

Narrabri Gas Project – Produced Water Management Plan

Narrabri CCC

14 May 2014

Santos
We have the energy.



Produced Water Management Plan (PWMP)

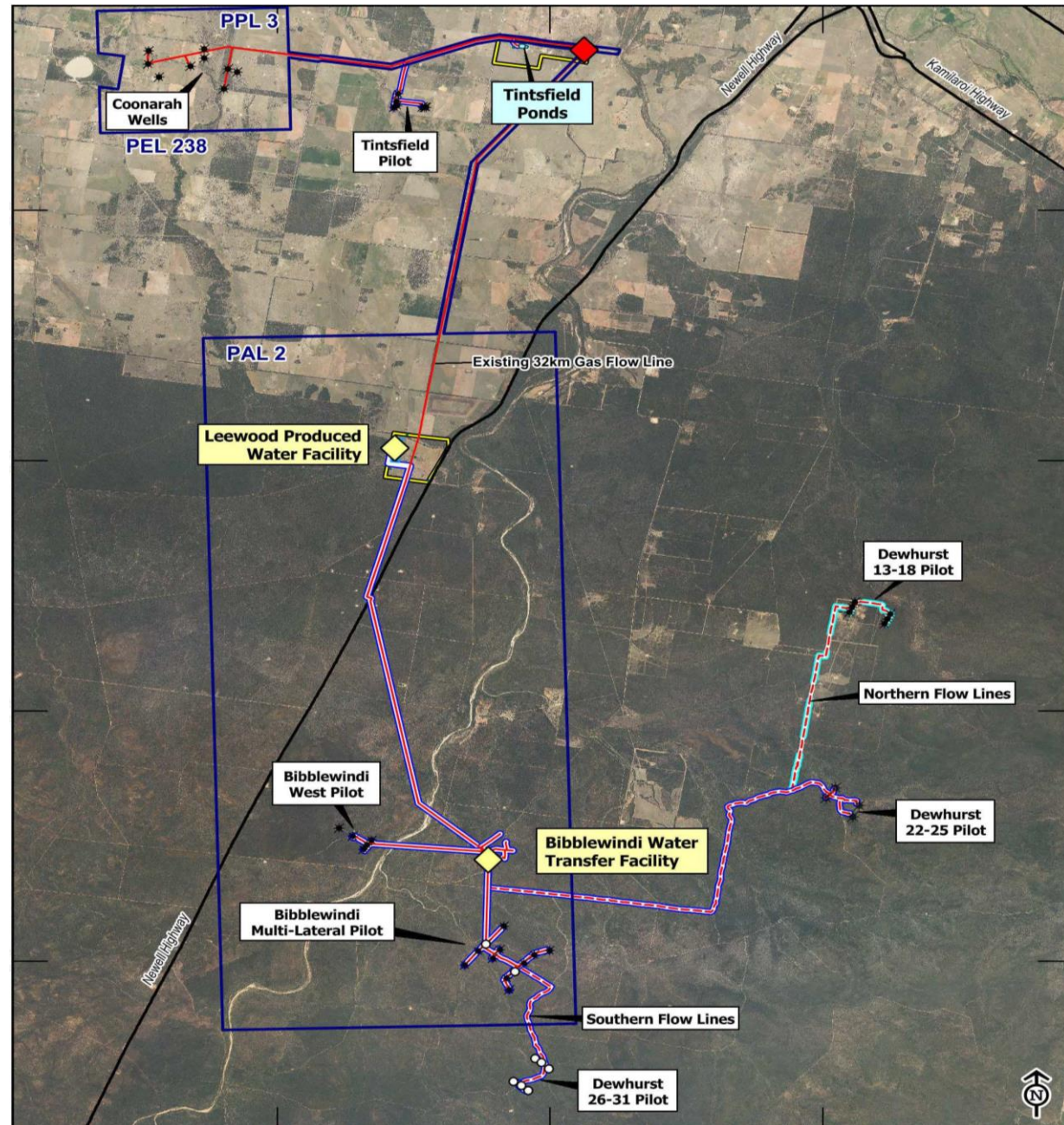
Ensuring management processes for produced water
are in place

PWMP requirement under condition 14 of PEL238

1. Expected sources and estimated quantities of produced water
2. Proposed containment measures
3. Proposed treatment measures
4. Proposed beneficial reuse
5. Controls to be implemented to prevent and/or minimise pollution
6. Record keeping for the quality, quantity, transport and disposal of produced water

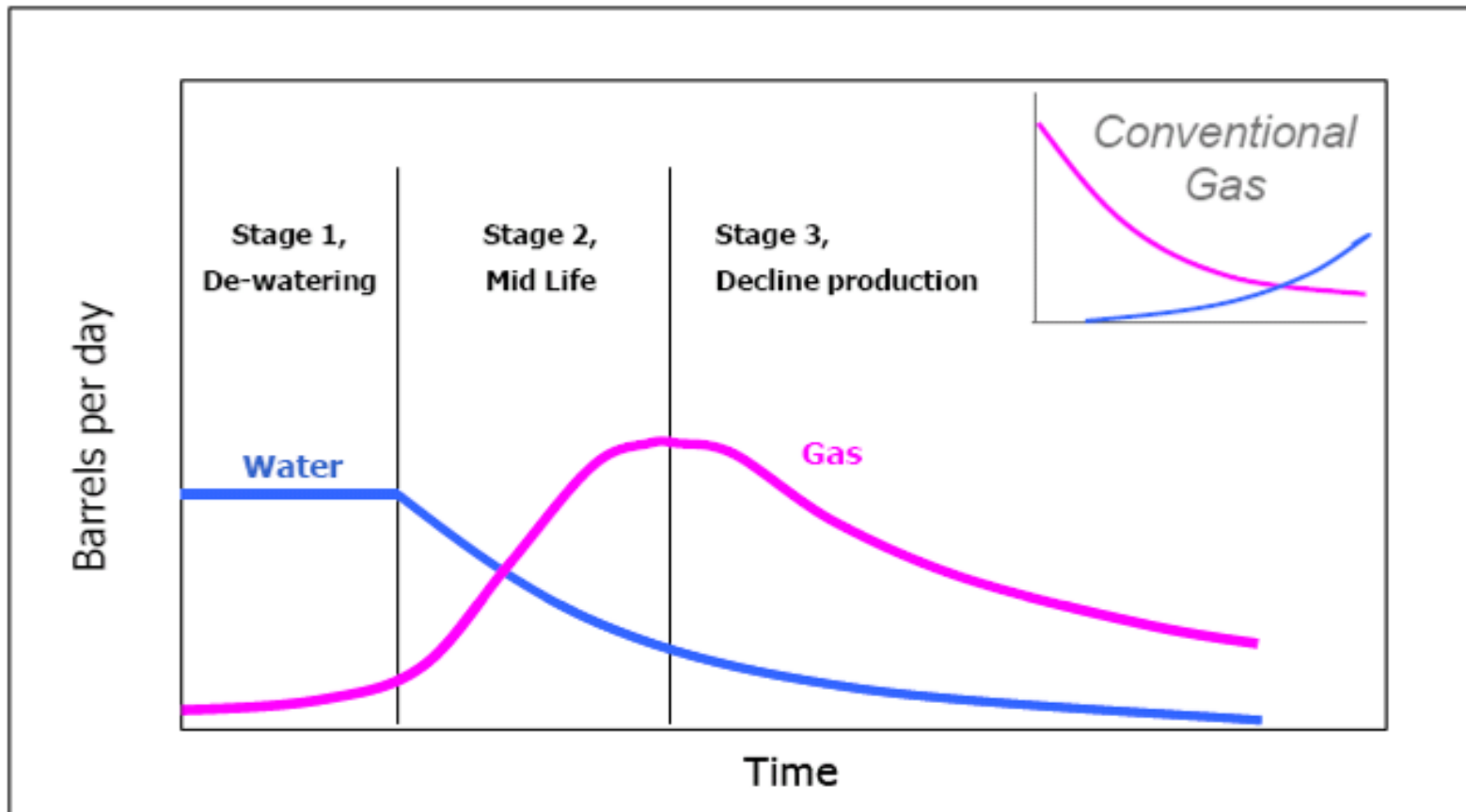
Appraisal water infrastructure

- This PWMP applies to the management of produced water produced during the exploration and appraisal activities.
- Santos will complete an evaluation of treatment and management options for produced water associated with the Narrabri Gas Project during EIS.
- PWMP will constantly evolve as new appraisal information and options review develop.



Produced water forecast

Stages of produced water and coal seam gas production



Exploration and appraisal program

Estimated produced water volume

Pilot	Total Extraction over operation of pilot – based on average extraction rates (ML)	Maximum Extraction (ML/day)	Average Extraction (ML/day)
Dewhurst 13-18	331.1	0.40	0.30
Dewhurst 22-25	285.1	0.27	0.26
Dewhurst 26-31	413.8	0.45	0.38
Bibblewindi Multi-lateral	285.1	0.58	0.26
Bibblewindi West	93	0.21	0.09
Tintsfield 2-7	25.2	0.04	0.02

Exploration and appraisal program

Managing water from previous operations

Storage name	Volume (ML) (3 February 2014)	Water quality field measurements (January 2014)		
		pH	Temperature (C)	Total Dissolved Solids (mg/L)
Bibblewindi Water Transfer Facility (Pond 3)	96	9.35	36.6	33,020
Tintsfield Ponds (Pond 2)	47	9.51	30.2	34,320

Produced Water

Average water quality concentrations across Narrabri Gas Development

Parameter	Units	Produced Water Average concentration
Total Dissolved Solids (TDS)	mg/L	12,000 – 16,000
Temperature	°C	15 - 30
pH		5.5 – 9.5
Total Suspended Solids (TSS)	mg/L	30
Turbidity	NTU	50
Carbonate (CO ₃)	mg/L as CaCO ₃	670
Bicarbonate (HCO ₃)	mg/L as CaCO ₃	10,100
Chloride (Cl)	mg/L	2,000
Sodium (Na)	mg/L	6,200
Sulphate (SO ₄)	mg/L	4
Calcium (Ca)	mg/L	7
Magnesium (Mg)	mg/L	4.0
Potassium (K)	mg/L	45
Strontium (Sr)	mg/L	1.3
Barium (Ba)	mg/L	13
Fluoride (F)	mg/L	5.8
Silica (SiO ₂)	mg/L	23
Boron (B)	mg/L	0.87
Iron (Fe, dissolved)	mg/L	0.28
Cyanide (Total)	mg/L	0.004

Parameter	Units	Produced Water Average concentration
Manganese (Total)	mg/L	0.009
Aluminium (Total)	mg/L	0.10
Phosphorus (Total)	mg/L	0.14
Ammonia	mg/L as N	13
Nitrate	mg/L as N	0.10
Nitrogen (Total)	mg/L	14
Copper (Total)	mg/L	0.022
Zinc (Total)	mg/L	0.023
Arsenic (Total)	mg/L	0.010
Chromium (Total)	mg/L	0.006
Hexavalent Chromium	mg/L	<0.05
Cadmium (Total)	mg/L	0.0053
Mercury (Total)	mg/L	0.00071
Molybdenum (Total)	mg/L	0.00064
Nickel (Total)	mg/L	0.0013
Antimony (Total)	mg/L	0.00012
Selenium (Total)	mg/L	0.0150
Uranium (Total)	mg/L	0.0001
Lead (Total)	mg/L	0.0037

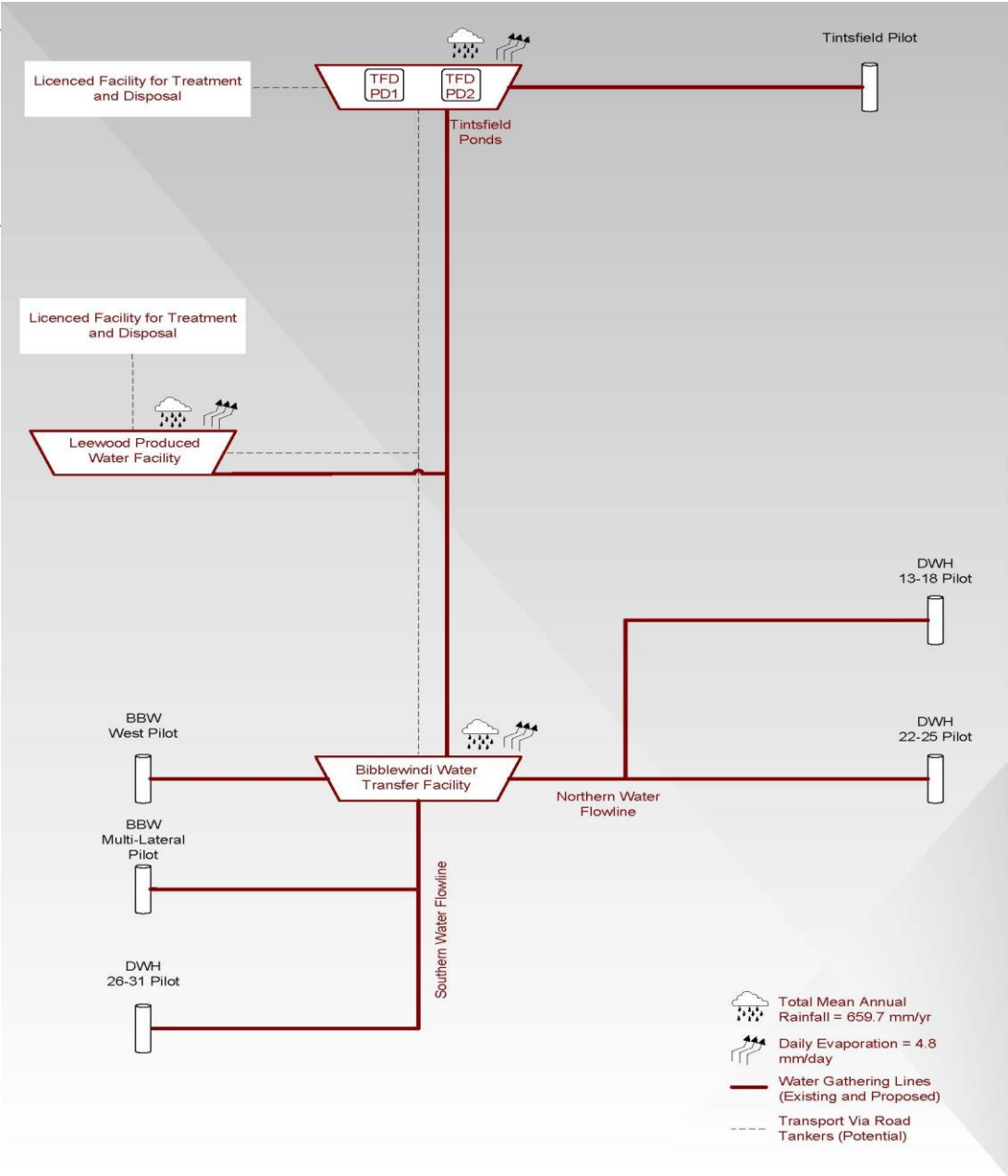
Diagrammatic overview of produced water infrastructure



Optimized by www.ImageOptimizer.net

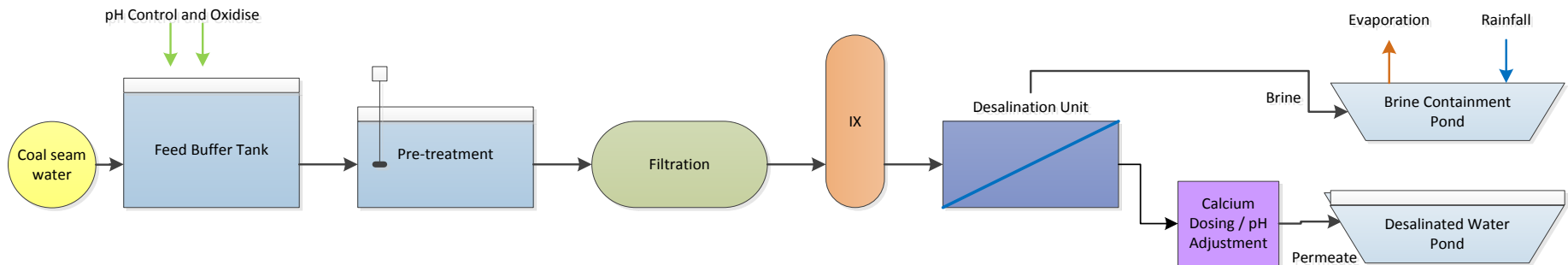


Optimized by www.ImageOptimizer.net



Proposed containment and treatment processes

Desalination and Amendment of water for beneficial uses



Reverse Osmosis (RO) desalination typically involves several steps that include:

- Pre-treatment by filtration, clarification, ion exchange and bio-fouling control;
- Desalination; and
- Post treatment as required by final water use (potentially including ammonia removal, dechlorination, calcium and magnesium addition to achieve required sodium adsorption ratio (SAR) and pH adjustment).



Proposed beneficial re-use of treated water

Providing a 'new source' of water for beneficial re-use

Following treatment, produced water may be directed to beneficial uses that could include:

- Dust suppression, use in construction and drilling and firefighting;
- Irrigation; and/or
- Discharge to surface water as environmental flows



Containment controls and record keeping

Ensuring good quality control and assurance processes

Key records associated with this PWMP that will be stored and managed will include:

- Inspection and monitoring records for facilities and dams;
- Operational monitoring and performance data for treatment systems;
- Water sampling and laboratory analytical reports;
- Calibration records for field instruments and continuous water quality monitoring systems;
- Waste Transportation and Disposal Certificates;
- Annual Inspection reports and/or certifications of storages.

End.