



Regulatory requirements for transportation, storage and use of chemicals in the CSG industry

Queensland

Risk	Legislation/instrument	Description	How risk is mitigated
Transport risks – e.g. traffic accident, leakage, operator exposure	Australian Dangerous Goods code	Relevant provisions enacted through state legislation (Transport Operations (Road Use Management) Act in QLD)	Sets out a range of requirements for workers and organisations including training, routes, goods too dangerous to be transported by road, packaging, incompatibility etc. Also places specific duties on consignors, packers, loaders and drivers to comply with the ADG Code http://www.ntc.gov.au/heavy-vehicles/safety/australian-dangerous-goods-code/
	Dangerous Goods Driver Licence	Operator training for avoiding issues and managing emergencies	Ensures drivers have the training to act appropriately http://www.qld.gov.au/transport/licensing/driver-licensing/applying/dangerous/driver/index.html
	Dangerous Goods Vehicle Licence	Vehicle operation and technical specification requirements	Ensures vehicles are of appropriate specification, condition and equipped http://www.qld.gov.au/transport/licensing/driver-licensing/applying/dangerous/vehicle/index.html
	Dangerous Goods Documents	Records and Emergency Procedure Guide	Enable compliance to be established regarding the transport of the chemicals, and assist in appropriate responses to emergency situations such as spills http://www.tmr.qld.gov.au/~media/busind/accreditations/Dangerous%20goods/dangerousgoodsgeneralinfofactsheet.pdf
	Work Health and Safety Act 2011	Duty to do everything reasonably practical to keep workers and public safe, including adequately addressing chemical exposure risks	Incumbent upon chemical transport companies to have systems in place to ensure their staff are protected from risks such as crashes and spills. These are in combination with the specific requirements and duties set out in the Dangerous Goods Code. https://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WorkHSA11.pdf https://www.worksafe.qld.gov.au/injury-prevention-safety/managing-risks
	General Environmental Duty	The Environmental Protection Act require doing everything reasonable and practical to avoid harming the environment.	Incumbent upon chemical transporters to ensure that risks of spilling chemicals (both during transit and transfer operations) are mitigated. These could include only transferring chemicals in contained hardstand areas, having spill response procedures etc.) https://www.ehp.qld.gov.au/management/planning-guidelines/legislation/general_environmental_duty.html
	Waste tracking requirements for waste transport (EP Act)		Applies to frack flowback transport – requiring detailed records to demonstrate compliance with the relevant waste management requirements for the particular waste http://www.ehp.qld.gov.au/waste/pdf/managing-wt-qld-overview.pdf



<p>Off-tenure product handling risks – e.g. worker contact during bulk mixing and preparation of chemicals; spillage of chemicals; chemical fire</p>	<p><i>Environmental Protection Act 1994;</i> <i>Environmental Protection Regulation 2008</i> – ERA 8</p>	<p>Storing 200t or more of chemicals triggers Environmentally Relevant Activity 8 - “Chemical Storage”. To legally undertake this activity an environmental authority (EA) is required. This EA contains conditions specific to the operation that require mitigation of environmental risks. Conditions will likely include bunding and storage requirements (in line with relevant Aust. Standards), emergency response procedures, training, monitoring and reporting requirements.</p>	<p>Will ensure that environmental risk of the chemical storage and handling activities is adequately controlled. It would be unlikely such a facility would be approved in close proximity to aquatic ecosystems or other environmentally sensitive areas. https://www.ehp.qld.gov.au/licences-permits/business-industry/index.html https://www.legislation.qld.gov.au/LEGISLTN/CURRENT/E/EnvProtR08.pdf</p>
	<p>Work Health and Safety Act 2011</p>	<p>Duty to do everything reasonably practical to keep workers and the general public safe, including adequately addressing risk of chemical exposure and spills</p>	<p>Incumbent upon chemical storage companies to have systems in place to ensure their staff and the public are protected from risks such as spills and exposure to chemicals. There is also a duty for all staff to follow safety systems and protect themselves and others. These are in combination with the specific requirements of the relevant EA. https://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WorkHSA11.pdf https://www.worksafe.qld.gov.au/injury-prevention-safety/managing-risks</p>
	<p>Sustainable Planning Act 2009</p>	<p>Such a facility require a development approval assessed against the local planning scheme and relevant state planning instruments. These would include public safety, bushfire risk, proximity of sensitive receptors, proximity of wetlands and many other considerations.</p>	<p>If the facility was to be approved in the proposed location it would have a range of conditions about how the site was to be developed and operated in order to ensure safety and consistency with adjacent land uses. http://www.dsdp.qld.gov.au/resources/publication/guide-to-spa.pdf</p>



<p>On-tenure chemical handling (pre-fracture) E.g. worker exposure to chemicals; chemical release to the environment while mixing or preparing</p>	<p>Environmental Protection Act – Resource Activities</p>	<p>Any activity performed under the <i>Petroleum and Gas (Production and Safety) Act 2004</i> is classed as an Environmentally Relevant Activity. An environmental authority (EA) is required to legally undertake such an activity. This EA has conditions specific to the operation that require mitigation of environmental risks. Special conditions apply to fracking. A range of more general conditions also apply to the chemical handling associated with fracking.</p>	<ul style="list-style-type: none"> - A blanket prohibition of releasing chemicals to land - a requirement that chemicals must be contained and comply with relevant Aust. Standards - notification of chemical spills - prohibition of activities within 200m of HES wetlands - prohibition on releasing contaminants to waterways - development of contingency procedures for emergencies including risk mitigation measures, remediation measures and investigative procedures - a site specific risk assessment of hydraulic fracturing activities to avoid environmental harm and including a list of chemicals to be used and an environmental hazard assessment for these chemicals and human health exposure pathways to operators and the general population - no use of BTEX or PAH compounds -no oil or synthetic based drilling muds - Monitoring standards and requirements - Laboratory analysis standards <p>http://www.ehp.qld.gov.au/management/non-mining/documents/guide-model-conditions-petroleum.pdf https://www.ehp.qld.gov.au/management/non-mining/documents/application-requirements-petroleum-guideline.pdf</p>
	<p><i>Petroleum and Gas (Production and Safety) Act 2004</i> – Chapter 9 – Safety management plan</p>	<p>A safety management plan is required for “operating plant”. This would be interpreted to include fracturing operations, and associated chemical handling. Section 675 of the Act stipulates a detailed list of requirements for SMPs.</p>	<p>Sets out personal responsibility for safety matters and requires a risk based approach to controls, training, skills and standards. A failure to address safety and health risks associated with chemical handling would be subject to high penalties. Competency requirements for well service workers are also set out through relevant standards under the P&G Act.</p> <p>http://mines.industry.qld.gov.au/safety-and-health/safeop.htm https://www.dnrm.qld.gov.au/_data/assets/pdf_file/0015/2407/02/competency-std-p-g-well-drilling.pdf</p>
<p>Loss of sub-surface containment of fracture fluids risks; e.g. contamination of aquifers; contamination of groundwater resources</p>	<p>Well construction and abandonment code</p>	<p>Sets out the minimum requirements for well design, casing, cementing, control equipment, logging, fluids and monitoring.</p>	<p>Ensures that the well will maintain its integrity and not release chemicals into formations other than the target formation. Deals with risks such as casing failure, cementing isolation etc. to ensure that chemicals do not leak out of the well or migrate between formations.</p> <p>https://www.dnrm.qld.gov.au/_data/assets/pdf_file/0011/119666/code-of-practice-csg-wells-and-bores.pdf</p>
	<p><i>Petroleum and Gas (Production and Safety) Regulation 2004</i> R20, r20A</p>	<p>Require a notice of intent to fracture and a notice of completion of fracturing, as well as drilling reports with technical detail around fracturing operations.</p>	<p>Gives government and landholders an opportunity to comment if any issues are raised with the notice of intent. Also provides specifics to allow rapid responses and ensure compliance.</p> <p>https://www.legislation.qld.gov.au/LEGISLTN/CURRENT/P/PetroleumR04.pdf</p>



	<p><i>Petroleum and Gas (Production and Safety) Act 2004 – Chapter 9 – Safety management plan</i></p>	<p>A safety management plan is required for “operating plant” which would be interpreted to include fracturing operations. Section 675 of the Act stipulates a detailed list of requirements for SMPs.</p>	<p>Sets out personal responsibility for safety matters such as well failure and requires a risk based approach to controls, training, skills and standards. A failure to address safety and health risks associated with chemical handling would be subject to high penalties. http://mines.industry.qld.gov.au/safety-and-health/safeop.htm</p>
	<p><i>Environmental Protection Act 1994– Chapter 5, ERA for Resource Activities</i></p>	<p>The undertaking of activities under the <i>Petroleum and Gas (Production and Safety) Act 2004</i> is classed as an Environmentally Relevant Activity. In order to legally undertake this activity an environmental authority (EA) is required. This EA contains conditions which are specific to the operation and require environmental risks to be mitigated. Due to the higher risks of fracking it is specifically conditioned. A range of more general conditions also apply to fracking.</p>	<ul style="list-style-type: none"> - a detailed site specific risk assessment of hydraulic fracturing including environmental and geotechnical factors and cumulative impacts to avoid environmental harm *detailed requirements below - notification of incidents including impacting the water quality of aquifers and causing the interconnection of aquifers - practices and procedures to detect the interconnection of aquifers as soon as practical - demonstration that 150% of the volume of fluid injected into the well has flowed back - extensive pre- and post-fracturing groundwater quality monitoring (including nearby landholder bores)** - flowback water monitoring** - post-event monitoring must continue for at least 5 years - prohibition on releasing contaminants to waters - development of contingency procedures for emergencies including risk mitigation measures, remediation measures and investigative procedures - no use of BTEX or PAH compounds -no oil or synthetic based drilling muds - Monitoring standards and requirements - Laboratory analysis standards <p>http://www.ehp.qld.gov.au/management/non-mining/documents/guide-model-conditions-petroleum.pdf</p>
<p>Handling of chemicals post-fracture (on tenure) risks – e.g. soil contamination; seepage into shallow groundwater; worker exposure; exposure in final waste management solution</p>	<p><i>Environmental Protection Act 1994– Chapter 5, ERA for Resource Activities</i></p>	<p>Any activity performed under the <i>Petroleum and Gas (Production and Safety) Act 2004</i> is classed as an Environmentally Relevant Activity. In order to legally undertake this activity an environmental authority (EA) is required. This EA contains conditions which are specific to</p>	<ul style="list-style-type: none"> - a detailed site specific risk assessment of hydraulic fracturing including potential environmental and human health risks for water quality and air impacts - notification of incidents - prohibition on releasing contaminants to waters - prohibition on releasing contaminants to land - all waste fluids must be stored in an above ground container (e.g. tank) or in a dam or pond which contains the wetting front - strict standards for the design, construction and operation of dams, including items such as double lining, leak detection and appropriate design storage allowances <p>http://www.ehp.qld.gov.au/land/mining/pdf/guide-structures-dams-levees-mining-em634.pdf</p>



		<p>the operation and require environmental risks to be mitigated. Due to the higher risks of fracking it is specifically conditioned. A range of more general conditions also apply to fracking.</p>	<ul style="list-style-type: none"> - requirements for annual monitoring of dams and certification and re-certification of medium and high risk dams by suitably qualified registered engineers https://www.ehp.qld.gov.au/land/mining/pdf/mn-mi-assess-haz-cat-hyd-perf-dams-em635.pdf - a seepage monitoring program must be developed by a suitably qualified person in order to detect contaminants escaping from ponds or dams*** - development of contingency procedures for emergencies including risk mitigation measures, remediation measures and investigative procedures - requirement to site major ponds outside of environmentally sensitive areas and associated buffers - no use of BTEX or PAH compounds -no oil or synthetic based drilling muds - any contaminated land is remediated and rehabilitated - Monitoring standards and requirements - Laboratory analysis standards http://www.ehp.qld.gov.au/management/non-mining/documents/guide-model-conditions-petroleum.pdf
<p><i>Environmental Protection Act 1994</i>– Chapter 5, ERA for Resource Activities</p>	<p>EA application requirements for CSG require detailed site specific information regarding how CSG water and associated wastes will be managed</p>	<p>This site specific information will need to identify the amount and quality of water that is expected to be produced from both fractured and non-fractured wells. It must then propose:</p> <ul style="list-style-type: none"> - how the water will be managed - criteria to measure the effectiveness of the management solution - how waste from water management (including flowback water) will be managed <p>This information will then be used to place appropriate requirements on the environmental authority based on how operations will be undertaken</p>	<p>https://www.ehp.qld.gov.au/management/non-mining/documents/application-requirements-petroleum-guideline.pdf http://www.ehp.qld.gov.au/management/non-mining/documents/csg-water-measurable-criteria.pdf</p>
<p><i>Petroleum and Gas (Production and Safety) Act 2004</i> – Chapter 9 – Safety management plan</p>	<p>A safety management plan is required for “operating plant” which would be interpreted to include fracturing operations, and associated post-fracture waste management. Section 675 of the Act stipulates a detailed list of requirements for SMPs****.</p>	<p>Sets out personal responsibility for safety matters and requires a risk based approach to controls, training, skills and standards. A failure to address safety and health risks associated with chemical handling would be subject to high penalties.</p>	<p>http://mines.industry.qld.gov.au/safety-and-health/safeop.htm Competency requirements for well workers are also set out through relevant standards under the P&G Act. https://www.dnrm.qld.gov.au/_data/assets/pdf_file/0/015/240702/competency-std-p-g-well-drilling.pdf</p>

***Detailed stimulation risk assessment requirements**

The stimulation risk assessment must be carried out for every well to be stimulated prior to stimulation being carried out at that well and address issues at a relevant geospatial scale such that changes to features and attributes are adequately described and must include, but not necessarily be limited to:

- (a) a process description of the stimulation activity to be applied, including equipment and a comparison to best international practice
- (b) provide details of where, when and how often stimulation is to be undertaken on the tenures covered by this environmental authority
- (c) a geological model of the field to be stimulated including geological names, descriptions and depths of the target gas producing formation(s)
- (d) naturally occurring geological faults
- (e) seismic history of the region (e.g. earth tremors, earthquakes)
- (f) proximity of overlying and underlying aquifers
- (g) description of the depths that aquifers with environmental values occur, both above and below the target gas producing formation
- (h) identification and proximity of landholders' active groundwater bores in the area where stimulation activities are to be carried out
- (i) the environmental values of groundwater in the area
- (j) an assessment of the appropriate limits of reporting for all water quality indicators relevant to stimulation monitoring in order to accurately assess the risks to environmental values of groundwater
- (k) description of overlying and underlying formations in respect of porosity, permeability, hydraulic conductivity, faulting and fracture propensity
- (l) consideration of barriers or known direct connections between the target gas producing formation and the overlying and underlying aquifers
- (m) a description of the well mechanical integrity testing program
- (n) process control and assessment techniques to be applied for determining extent of stimulation activities (e.g. microseismic measurements, modelling etc.)
- (o) practices and procedures to ensure that the stimulation activities are designed to be contained within the target gas producing formation
- (p) groundwater transmissivity, flow rate, hydraulic conductivity and direction(s) of flow
- (q) a description of the chemical compounds used in stimulation activities (including estimated total mass, estimated composition, chemical abstract service numbers and properties), their mixtures and the resultant compounds that are formed after stimulation
- (r) a mass balance estimating the concentrations and absolute masses of chemical compounds that will be reacted, returned to the surface or left in the target gas producing formation subsequent to stimulation
- (s) an environmental hazard assessment of the chemicals used including their mixtures and the resultant chemicals that are formed after stimulation including:
 - toxicological and ecotoxicological information of chemical compounds used
 - information on the persistence and bioaccumulation potential of the chemical compounds used; and
 - identification of the chemicals of potential concern in stimulation fluids derived from the risk assessment
- (t) an environmental hazard assessment of use, formation of, and detection of polycyclic aromatic hydrocarbons in stimulation activities
- (u) identification and an environmental hazard assessment of using radioactive tracer beads in stimulation activities
- (v) an environmental hazard assessment of leaving chemical compounds in stimulation fluids in the target gas producing formation for extended periods subsequent to stimulation
- (w) human health exposure pathways to operators and the regional population
- (x) risk characterisation of environmental impacts based on the environmental hazard assessment



- (y) potential impacts to landholder bores as a result of stimulation activities
- (z) an assessment of cumulative underground impacts, spatially and temporally of the stimulation activities to be carried out on the tenures covered by this environmental authority; and
- (aa) potential environmental or health impacts which may result from stimulation activities including but not limited to water quality, air quality (including suppression of dust and other airborne contaminants), noise and vibration

**** Fracturing water quality and well monitoring analyte requirements:**

- (a) pH
- (b) electrical conductivity
- (c) turbidity [NTU]
- (d) total dissolved solids [mg/L]
- (e) temperature [°C]
- (f) dissolved oxygen [mg/L]
- (g) dissolved gases (methane, chlorine, carbon dioxide, hydrogen sulfide) [mg/L]
- (h) alkalinity (bicarbonate, carbonate, hydroxide and total as CaCO₃) [mg/L]
- (i) sodium adsorption ratio (SAR)
- (j) anions (bicarbonate, carbonate, hydroxide, chloride, sulphate) [mg/L]
- (k) cations (aluminium, calcium, magnesium, potassium, sodium) [mg/L]
- (l) dissolved and total metals and metalloids (including but not necessarily being limited to: aluminium, arsenic, barium, borate (boron), cadmium, total chromium, copper, iron, fluoride, lead, manganese, mercury, nickel, selenium, silver, strontium, tin and zinc)
- (m) total petroleum hydrocarbons
- (n) BTEX (as benzene, toluene, ethylbenzene, ortho-xylene, para- and meta-xylene, and total xylene)
- (o) polycyclic aromatic hydrocarbons (including but not necessarily being limited to: naphthalene, phenanthrene, benzo[a]pyrene)
- (p) sodium hypochlorite [mg/L]
- (q) sodium hydroxide [mg/L]
- (r) formaldehyde [mg/L]
- (s) ethanol [mg/L]; and
- (t) gross alpha + gross beta or radionuclides by gamma spectroscopy [Bq/L]

*****Seepage monitoring program requirements**

- (a) identification of the containment facilities for which seepage will be monitored
- (b) identification of trigger parameters that are associated with the potential or actual contaminants held in the containment facilities
- (c) identification of trigger concentration levels that are suitable for early detection of contaminant releases at the containment facilities
- (d) installation of background seepage monitoring bores where groundwater quality will not have been affected by the petroleum activities authorised under this environmental authority to use as reference sites for determining impacts
- (e) installation of seepage monitoring bores that:
 - are within formations potentially affected by the containment facilities authorised under this environmental authority (i.e. within the potential area of impact)
 - provide for the early detection of negative impacts prior to reaching groundwater dependent ecosystems, landholder's active groundwater bores, or water supply bores
 - provide for the early detection of negative impacts prior to reaching migration pathways to other formations (i.e. faults, areas of unconformities known to connect two or more formations)
- (f) monitoring of groundwater at each background and seepage monitoring bore at least quarterly for the trigger parameters identified in condition (Water 14(b))



- (g) seepage trigger action response procedures for when trigger parameters and trigger levels identified in conditions (Water 14(b)) and (Water 14(c)) trigger the early detection of seepage, or upon becoming aware of any monitoring results that indicate potential groundwater contamination
- (h) a rationale detailing the program conceptualisation including assumptions, determinations, monitoring equipment, sampling methods and data analysis; and
- (i) provides for annual updates to the program for new containment facilities constructed in each annual return period.

******Safety management plan requirements**

A safety management plan for an operating plant must include details of each of the following to the extent they are appropriate for the plant—

- (a) a description of the plant, its location and operations;
- (b) organisational safety policies;
- (c) organisational structure and safety responsibilities;
- (ca) for an operating plant, other than a coal mining–CSG operating plant—the operator of the plant;
- (d) each site at the plant for which a site safety manager is required;
- (e) a formal safety assessment consisting of the systematic assessment of risk and a description of the technical and other measures undertaken, or to be undertaken, to control the identified risk;
- (f) if there is proposed, or there is likely to be, interaction with other operating plant or contractors in the same vicinity, or if there are multiple operating plant with different operators on the same petroleum tenure, geothermal tenure or GHG authority—
 - a description of the proposed or likely interactions, and how they will be managed; and
 - an identification of the specific risks that may arise as a result of the proposed or likely interactions, and how the risks will be controlled; and (iii) an identification of the safety responsibilities of each operator;
- (g) a skills assessment identifying the minimum skills, knowledge, competencies and experience requirements for each person to carry out specific work;
- (h) a training and supervision program containing the mechanism for imparting the skills, knowledge, competencies and experience identified in paragraph (g) and assessing new skills, monitoring performance and ensuring ongoing retention of skill levels;
- (i) safety standards and standard operating and maintenance procedures applied, or to be applied, in each stage of the plant;
- (j) control systems, including, for example, alarm systems, temperature and pressure control systems, and emergency shutdown systems;
- (k) machinery and equipment relating to, or that may affect, the safety of the plant; (l) emergency equipment, preparedness and procedures;
- (m) communication systems including, for example, emergency communication systems;
 - (ma) a process for managing change including a process for managing any changes to plant, operating procedures, organisational structure, personnel and the safety management plan;
- (n) the mechanisms for implementing, monitoring and reviewing and auditing safety policies and safety management plans;
- (p) key performance indicators to be used to monitor compliance with the plan and this Act;
- (q) mechanisms for—
 - recording, investigating and reviewing incidents at the plant; and
 - implementing recommendations from an investigation or review of an incident at the plant;
- (r) record management, including, for example, all relevant approvals, certificates of compliance and other documents required under this Act;
- (s) to the extent that, because of the Work Health and Safety Act 2011, schedule 1, part 2, division 1, that Act does not apply to a place or installation at the plant, details, including codes and standards adopted, addressing all relevant requirements under that Act that would, other than for that section, apply;
- (t) if the operating plant is, under the NOHSC standard, a major hazard facility—each matter not mentioned in paragraphs (b) to (r) that is provided for under chapters 6 to 10 of that standard.



New South Wales

Risk	Legislation/ instrument	Description	How risk is mitigated
Transport risks – e.g. traffic accident, leakage, operator exposure	Australian Dangerous Goods code	Relevant provisions enacted through state legislation <i>Dangerous Goods (Road and Rail Transport) Act 2008</i> and <i>Dangerous Goods (Road and Rail Transport) regulation 2014</i>	Hazardous materials are substances falling within the classification of the Australian Code for <i>Transportation of Dangerous Goods by Road and Rail (Dangerous Goods Code)</i> The EPA regulates the on-road transport of dangerous goods while WorkCover regulates activities prior to transport, including correct classification, packaging and labelling. These are effectively the same as the Queensland regime as they are both based on national model legislation. http://www.legislation.nsw.gov.au/sessionalview/sessional/sr/2014-398.pdf
	Dangerous Goods Driver Licence	Operator training for avoiding issues and managing emergencies	Ensures drivers have the training to act appropriately
	Dangerous Goods Vehicle Licence	Vehicle operation and technical specification requirements	Ensures vehicles are of appropriate specification, condition and equipped
	Dangerous Goods Documents	Records and Emergency Procedure Guide	Enable compliance to be established regarding the transport of the chemicals, as well as assisting in appropriate responses to emergency situations such as spills
	<i>Work Health and Safety Act 2011</i>	Duty to for officers to exercise due diligence to ensure safety of employees and duty of workers to ensure safety of themselves and other persons and comply with instructions	Incumbent upon chemical transport companies to have systems in place to ensure their staff are protected from risks such as crashes and spills. These are in combination with the specific requirements set out in the Dangerous Goods Code. http://www.legislation.nsw.gov.au/maintop/view/inforce/act+10+2011+cd+0+N
	Environmental offences	The <i>Protection of the Environment Operations Act 1997</i> provides offences for wilfully or negligently causing harm to the environment.	Incumbent upon chemical transporters to ensure that risks of spilling chemicals (both during transit and transfer operations) are mitigated. These could include only transferring chemicals in contained hardstand areas, having spill response procedures etc.) The Environment Protection Authority (EPA) has the power to inspect and prosecute companies for environmental and health breaches. http://www.epa.nsw.gov.au/legislation/aboutpoeo.htm#P90_6221



	Waste tracking requirements for waste transport	The <i>Protection of the Environment Operations (Waste) Regulation 2005</i> implements requirements to track and record transportation of wastes with high environmental risk.	Would likely apply to frack flowback transport – requiring detailed records to demonstrate compliance with the relevant waste management requirements for the particular waste http://www.legislation.nsw.gov.au/inforcepdf/2005-497.pdf?id=15937bef-eef8-c8ed-d2c1-dd4c148cc79c
Off-tenure product handling risks – e.g. worker contact during bulk mixing and preparation of chemicals; spillage of chemicals; chemical fire	Environmental Protection Licence – Chemical Storage	Storing 5,000kL or more of chemicals requires an Environment Protection Licence (EPL). EPLs contain conditions specific to the operation requiring mitigation of environmental risks.	Will ensure that environmental risk of the chemical storage and handling activities is adequately controlled. It would be unlikely such a facility would be approved in close proximity to aquatic ecosystems or other environmentally sensitive areas. http://www.legislation.nsw.gov.au/fragview/inforce/subordleg+211+2009+sch.1+0+N?SRTITLE=%22Protection%20of%20the%20Environment%20Operations%20(General)%20Regulation%202009%22&nohits=y&tocnav=y
	<i>Work Health and Safety Act 2011</i>	Duty for officers to exercise due diligence to ensure safety of employees and duty of workers to ensure safety of themselves and other persons and comply with instructions	Incumbent upon companies handling chemicals to have systems in place to ensure their staff are protected from risks such as exposure and spills. These are in combination with the specific requirements set out in the PEL where over the 5,000kL threshold. http://www.legislation.nsw.gov.au/maintop/view/inforce/act+10+2011+cd+0+N
	Environmental Planning and Assessment Act 1979	Such a facility would require a development application be submitted to Council and assessed against the planning scheme and relevant state instruments. It also goes to the joint regional planning panel for regional development.	If the facility was to be approved in the proposed location it would be likely to have a range of conditions, about how the site was to be developed and operated in order to ensure safety and consistency with adjacent land uses. http://www.legislation.nsw.gov.au/maintop/view/inforce/act+203+1979+cd+0+N
On-tenure chemical handling (pre-fracture) e.g. worker exposure to chemicals;	<i>Protection of the Environment Operations Act 1997</i>	Undertaking CSG exploration and production activities triggers a requirement for an Environment Protection Licence	Requires compliance with a range of conditions built around mitigating impacts associated with discharges to land, air and water. Requires the preparation of pollution incident response management plans and or pollution reduction programs for non-compliance with EPL conditions. These conditions have requirements



chemical release to the environment while mixing/preparation			relating to contingency management and chemical storage standards etc. No “model conditions” for CSG EPLs are currently available, however examples can be obtained from various recent approvals. http://www.legislation.nsw.gov.au/sessionalview/sessional/sr/2014-852.pdf
	<i>Petroleum (Onshore) Act 1991 and Work Health and Safety Act 2011</i>	Office of Coal Seam Gas is responsible for implementing safety requirements for CSG operations, including those around chemical handling and storage. Both pieces of legislation apply.	It is incumbent upon companies handling chemicals to have systems in place to ensure their staff are protected from risks such as exposure and spills. The safety standards for the NSW CSG industry are currently under review with recommendations due early 2015. http://www5.austlii.edu.au/au/legis/nsw/consol_act/whasa2011218/ http://www.legislation.nsw.gov.au/xref/inforce/?xref=Type%3Dact%20AND%20Year%3D1991%20AND%20no%3D84&nohits=y
	Code of Practice for Fracture Stimulation	The Code of Practice for Fracture Stimulation has been approved by the Minister for Resources and Energy and is mandatory for CSG operators	The Code of Practice for CSG fracking provides that chemical use should be minimised and prevents the use of BTEX chemicals. It also requires a fracture stimulation management plan which outlines: - The volumes and concentrations of those chemicals - Potential risks to human health arising from exposure to those chemicals - The risk, likelihood and consequence of surface spills of these chemicals - How those chemicals will be stored and managed. The code also provides for the development of an Emergency Plan dealing with matters such as evacuation procedures, medical treatment and assistance and training requirements. Further, the code provides for the mandatory development of an Environmental Incident Response Plan dealing with matters including chemical spills and other pollution incidents including: - details of the pre-emptive action to be taken to minimise or prevent any risk of harm to human health or the environment arising out of the activity - an inventory of potential pollutants on the premises or used in carrying out the activity, - the maximum quantity of any pollutant that is likely to be stored or held at the location of the fracture stimulation activity - a description of the safety equipment or other devices that are used to minimise the risks to



			<p>human health or the environment and to contain or control a pollution incident</p> <ul style="list-style-type: none"> - details of the mechanisms for providing early warnings and regular updates to the owners and occupiers of premises in the vicinity of the fracture stimulation activity - the arrangements for minimising the risk of harm to any persons who are present where the fracture stimulation activity is being carried out <p>http://www.resourcesandenergy.nsw.gov.au/_data/assets/pdf_file/0018/516114/Code-of-Practice-for-Coal-Seam-Gas-Fracture-Stimulation.PDF</p>
Loss of sub-surface containment of fracture fluids risks; e.g. contamination of aquifers; contamination of groundwater resources	Well Integrity Code	Sets out the mandatory minimum requirements in relation to well construction to ensure integrity.	<p>Requires risk management planning to be applied to well operations in the context of the <i>Work Health and Safety Act 2011</i> and further requires a Safety Management Plan to be developed for each stage of well operations. The code details reporting requirements including a record of all work undertaken on a well*. Cementing reports are also required in order to demonstrate isolation.</p> <p>Extensive requirements to ensure that no loss of containment are stipulated in relation to the following:</p> <ul style="list-style-type: none"> - well design (including casing setting depths accounting for aquifers and production zone locations) - casing (e.g. designed to withstand loads and pressures and meet API standards) - cementing (including cementing from shoe to surface and verification of zonal isolation) - well heads (to API standards) - drilling fluids (including no oil-based muds, records of each chemical used and managed in accordance with MSDS requirements) - evaluation (well downhole survey carried out) - ongoing appropriate monitoring and maintenance - suspension and abandonment (including extensive requirements to ensure safety and integrity of the well into the foreseeable future) <p>http://www.resourcesandenergy.nsw.gov.au/_data/assets/pdf_file/0006/516174/Code-of-Practice-for-Coal-Seam-Gas-Well-Integrity.PDF</p>
	Code of Practice for Fracture Stimulation	The Code of Practice for Fracture Stimulation has been approved by the Minister for Resources and Energy and is mandatory for CSG operators	<p>Contains extensive detailed requirements and implements a risk based approach to ensuring safety and environmental outcomes in relation to hydraulic fracturing activities.</p> <p>Requires a fracture stimulation management plan* be in place prior to fracturing including in relation to fracture stimulation design, assessment of risks, protection of water resources and monitoring requirements.</p>



			Further, the code requires an Environmental Emergency Response Plan which deals specifically with loss of well integrity. A completion report must be submitted following fracturing events which demonstrates that no environmental harm has been caused. http://www.resourcesandenergy.nsw.gov.au/_data/assets/pdf_file/0018/516114/Code-of-Practice-for-Coal-Seam-Gas-Fracture-Stimulation.PDF
	<i>Protection of the Environment Operations Act 1997</i>	The undertaking of CSG exploration and production activities triggers a requirement for an Environment Protection Licence	Requires preparing pollution incident response management plans and complying with a range of conditions. These conditions have requirements relating to hydraulic fracturing activities. No “model conditions” for CSG EPLs are currently available, but examples can be obtained from various recent approvals. http://www.legislation.nsw.gov.au/sessionalview/sessional/sr/2014-852.pdf
	<i>Strategic Regional Land Use Policy</i>	An Agricultural Impact Statement is required for various CSG activities at the exploration and development application stages	A comprehensive Agricultural Impact Statement must be provided by the applicant at both the exploration stage (where there is a requirement for a Review of Environmental Factors) and at the development application stage. http://www.resourcesandenergy.nsw.gov.au/miners-and-explorers/rules-and-forms/pgf/guidelines/agricultural-impact-statements
	<i>Water Management Act 2000</i>	A Water Access License is required to take water in the course of undertaking a mining activity.	Determines requirements for taking groundwater, whether for consumption or incidentally, unless an exemption applies. Any new mining and petroleum exploration activities taking more than three megalitres per year from groundwater sources must hold a WAL.
Handling of chemicals and flowback post-fracture (on tenure) risks – e.g. soil contamination; seepage into shallow groundwater; worker exposure; exposure in final waste management solution	<i>Protection of the Environment Operations Act 1997</i>	The undertaking of CSG exploration and production activities triggers a requirement for an Environment Protection Licence	Requires preparing pollution incident response management plans and compliance with a range of conditions. These conditions have requirements relating to hydraulic fracturing activities. Flowback water is defined as a liquid waste that must be managed, stored, transported and disposed of in a way that protects the environment and in accordance with the EPL condition requirements. The EPA requires that flowback water must be appropriately stored and transported to a facility licensed by the EPA to take that type of waste. All CSG facilities must keep detailed records of their liquid waste. No “model conditions” for CSG EPLs are currently available, however examples can be obtained from various recent approvals. http://www.legislation.nsw.gov.au/sessionalview/sessional/sr/2014-852.pdf http://www.epa.nsw.gov.au/resources/licensing/150007_csgflowbackwater.pdf



Code of Practice for Fracture Stimulation	The Code of Practice for Fracture Stimulation has been approved by the Minister for Resources and Energy and is mandatory for CSG operators	Contains extensive detailed requirements and implements a risk-based approach to ensuring safety and environmental outcomes in relation to hydraulic fracturing activities. A fracture stimulation management plan must be in place before fracturing. It must meet fracture stimulation design, assessment of risks, protection of water resources and monitoring requirements. It is specifically required to detail the management, storage and disposal of flowback water. The code requires an Environmental Emergency Response Plan that deals specifically with spills. A completion report must be submitted following fracturing events that demonstrates there has been no environmental harm. http://www.resourcesandenergy.nsw.gov.au/_data/assets/pdf_file/0018/516114/Code-of-Practice-for-Coal-Seam-Gas-Fracture-Stimulation.PDF
<i>Petroleum (Onshore) Act 1991</i> and Work Health and Safety Act 2011	Office of Coal Seam Gas is responsible for implementing safety requirements for CSG operations, including those around chemical handling and storage. Both pieces of legislation apply.	Companies handling chemicals must have systems in place to protect their staff from risks such as exposure and spills. The safety standards for the NSW CSG industry are currently under review with recommendations due early 2015. http://www5.austlii.edu.au/au/legis/nsw/consol_act/whasa2011218/ http://www.legislation.nsw.gov.au/xref/inforce/?xref=Type%3Dact%20AND%20Year%3D1991%20AND%20no%3D84&nohits=y

*** Good industry practice well records:**

- Engineering design basis
- Kick tolerance/well control design assumptions
- BOP pressure testing requirements, and actual test records
- Laboratory test results for cement slurries
- Casing tallies for all casing strings run (including lengths, weights, grades, inside diameter, outside diameter, setting depth)
- Cementing records for each casing string in each well
- Casing pressure test reports
- Leak off test and/or formation integrity test reports
- Wireline logs
- Core description reports
- Downhole installation records/schematic records of chemicals used downhole, including any chemicals used in drilling fluid, treatment and workover or other well procedures (name, type CAS number and volume of each chemical used should be recorded)
- Records of drilling and cementing, including any problems encountered during the drilling
- Risk assessments
- Well drilling and completion programs including casing running and cementing procedures
- Daily rig reports
- Daily geological reports, if relevant
- Service company reports



**** Requirements for fracture stimulation management plans:**

- a) Fracture stimulation activities must not be conducted except in accordance with a FSMP approved by the department.
- b) The FSMP must describe the nature, location, scale, timing, duration, hours of operation and other relevant features of the fracture stimulation activity.
- c) The FSMP must demonstrate that all risks to the environment, existing land uses, the community and workforce, as a result of the fracture stimulation activity, are managed through an effective risk management process that includes identification of hazards, assessment of risks, implementation of control measures and monitoring of the integrity and effectiveness of the control measures.
- d) The FSMP must identify how the titleholder will address and comply with the Code's requirements.
- e) The FSMP must be reviewed and as necessary revised by the titleholder:
 - before making a significant change to the design or operation of the fracture stimulation activity
 - if the sensitivity of potentially affected environmental, land use or community features significantly increases
 - in the event that monitoring indicates that the consequences of the fracture stimulation activity exceed those identified in the FSMP, or that a risk control measure does not adequately control the risk Fracture Stimulation Activities
- f) The detail provided in the FSMP must be appropriate to the nature, scale, intensity and potential impacts of the proposed fracture stimulation activity.
- g) The FSMP is a public document and may be published by the department. Commercially sensitive or personal information should not be included in an FSMP unless specifically required by this Code.

The design of the fracture stimulation activity must be described in the FSMP.

This description must:

- a) characterise geological formations, including the identification of rock types and conditions, aquifers and hydrocarbon-bearing zones
- b) define distances to these aquifers from the target coal beds
- c) identify the characteristics of intervening strata, including porosity/permeability and the extent of natural fracturing
- d) determine geological stress fields and areas of faulting
- e) determine maximum pressures to be used for fracture stimulation, based on the characteristics of the surrounding geology
- f) model the likely fracture propagation field, including extent and orientation
- g) discuss any potential for the fracture propagation field to exceed that modelled in (f).

Risk assessment

- a) The FSMP must include a risk assessment complying with AS/NZS ISO 31000:2009 Risk management - Principles and Guidelines.
- b) The risk assessment must identify risks associated with the fracture stimulation activity, the likelihood of each risk and the consequence of each risk.
- c) The risk assessment must define appropriate management controls to ensure identified risks are constrained to acceptable levels.
- d) At a minimum, the risk assessment must address risks associated with:
 - i. workplace health and safety (see heading 5 of this Code)
 - ii. public safety (see heading 5 of this Code)
 - iii. chemical use (see heading 6 of this Code)
 - iv. impacts on water resources (see headings 7 and 8 of this Code)



- v. land contamination
- vi. air pollution
- vii. noise & vibration
- viii. waste management (e.g. flowback water as per heading 8 of this Code)
- ix. loss of well integrity
- x. induced seismicity
- xi. induced subsidence or other induced ground movements
- xii. conflicts with existing land uses

Water resources

- a) Identify the location, extent, pre-existing water quality and use of water sources which have the potential to be impacted by the fracture stimulation activity.
- b) Identify sources of fracture stimulation injection water, the estimated quality and volume to be injected and any licensing/approval requirements under the Water Management Act 2000 or Water Act 1912.
- c) Include a qualitative risk assessment for risks associated with the fracking activity, including:
 - i. cross-contamination between coal bed waters and shallower water sources
 - ii. changes to groundwater pressure and levels
 - iii. changes to surface water levels
 - iv. changes to water quality characteristics.
- d) If the risk of establishing a connection between the target coal bed and other water sources as a result of the fracture stimulation activity is assessed to be moderate or higher, then a fate and transport model study must be undertaken to quantify the impacts on water sources and the likelihood of any changes to the beneficial use category applicable to any affected aquifer.
- e) If there is a moderate or greater risk of significant changes to pressure or levels as referred to in c) (ii) or (iii), the impacts on all affected aquifers must be quantitatively assessed.
- f) Describe consultation undertaken with the NSW Office of Water in developing the water resources component of the risk assessment.

Monitoring

- a) The FSMP must describe any monitoring arrangements, including monitoring before, during and after the fracture stimulation activity.
- b) The titleholder must carry out sufficient monitoring to establish that significant risks have been:
 - i. identified
 - ii. quantified
 - iii. avoided, or appropriately managed so that residual risks are within acceptable limits before, during and after the fracture stimulation activity.
- c) Monitoring of overlying water sources must be undertaken over an area sufficient to encompass the predicted fracture length plus a sufficient margin to provide for any uncertainty.
- d) Prior to fracture stimulation, monitoring must be undertaken to characterise water source level, pressure and quality. This monitoring should include existing wells and water bores at a minimum.
- e) During fracture stimulation, monitoring must be undertaken to:
 - i. record key parameters such as bottom hole pressure and surface injection pressure
 - ii. establish the volume, composition, viscosity and pumping rate of fracture fluids and proppants
- f) Post-stimulation monitoring must be undertaken to ensure that induced inter-aquifer connectivity has been prevented by:
 - i. determining the volume and quality of flowback and produced water
 - ii. quantifying any changes in surrounding water sources
 - iii. pressure testing of casing to verify that the integrity of the well and well equipment has been maintained.