose to finish Task 1 in 24 months

BACKGROUND: The two existing CSIRO GISERA sites (Ironbark and Burncluith) were deployed as part of the GISERA Project number GAS1315 "Characterisation of Regional Fluxes of Methane in the Surat Basin, Queensland" (Day et al. 2015). These sites were located 10-20 km away from the region of highest CSG production, with the aim of integrating emissions across the wider region. Meteorological modelling undertaken by Day et al. (2015) shows the predominant wind direction for Miles (selected to be representative of the wider basin) is east/north easterly (September-April), and south westerly (May-August). The two CSIRO GISERA sites have been situated so that one is usually 'upwind' of the region of concentrated infrastructure while the other is usually 'downwind'. The inclusion of these sites in SBAMP will greatly strengthen the program by providing an upwind and downwind regional average in contrast to the three Undulla Nose sites which are located in a region of highest CSG production. The site which is upwind will provide an understanding of typical background concentrations of air quality parameters in this area. This will be crucial to assess any enhancement above background due to CSG activities. The downwind site will allow assessment of whether there is any formation of secondary pollutants such as ozone downwind of the CSG field, which typically form some hours after emission of precursors. Inclusion of these two CSIRO/GISERA sites in SBAMP will provide a comprehensive assessment of air quality in the Surat Basin.

Data obtained from the air quality instrumentation will be provided to the Regional Methane Flux project. Methane, CO (Burncluith) and meteorological data from the two CSIRO/GISERA sites will be incorporated into SBAMP. Addition of air quality measurements at these sites will enhance collaboration and data sharing and will strengthen both projects.

TASK OBJECTIVE: To integrate air quality instrumentation at Ironbark and Burncluith sites

- Carbon monoxide (CO), ozone (O_3) and oxides of nitrogen (NO_x) instrumentation will be installed at the Tara region site (Ironbark) and ozone and oxides of nitrogen instrumentation will be installed at the Burncluith site.
- Installations will be carried out by Ecotech in conjunction with CSIRO. Instruments will be routinely calibrated and maintained by Ecotech who will provide data to CSIRO.

TASK OUTPUTS:

- Additional air quality parameters from Tara region (Ironbark) (ozone, NOx, CO) and Burncluith (ozone and NOx) will be incorporated into SBAMP reporting and data will be streamed live to DEHP website (if Additional Component 1 supported). Data obtained will be used to validate outputs from modelling study.
- Air quality measurements will be made available to GISERA Regional Methane flux project

SPECIFIC DELIVERABLES:

- Quality assured air quality data produced from Tara region (Ironbark) and Burncluith sites (Milestone 1.1)

- Reporting will include data from these additional sites, including an estimate of measurement uncertainty for all parameters measured (Milestone 2.1 and 4.1)

Task 2

TASK NAME: Data reporting and interpretation

TASK LEADER: Sarah Lawson

OVERALL TIMEFRAME: Propose to finish Task 2 in 26 months

BACKGROUND: Ambient air quality data from the three Undulla Nose sites and two CSIRO/GISERA Regional Methane Flux sites would be made by Ecotech Pty Ltd, according to National Association of Testing Authorities (NATA) accredited procedures. Ecotech will provide quality assured ambient air data from these sites to CSIRO. Methane, meteorological data from Ironbark and Burncluith, and CO data from Burncluith will be provided by CSIRO/GISERA.

SGS Leeder will undertake sampling and analysis of passive sampler measurements, and will provide quality assured data to CSIRO.

CSIRO will use this data to produce reports which summarises data from all 5 ambient air sites and 10 passive sampler sites, and assesses levels of air quality parameters observed against air quality objectives. Where levels exceed air quality objectives, an investigation into the source/s of the emissions will be undertaken, using knowledge of source emission ratios, meteorology and local activities.

TASK OBJECTIVE: To provide quarterly assessments of air quality data collected, including measurement uncertainty, and comparison of levels observed with air quality objectives, and investigation of sources where levels exceed air quality objectives. These reports will be written in a way that is easily accessible to members of the public and will be made available on the GISERA website.

TASK OUTPUTS: Quarterly data summary reports

SPECIFIC DELIVERABLES: Reports (Milestone 2.1)

Task 3

TASK NAME: Air quality modelling study

TASK LEADER: Sarah Lawson

OVERALL TIMEFRAME: Propose to finish Task 3 in 10 months

BACKGROUND: As part of the SBAMP, CSIRO will undertake an air quality modelling study using a CSIRO meteorological model and a chemical transport model. The study will examine the distribution of primary pollutants such as CO, NO_x and VOCs in the Surat Basin as well as secondary pollutants, such as ozone and secondary particulates. The study will examine the contribution from CSG and other sources to observed levels of pollutants in the Surat Basin. Air quality parameters will be modelled at hourly, 1 km resolution for one year.

The two aims of the modelling study are:

- to determine spatial variability of NOx, CO, O3 , VOCs and particulate matter (PM) in the Surat Basin to ensure the location of the three Origin Undulla Nose ambient air quality sites is representative of regional air quality.
- to assess the impact of CSG operations on ambient levels of NOx, CO, O3, VOCs and primary and secondary PM in the Surat Basin.

The modelling study will include the following tasks:

- Katestone Environmental are constructing a detailed emissions inventory for emissions of NOx, CO, VOCs, SOx, PM10, PM2.5 and ammonia in the Surat Basin, in consultation with CSIRO. The emission inventory includes emissions from CSG infrastructure, other industry, domestic and commercial activities, motor vehicles and intensive farming. Detailed emission estimates from APLNG are being incorporated. QGC emissions are currently being estimated using publically reported data.
- CSIRO will source a) the South East Queensland Region (SEQR) inventory b) fire emissions inventory (bushfires and large fuel reduction burns) and c) local biogenic emissions inventory
- CSIRO will run the CSIRO meteorological and chemical transport models for the 12 month period (2014 calendar year). The following scenarios will be simulated.
    - All sources including the Surat Basin CSG emissions;
    - All sources excluding the Surat Basin CSG emissions;

TASK OBJECTIVE: Obtain and incorporate detailed QGC emission estimates in to the model emissions inventory. Emissions sought from QGC would include:

- Shape file and emissions estimates of wells, incorporating emissions from pressure relief vents, pneumatic control valves, microturbines, surface casing vents, estimated general leaks
- Shape file and emission estimates from gas plants and emissions points (TEG storage and units, oil, coolant, pressure safety valves, flares, gas fired compressors (if applicable), gas fired power generators (where applicable), flares, nitrogen purging etc.)
- Shape file and emission estimates from ponds and water gathering stations; feed and transfer ponds, effluent ponds , transfer tanks, brine/ evaporation ponds, water treatment facilities (Cleaning and regeneration chemicals , power generators)
- Shape file and emission estimates for gathering network emission points; low point drains, high point vents
- Shape file and emission estimates for ancillary sources: camps, diesel generators for remote sites, toilets, office blocks, warehouses, laydown yards, diesel storages, general chemical storages.
- Activity log and inventory data for drilling and completion activities: general truck usage, fuel storages, diesel generator sizes, vehicles, drilling rig, bulk material stores, ponds, tanks for drilling fluid storage, flaring and venting.
- Shape file of field roads; approximate distance and projected usage

- Available gas composition data, compliance stack testing data and ambient air monitoring data

TASK OUTPUTS: Incorporation of QGC emission estimates into detailed model emissions inventory, model output incorporating QGC emissions

SPECIFIC DELIVERABLES: Report which will assess the overall impact of CSG production activities on ambient levels of primary and secondary air quality parameters in the Surat Basin. The report will also describe the modelling tasks, together with assumptions and uncertainties of the study.

(Milestone 3.1).

Additional components recommended by Qld Government Stakeholders:

Task 4

TASK NAME: Additional Component 1 –live data streaming

TASK LEADER: Sarah Lawson

OVERALL TIMEFRAME: Propose to finish Task 5 in 24 months

BACKGROUND:
CSIRO hosted a stakeholder meeting in October 2015 to present plans for the SBAMP to key stakeholders and to receive feedback about the study design. A strong recommendation from Queensland Government Stakeholders (DEHP, DSITIA, Queensland Health and DNRM) was that where possible, provisional hourly air quality data collected from the SBAMP sites be streamed live to the DEHP website. Data would be streamed and displayed in the same format as current Queensland Air quality stations, and allocated an air quality index value - see http://www.ehp.qld.gov.au/air/data/search.php. Data to be displayed would include NOx, CO, TSP, PM2.5, PM10 and O_3. The live data would be labelled as provisional, and CSIRO would provide quality assured data via the website at the end of each month. DEHP have indicated their willingness to host the data and DSITIA have indicated their support in coordinating the live streaming with CSIRO. Stakeholders unanimously supported the live streaming of data and identified the transparency of this approach as having significant benefits for communities, industry and government.

TASK OBJECTIVE: To coordinate and oversee live streaming of data from SBAMP sites for approximately one year.

TASK OUTPUTS: Data live streamed to DEHP website.

SPECIFIC DELIVERABLES: Availability of SBAMP data on DEHP website, including comparison of SBAMP data with other sites in Queensland.

Task 5

TASK NAME: Additional component 2 – particulate validation study

TASK LEADER: Sarah Lawson

OVERALL TIMEFRAME: Propose to finish Task 5 in 12 months

BACKGROUND: CSIRO recommended that particulate mass <2.5 µm (PM2.5) and particulate mass <10 µm (PM10) be measured initially at the three Undulla Nose sites with an option to later expand measurement to the two CSIRO sites. While the emissions of PM from CSG activities are not expected to cause exceedences of air quality objectives on their own, CSIRO recommended measurement of PM due to the cumulative contribution of several sources to PM in the Surat Basin, and due to the as-yet unassessed potential for secondary particulate formation from CSG activities (this will be assessed via the modelling study). Measurement of both PM10 and PM2.5 allows differentiation of different sources of particulates, for example road dust (predominantly PM10) and combustion, diesel emissions and secondary particles (predominantly PM2.5).

The PM instrumentation deployed at the SBAMP sites was selected because it provided a cost effective means of simultaneously measuring TSP, PM2.5 and PM10. The instrument uses an optical technique and is a European certified method for measurements of PM2.5 and PM10. However, because the accuracy of the optical technique is influenced somewhat by the chemical composition of particulates, stakeholders recommended that a particulate matter (PM) validation study be undertaken at one Surat Basin site to ensure the optical technique produces data equivalent to an Australian Standard Method. This validation study will provide a high degree of confidence in the quality of PM data collected using the optical technique.

TASK OBJECTIVE: measure PM2.5 and PM10 at one SBAMP site for 6 months according to AS/NZS 3580.9.11.2008 (PM10) and AS/NZS 3580.9.12:2013 (PM2.5)

TASK OUTPUTS: 6 months of PM2.5 and PM10 data collected.

SPECIFIC DELIVERABLES: Validated data will be made available on the DEHP website by CSIRO. The uncertainty in the measurement will be reported.

References used in task section

AS/NZS 3580.9.11.2008 (2008) Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM10 beta attenuation monitors, Standards Australia

AS/NZS 3580.9.12:2013 (2013) Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM2.5 beta attenuation monitors, Standards Australia

Day, S., Ong., C., Rodger, A., Etheridge, D., Hibberd, M., van Gorsel, E., Spencer, D., Krummel, P., Zegelin, S., Fry, R., Dell'Amico, M., Sestak, S., Williams, D., Loh, Z. and Barrett, D. (2015) Characterisation of Regional Fluxes of Methane in the Surat Basin, Queensland. Phase 2: A pilot study to detect and quantify methane sources. CSIRO, Australia. 80p.

Katestone Environmental (2015) Hopelands Pastoral Ambient Air Monitoring Program Draft Report 53p

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13. Communications Plan

General communication will be managed by GISERA.

14. Intellectual Property and Confidentiality

Background IP (clause 11.1, 11.2)	**Party**	**Description of Background IP**	**Restrictions on use (if any)**	**Value**
	Origin Energy	Data collected as part of Origin Energy Surat Basin Air Quality project will be utilised in this work	As Origin Energy (through APLNG) are a GISERA partner, there are no known restrictions on utilising this data	$
				$
Ownership of Non-Derivative IP (clause 12.3)	CSIRO			
Confidentiality of Project Results (clause 15.6)	Project results are not confidential.			
Additional Commercialisation requirements (clause 13.1)	Not applicable			
Distribution of Commercialisation Income (clause 13.4)	Not applicable			

Commercialisation Interest (clause 1.1)	**Party**	**Commercialisation Interest**
	APLNG	None
	QGC	None
	CSIRO	None

2 Variations to Project Order

Changes to research Project Orders are approved by the GISERA Director, acting with authority provided by the GISERA National Research Management Committee, in accordance with the National GISERA Alliance Agreement.

The table below details variations to research Project Order.

Register of changes to Research Project Order

Date	Issue	Action	Authorisation
25/11/16	There have been delays in obtaining data from the industry. The repairs on instrument required.	Milestone 3.1 will be pushed back to Nov-17 Milestone 5.1 will be pushed back to Aug-17	
21/6/17	A third instrument will need to be installed to complete the particulate validation study resulting in a 3 month delay.	Milestone 5.1 will be pushed back to Nov 17	
26/3/18	There have been delays in obtaining data from industry. There is a need to thoroughly investigate a comparison of instruments due to result discrepancies.	Milestone 2.1, Milestone 3.1 and Milestone 5.1 will be pushed back to Jun-18.	
25/6/18	More time is required to analyse and compare the model outputs with observations from the air quality stations.	Milestone 3.1 pushed back to Sept-18.	

3 Progress against project milestones

Progress against milestones are approved by the GISERA Director, acting with authority provided by the GISERA National Research Management Committee, in accordance with the National 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 approved for one amber light.
     - 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 and undertaken by GISERA Research Advisory Committee.

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

ID	Task Title	Task Leader	Scheduled Start	Scheduled Finish
1	Integrate air quality measurements at GHG sites	Sarah Lawson	Feb 16	Feb-18
2	Data reporting and interpretation	Sarah Lawson	Feb 16	Jun-18
3	Modelling study	Sarah Lawson	Feb 16	Sep-18
4	Additional component 1 – streaming of live data	Sarah Lawson	Feb 16	Feb-18
5	Additional component 2 – particulate validation study	Sarah Lawson	Feb 16	Jun-18

Project Schedule Report

Task 1

TASK NAME: Integrate air quality measurements at GHG sites

TASK LEADER: Sarah Lawson

OVERALL TIMEFRAME: Propose to finish Task 1 in 24 months

BACKGROUND: The two existing CSIRO GISERA sites (Ironbark and Burncluith) were deployed as part of the GISERA Project number GAS1315 "Characterisation of Regional Fluxes of Methane in the Surat Basin, Queensland" (Day et al. 2015). These sites were located 10-20 km away from the region of highest CSG production, with the aim of integrating emissions across the wider region. Meteorological modelling undertaken by Day et al. (2015) shows the predominant wind direction for Miles (selected to be representative of the wider basin) is east/north easterly (September-April), and south westerly (May-August). The two CSIRO GISERA sites have been situated so that one is usually 'upwind' of the region of concentrated infrastructure while the other is usually 'downwind'. The inclusion of these sites in SBAMP will greatly strengthen the program by providing an upwind and downwind regional average in contrast to the three Undulla Nose sites which are located in a region of highest CSG production. The site which is upwind will provide an understanding of typical background concentrations of air quality parameters in this area. This will be crucial to assess any enhancement above background due to CSG activities. The downwind site will allow assessment of whether there is any formation of secondary pollutants such as ozone downwind of the CSG field, which typically form some hours after emission of precursors. Inclusion of these two CSIRO/GISERA sites in SBAMP will provide a comprehensive assessment of air quality in the Surat Basin.

Data obtained from the air quality instrumentation will be provided to the Regional Methane Flux project. Methane, CO (Burncluith) and meteorological data from the two CSIRO/GISERA sites will be incorporated into SBAMP. Addition of air quality measurements at these sites will enhance collaboration and data sharing and will strengthen both projects.

TASK OBJECTIVE: To integrate air quality instrumentation at Ironbark and Burncluith sites

- Carbon monoxide (CO), ozone (O_3) and oxides of nitrogen (NO_x) instrumentation will be installed at the Tara region site (Ironbark) and ozone and oxides of nitrogen instrumentation will be installed at the Burncluith site.
- Installations will be carried out by Ecotech in conjunction with CSIRO. Instruments will be routinely calibrated and maintained by Ecotech who will provide data to CSIRO.

TASK OUTPUTS:

- Additional air quality parameters from Tara region (Ironbark) (ozone, NOx, CO) and Burncluith (ozone and NOx) will be incorporated into SBAMP reporting and data will be streamed live to DEHP website (if Additional Component 1 supported). Data obtained will be used to validate outputs from modelling study.
- Air quality measurements will be made available to GISERA Regional Methane flux project

SPECIFIC DELIVERABLES:

- Quality assured air quality data produced from Tara region (Ironbark) and Burncluith sites (Milestone 1.1)
- Reporting will include data from these additional sites, including an estimate of measurement uncertainty for all parameters measured (Milestone 2.1 and 4.1)

PROGRESS REPORT:

Task complete.

Quality assured data has been produced from Tara region (Ironbark) and Burncluith since June 2016. Preliminary hourly air quality data from these sites has been streamed to the Queensland Department of Environment and Heritage Protection website since August 2016. Validated data to the end of November 2017 has been provided to Queensland Department of Science, Information Technology and Innovation (DSITI) for uploading to the DEHP the website in January 2018. Air quality data from Tara region and Burncluith is currently being incorporated into data reporting for this project.

Note: power issues at the Tara Region site over the past 12 months have resulted in lower data capture than at other sites. This has not impacted the project's ability to meet scientific objectives, as air quality data from gas field sites will be compared with a second regional site (Burncluith), and will also be compared to Australian standards.

Task 2

TASK NAME: Data reporting and interpretation

TASK LEADER: Sarah Lawson

OVERALL TIMEFRAME: Propose to finish Task 2 in 26 months

BACKGROUND: Ambient air quality data from the three Undulla Nose sites and two CSIRO/GISERA Regional Methane Flux sites would be made by Ecotech Pty Ltd, according to National Association of Testing Authorities (NATA) accredited procedures. Ecotech will provide quality assured ambient air data from these sites to CSIRO. Methane, meteorological data from Ironbark and Burncluith, and CO data from Burncluith will be provided by CSIRO/GISERA.

SGS Leeder will undertake sampling and analysis of passive sampler measurements, and will provide quality assured data to CSIRO.

CSIRO will use this data to produce reports which summarises data from all 5 ambient air sites and 10 passive sampler sites, and assesses levels of air quality parameters observed against air quality objectives. Where levels exceed air quality objectives, an investigation into the source/s of the emissions will be undertaken, using knowledge of source emission ratios, meteorology and local activities.

TASK OBJECTIVE: To provide quarterly assessments of air quality data collected, including measurement uncertainty, and comparison of levels observed with air quality objectives, and investigation of sources where levels exceed air quality objectives. These reports will be written in a way that is easily accessible to members of the public and will be made available on the GISERA website.

TASK OUTPUTS: Quarterly data summary reports

SPECIFIC DELIVERABLES: Reports (Milestone 2.1)

PROGRESS REPORT:

Task complete. Two data summary reports have been completed, the first summarising data from 2014-2016 (Interim data summary published May 2018) and the second summarising data from 2017-2018 (Final data summary submitted July 2018). A third additional report has also been produced which provides an overall assessment of air quality in the study region, incorporating results from the two data summary reports (submitted July 2018).

Task 3

TASK NAME: Air quality modelling study

TASK LEADER: Sarah Lawson

OVERALL TIMEFRAME: Propose to finish Task 3 in 10 months

BACKGROUND: As part of the SBAMP, CSIRO will undertake an air quality modelling study using a CSIRO meteorological model and a chemical transport model. The study will examine the distribution of primary pollutants such as CO, NOx and VOCs in the Surat Basin as well as secondary pollutants, such as ozone and secondary particulates. The study will examine the contribution from CSG and other sources to observed levels of pollutants in the Surat Basin. Air quality parameters will be modelled at hourly, 1 km resolution for one year.

The two aims of the modelling study are:

- To determine spatial variability of NOx, CO, O3, VOCs and particulate matter (PM) in the Surat Basin to ensure the location of the three Origin Undulla Nose ambient air quality sites is representative of regional air quality.
- To assess the impact of CSG operations on ambient levels of NOx, CO, O3, VOCs and primary and secondary PM in the Surat Basin.

The modelling study will include the following tasks:

- Katestone Environmental are constructing a detailed emissions inventory for emissions of NOx, CO, VOCs, SOx, PM10, PM2.5 and ammonia in the Surat Basin, in consultation with CSIRO. The emission inventory includes emissions from CSG infrastructure, other industry, domestic and commercial activities, motor vehicles and intensive farming. Detailed emission estimates from APLNG are being incorporated. QGC emissions are currently being estimated using publically reported data.
- CSIRO will source a) the South East Queensland Region (SEQR) inventory b) fire emissions inventory (bushfires and large fuel reduction burns) and c) local biogenic emissions inventory
- CSIRO will run the CSIRO meteorological and chemical transport models for the 12 month period (2014 calendar year). The following scenarios will be simulated.
- All sources including the Surat Basin CSG emissions;
- All sources excluding the Surat Basin CSG emissions;

TASK OBJECTIVE: Obtain and incorporate detailed QGC emission estimates in to the model emissions inventory. Emissions sought from QGC would include:

- Shape file and emissions estimates of wells, incorporating emissions from pressure relief vents, pneumatic control valves, microturbines, surface casing vents, estimated general leaks
- Shape file and emission estimates from gas plants and emissions points (TEG storage and units, oil, coolant, pressure safety valves, flares, gas fired compressors (if applicable), gas fired power generators (where applicable), flares, nitrogen purging etc.)
- Shape file and emission estimates from ponds and water gathering stations; feed and transfer ponds, effluent ponds , transfer tanks, brine/ evaporation ponds, water treatment facilities (Cleaning and regeneration chemicals , power generators)
- Shape file and emission estimates for gathering network emission points; low point drains, high point vents
- Shape file and emission estimates for ancillary sources: camps, diesel generators for remote sites, toilets, office blocks, warehouses, laydown yards, diesel storages, general chemical storages.
- Activity log and inventory data for drilling and completion activities: general truck usage, fuel storages, diesel generator sizes, vehicles, drilling rig, bulk material stores, ponds, tanks for drilling fluid storage, flaring and venting.
- Shape file of field roads; approximate distance and projected usage
- Available gas composition data, compliance stack testing data and ambient air monitoring data

TASK OUTPUTS: Incorporation of QGC emission estimates into detailed model emissions inventory, model output incorporating QGC emissions

SPECIFIC DELIVERABLES: Report which will assess the overall impact of CSG production activities on ambient levels of primary and secondary air quality parameters in the Surat Basin. The report will also describe the modelling tasks, together with assumptions and uncertainties of the study.

PROGRESS REPORT:

The final model runs have been completed, the model output analysed and interpreted, and report written. The report estimates the overall impact of CSG operational activities on ambient levels of NO2, CO, PM2.5, O3, and VOCs on air quality levels in the Surat Basin in 2015-16. The report also describes the modelling tasks, the assumptions and uncertainties of the study and possible next steps.

Task 4

TASK NAME: Additional Component 1 –live data streaming

TASK LEADER: Sarah Lawson

OVERALL TIMEFRAME: Propose to finish Task 5 in 24 months

BACKGROUND: CSIRO hosted a stakeholder meeting in October 2015 to present plans for the SBAMP to key stakeholders and to receive feedback about the study design. A strong recommendation from Queensland Government Stakeholders (DEHP, DSITIA, Queensland Health and DNRM) was that where possible, provisional hourly air quality data collected from the SBAMP

sites be streamed live to the DEHP website. Data would be streamed and displayed in the same format as current Queensland Air quality stations, and allocated an air quality index value - see **http://www.ehp.qld.gov.au/air/data/search.php**. Data to be displayed would include NOx, CO, TSP, PM2.5, PM10 and O_3. The live data would be labelled as provisional, and CSIRO would provide quality assured data via the website at the end of each month. DEHP have indicated their willingness to host the data and DSITIA have indicated their support in coordinating the live streaming with CSIRO. Stakeholders unanimously supported the live streaming of data and identified the transparency of this approach as having significant benefits for communities, industry and government.

TASK OBJECTIVE: To coordinate and oversee live streaming of data from SBAMP sites for approximately one year.

TASK OUTPUTS: Data live streamed to DEHP website.

SPECIFIC DELIVERABLES: Availability of SBAMP data on DEHP website, including comparison of SBAMP data with other sites in Queensland.

PROGRESS REPORT:

Task complete.

Preliminary data has been live streamed since August 2016 (18 months)

Validated data (until Nov 2017) from all 5 sites has been provided to DSITI for uploading to DEHP website (data provided Jan 2018).

Task 5

TASK NAME: Additional component 2 – particulate validation study

TASK LEADER: Sarah Lawson

OVERALL TIMEFRAME: Propose to finish Task 5 in 12 months

BACKGROUND: CSIRO recommended that particulate mass <2.5 µm (PM2.5) and particulate mass <10 µm (PM10) be measured initially at the three Undulla Nose sites with an option to later expand measurement to the two CSIRO sites. While the emissions of PM from CSG activities are not expected to cause exceedances of air quality objectives on their own, CSIRO recommended measurement of PM due to the cumulative contribution of several sources to PM in the Surat Basin, and due to the as-yet unassessed potential for secondary particulate formation from CSG activities (this will be assessed via the modelling study). Measurement of both PM10 and PM2.5 allows differentiation of different sources of particulates, for example road dust (predominantly PM10) and combustion, diesel emissions and secondary particles (predominantly PM2.5).

The PM instrumentation deployed at the SBAMP sites was selected because it provided a cost effective means of simultaneously measuring TSP, PM2.5 and PM10. The instrument uses an optical technique and is a European certified method for measurements of PM2.5 and PM10. However, because the accuracy of the optical technique is influenced somewhat by the chemical composition of particulates, stakeholders recommended that a particulate matter (PM) validation study be undertaken at one Surat Basin site to ensure the optical technique produces data equivalent to an Australian Standard Method. This validation study will provide a high degree of confidence in the quality of PM data collected using the optical technique.

TASK OBJECTIVE: measure PM2.5 and PM10 at one SBAMP site for 6 months according to AS/NZS 3580.9.11.2008 (PM10) and AS/NZS 3580.9.12:2013 (PM2.5)

TASK OUTPUTS: 6 months of PM2.5 and PM10 data collected.

SPECIFIC DELIVERABLES: Validated data will be made available on the DEHP website by CSIRO. The uncertainty in the measurement will be reported.

PROGRESS REPORT:

6 months of PM2.5 and PM10 data has been collected at the Miles Airport site (Mar – Aug 2017) using AS/NZS methods.

Processing and comparison of data is complete. Estimate of uncertainty and implications for study are provided in the final data summary report submitted July 2018. Provision of validated data currently being provided to DEPH to be made available on website. The final report titled 'Overall assessment of air quality in Surat Basin region from 2014-2018' and 'Final data summary: January 2017-February 2018'is available on the GISERA website.