APPENDIX 1

Glossary of Terms

Glossary	Explanation
Annulus	Empty space between the sidewall of a borehole or well and any material or equipment inserted into the bore. If the bore is fitted with casing, then it is the space between the natural sidewall of the bore and the outer surface of the casing. During drilling operations, it is the space between the drill string and the nearest inner surface of the hole being constructed. If the borehole is fitted with a pump or other instrumentation, it is the space between this equipment and the nearest inner surface of the borehole. The annular space, and in particular the space between the casing and the natural sidewall of the bore, may be filled with various types of material to serve specific purposes, e.g. with gravel to form a gravel pack or filter pack, or with cement grout to form a seal.
Additive (chemical)	A product composed of one or more chemical constituents that are added to a primary carrier fluid to modify its properties in order to form hydraulic fracturing fluid.
Aquifer	Part of a formation, a formation or a group of formations that in the natural environment is/are capable of both storing and transmitting groundwater, by virtue of possessing sufficient saturated and interconnected porous and/or permeable material, directly to a borehole, well or spring in sufficient quantities for an intended use. The porous and/or permeable material may comprise intergranular openings (pores), or one or a system of interconnected fissures, fractures and/or joints, or a combination of these features.
Base fluid	Any drilling fluid that must act as a mixing agent and carrier fluid during the process of hydraulic fracturing.
Baseflow	Portion of water flowing in a river or stream that derives from groundwater. It is generally best represented during the dry season when there is little or no rainfall and associated surface water runoff.
bbl	Barrel — 42 US gallons (approximately 160 litres).
Bcf	Billion cubic feet (approximately 28.3 million m^3).
Biocide	Also known as a "bactericide." An additive in the hydraulic fracturing fluid that kills bacteria.
Biome	A broad ecological unit representing major life zones of large natural areas defined mainly by vegetation structure, climate as well as major large-scale disturbance factors (such as fire).
Blowout	An uncontrolled flow of gas, oil or water from a well during drilling caused when high formation pressure is encountered.
Borehole	Typically a vertical hole usually made by drilling into rock formations to investigate various properties, such as whether the rock contains any groundwater and, if so, the quantity and quality of the water. Although the diameter may range from less than 50 mm to more than 400 mm, a typical water borehole is completed at a drilled diameter of 165 mm. Its depth may vary from only a few metres to hundreds of metres, the maximum depth generally being determined by such factors as the specific purpose of the borehole, the technical capacity of the drilling machinery and equipment, and the cost. Most commonly used for water supply purposes, other applications of a borehole include the monitoring of groundwater levels and quality in an environmental context, to serve as structures for artificial recharge purposes, and the exploration for minerals or other natural materials and substances.
Bossieveld	Local karoo term for arid shrubland consisting mostly of Asteraceae, Aizoaceae and grass
Brack water	South African term for saline water (TDS >1 000 mg/L)
Breaker	A chemical used to reduce the viscosity of a fluid (break it down) after the thickened fluid has finished the job it was designed for.

Glossary	Explanation
Brine	Water (either displaced from the geological formation or generated from the fracturing fluids used during hydraulic fracturing) which contains very high levels of dissolved solids (TDS >35 000 mg/L, i.e. more saline than sea water)
BTU	British Thermal Unit — equivalent to 1 055 joules.
Carrier fluid	The base fluid, such as water, into which additives are mixed to form the hydraulic fracturing fluid which transports proppant.
Casing	Pipe-like material used in the construction of a borehole or well to line the bore. As the purpose of fitting a bore with casing includes protection of the sidewall against collapse, the strength of the casing must be sufficient to withstand reasonable lateral pressure. Certain drilling methods may also require the casing to withstand vertical pressure exerted by downward (compressional) forces when inserting the casing and upward (tensional) forces when retrieving the casing. Although casing strength is determined mainly by the type of material (e.g. steel compared to uPVC), the thickness of the sidewall also contributes to the inherent strength of the casing, i.e. the greater the sidewall thickness, the stronger the casing.
CCGT	Combined-cycle Gas Turbine electric power station.
Cement / cementing	Material used to seal off formations and to stabilise the casing used in the well bore. Cement seals the annulus between the casing and the well bore sidewall, thus preventing the vertical migration of fluids in this space.
Ceramic proppant	A proppant (see proppant) that is composed of a ceramic material.
Chemical constituent	A discrete chemical with its own specific name or identity, such as a CAS Number, which is contained within an additive product.
Completion (well)	The activities and methods of preparing a well for extraction after it have been drilled to the target formation. This principally involves preparing the well to the required specifications; running in extraction tubing and its associated down hole tools, as well as perforating and stimulating the well by the use of hydraulic fracturing, as required.
Compressor	A facility which increases the pressure of natural gas to move it in pipelines or into storage.
Condensate	A low-density, high-gravity liquid hydrocarbon phase that generally occurs in association with natural gas. Its presence as a liquid phase depends on temperature and pressure conditions in the reservoir allowing condensation of liquid from vapour.
Contamination	Term used synonymously with pollution to describe the potential for activities associated with shale gas development to impact negatively on the environment in its broadest sense, i.e. whether aesthetically (visual disturbance, social disturbance, economic disturbance, etc.) or physically (atmospheric pollution, water pollution, noise pollution, etc.)
Conventional gas	In contrast to unconventional gas, conventional gas is trapped within a permeable rock reservoir, which in turn is overlain by a layer of impermeable rock (AfDB, 2013).
Corrosion inhibitor	Chemical agents that protect iron and steel from corrosive acid
Cross- linker	A compound, typically a metallic salt, mixed with a base-gel fluid, such as a guar-gel system, to create a viscous gel used in some stimulation or pipeline cleaning treatments. The crosslinker reacts with the multiple strand polymer to couple the molecules, creating a fluid of high viscosity.
Darcy	A unit of permeability. A medium with a permeability of 1 Darcy permits a flow of 1 cm^3/s of a fluid with viscosity 1 cP (1 mPa•s) under a pressure gradient of 1 atm/cm acting across an area of 1 cm.

Glossary	Explanation
Directional drilling	Deviation of a bore from the vertical during drilling so that it penetrates and follows a productive formation.
Distribution	Refers to the process whereby natural gas and associated products are conveyed to an end user through a local pipeline system; these pipelines are smaller in diameter in comparison to transmission pipelines (Branosky et al., 2012).
Drill bit	Tool at the leading (bottom) end of a drill string which cuts or crushes the rock in order to advance the depth (length) of the bore during drilling. The type of drill bit used, e.g. button bit, tricone bit or chisel bit, is dictated by the drilling method employed.
Drilling fluid	Describes any substance or mixture of substances applied during and used to facilitate the drilling process. Examples include the foam produced by mixing compressed air and "soapy" water (surfactant) in the case of rotary percussion drilling, and the mud-like substance produced by mixing certain chemicals with water in the case of rotary mud drilling. The drilling fluid serves five main functions, namely (1) to lubricate the drill bit, (2) to enhance the removal of drill cuttings from the borehole, (3) to support the borehole sidewall against collapse, (4) to combat the loss of fluid from the bore into the formation, and (5) to control the pressure in the bore during drilling.
Drilling mud	A thick viscous fluid normally prepared at the drill site by mixing water with materials (e.g. bentonite clay) and chemicals to enhance various characteristics of the fluid such as gel strength and density. This multipurpose mixture serves to lubricate the drill bit, block pores and minor fractures to minimise or prevent fluid loss from the bore and contamination of water resources, and prevent unexpected influxes of oil or gas from the formations penetrated.
Dry gas	Natural gas that occurs in the absence of condensate or liquid hydrocarbons, or gas that has had condensable hydrocarbons removed. Dry gas typically has a gas-to-oil ratio exceeding 100 000 scf/STB. The production of liquids from gas wells complicates the design and operation of surface process facilities required to handle and export the produced gas.
Dutch Disease	Economic term for over-strengthening of the exchange rate as a result of major natural resource discoveries and development
Ecological infrastructure	Ecological infrastructure means naturally functioning ecosystems that generate or deliver valuable services to people. It is the nature-based equivalent of built or hard infrastructure, and is just as important for providing services and underpinning socio-economic development. (SANBI, 2013)
Economically recoverable reserves	Technically recoverable petroleum for which the costs of discovery, development, extraction, and transport, including a return to capital, can be recovered at a given market price.
Ecosystem	A complex set of relationships of living organisms functioning as a unit and interacting with their physical environment. The boundaries of what could be called an ecosystem are somewhat arbitrary, depending on the focus of interest or study. Thus the extent of an ecosystem may range from very small spatial scales to, ultimately, the entire earth.
Endemic	A plant or animal species or a vegetation type which is naturally restricted to a particular, defined region.
Environmental impact assessment (EIA)	A public process by which the likely effects of a project on the environment are identified, assessed and then taken into account by the consenting authority in the decision-making process. This serves as a tool to facilitate sustainable development.

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Estimated ultimate recovery	Estimated ultimate recovery refers to the expected cumulative output of a given unconventional gas well. Estimated ultimate recovery may differ between wells depending on the underlying geology, whether a well is located in a 'sweet spot' i.e. where output is particularly high, or the degree to which advanced technologies in drilling and completing wells have been applied (IEA, 2012).
Exploration	Exploration typically refers to activities to locate subsurface reservoirs of water, gas (conventional and unconventional) and/or oil. Exploration may involve seismic exploration, surface mapping and exploratory drilling, and the use of equipment such as magnetometers, seismic streamers and sound array guns or gravity meters (Branosky et al., 2012).
Exploration right	A right granted to the applicant in terms of section 80 of Mineral and Petroleum Resources Development Act 28 of 2008 (MPRDA) to reprocess the existing seismic data, acquisition and processing of new seismic data or any other related activity to define a trap to be tested by drilling, logging and testing, including extended well testing, of a well with the intention of locating a discovery.
Extraction	Extraction as used in this report refers to all types of unconventional oil and gas extraction, thus to both shale gas (regulated under petroleum resource exploitation (Chapter 6 of the MPRDA) as well as coalbed methane (regulated under mining (Chapter 4 of the MPRDA)).
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Fault	A fracture or fracture zone in a geological formation along which there has been displacement of the sides relative to each other.
Flare	The burning of excess or unwanted gas from a well.
Flaring	Flaring involves intentionally burning methane over an open flame as it is released, as this reduces the carbon content by converting the methane to carbon dioxide (Barcella et al., 2011).
Flowback	Fluid returned to the surface after hydraulic fracturing has occurred, but before the well is placed into production. It typically consists of returned fracturing fluids in the first few days following hydraulic fracturing which are progressively replaced by produced water.
Fold	A bend in geological rock strata.
Formation	A rock body distinguishable from other rock bodies and useful for geological mapping or description. Formations may be combined into groups or subdivided into members.
Fracking, fraccing or fracing	Informal terms for "Hydraulic Fracturing".
Freshwater aquifer	Groundwater resource that contains potable water and could potentially be used to supply drinking water.
Fugitive emissions	Fugitive emissions denote gas losses from the upstream natural gas system (i.e. losses as a result of equipment leaks, venting and flaring). In this report, the term does not cover those GHG emissions associated with fuel combustion during the shale gas life cycle. Another term for fugitive emissions is 'methane leakage'. This definition stems from Day et al. (2012).

Glossary	Explanation
Gas in place	Gas determined to occur in shale layers but of which the productive volumes have not been established by means of hydraulic fracturing.
Gathering lines	Small diameter pipelines that move gas from the production field to a transmission line.
Global Warming Potential	Global Warming Potential is a common metric used to quantify and communicate the relative and absolute contributions to climate change of certain substances by accounting for the respective radiative efficiencies of these substances and their lifetimes in the atmosphere, and providing values relative to those for the reference gas carbon dioxide (IPCC, 2013).
Green completions	Green completion is considered good practice during the flow back period. Green completion (also referred to as reduced emissions completion) refers to the process whereby hydrocarbons are separated from the flow back prior to being sold, as opposed to being flared or vented into the atmosphere, and remaining flow back fluid is collected for processing and recycling or disposal. The capture and sale of gas during the initial flow-back phase requires investment in gas separation and processing facilities (IEA, 2012).
Greenhouse gas	These are gases (including water vapour, carbon dioxide and methane) that trap energy radiated from the Earth's surface in the atmosphere to produce warming (the greenhouse effect).
Groundwater	Water contained in and completely saturating the interstices that occur below the ground surface in unconsolidated and consolidated rock formations. It excludes water that is in the process of moving downward (infiltrating) from the surface through the unsaturated zone. Most commonly derived from and associated with meteoric (atmospheric) water, it also includes juvenile water and connate water.
GTL	The process of converting natural gas into synthetic liquid hydrocarbons — Gas-To-Liquids.
Horizontal drilling	Deviation of a bore from the vertical to penetrate and follow sub-horizontal bedded strata.
Hydraulic conductivity	Describes the ability of saturated material to transmit a fluid (most commonly water) on the basis of both the nature of the saturated material and considering the influence of properties such as the density and dynamic viscosity of the fluid. It is typically expressed in the unit metres per day (m/d). Less commonly referred to as coefficient of permeability or seepage coefficient, terms typically used in the petroleum industry where the fluids of interest include oil and gas, it is not to be confused with the term permeability.
Hydraulic fracturing	The act of pumping hydraulic fracturing fluid under pressure into a formation to increase its permeability. Hydraulic fracturing has been used in the industry in various forms, for either stimulation of water boreholes to produce water, or for stimulation of oil and gas wells to produce oil and/or gas.
Hydraulic fracturing fluid	Fluid used to perform hydraulic fracturing; includes the primary carrier fluid, proppant material, and all applicable additives.
Hydrocarbon	A naturally occurring organic compound comprising hydrogen and carbon. Hydrocarbons can be as simple as methane [CH4], but many are highly complex molecules, and can occur as gases, liquids or solids. The molecules can have the shape of chains, branching chains, rings or other structures. Petroleum is a complex mixture of hydrocarbons. The most common hydrocarbons are natural gas, oil and coal.

Glossary	Explanation
Life cycle assessment	A Life Cycle Assessment (LCA) is the assessment of the consecutive and interlinked stages of a system from which a product is produced from the acquisition or generation of a given raw material to its end of life. In the case of an LCA pertaining to GHG emissions from hydraulic fracturing the assessment may include calculating emissions from the production and transportation of material involved in the well development activities; emissions from fuel consumption for powering the drilling and fracturing equipment; fugitive emissions and fuel combustion emissions associated with gas production, processing, transmission, distribution, and natural gas combustion (Bradbury et al., 2013; Branosky et al., 2012).
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Liquids unloading	Liquids which could slow well production in mature wells are removed from the wellbore either through the use of a down-hole pump or through a reduction of wellhead pressure (Branosky et al., 2012).
Methane	The simplest hydrocarbon molecule, consisting of four atoms of hydrogen bonded to a single atom of carbon expressed by the formula CH_4.
Natural gas	Hydrocarbon gas consisting primarily of methane and existing naturally in subsurface formations. Marsh gas is the equivalent in surface environments.
Naturally Occurring Radioactive Material	Radioactive material that occurs naturally in rock formations such as certain shales, and where human activity such as drilling may increase the chances of exposure from drill cuttings and other wastes from a well, compared with the unaltered situation.
Perforate (well casing)	To make holes through the casing to allow the oil or gas to flow into the well or to squeeze cement behind the casing.
Permeability	A measure of the ability of a fluid to move through pores, fractures or other openings in a rock. The unit for measurement is Darcy.
Plateau	An area of highland, usually consisting of relatively flat terrain.
Play	The prospective geographic area where oil and gas could potentially be commercially developed and extracted.
Plug	A temporary or permanent measure taken to seal off a portion of the well by plugging the bore or casing with material such as cement or steel, and which is pressure tested once installed to establish its integrity.
Pneumatic controllers	Pneumatic controllers are responsible for regulating gas flow and pressure, liquid levels and automatically operating valves in the separator, gas dehydrator, and compressor (Harvey et al., 2012).
Polymer	Chemical compound of unusually high molecular weight composed of numerous repeated, linked molecular units.
Porosity	Property describing the capacity of soil and rock containing interstices (pores) to store fluids, generally expressed as the volume of pore space per cent of the total bulk volume of the rock.

Glossary	Explanation
Prime mover	Refers to a device which transforms energy from thermal to electrical or vice versa, or pressure to/ from mechanical form. A prime mover is typically an engine or turbine that powers the drilling rig (Broderick, 2011; AEA, 2012).
Produced water	Fluids displaced from the geological formation, which can contain substances that are found in the formation, and may include dissolved solids, gases (e.g. methane, ethane), trace metals, naturally occurring radioactive elements (e.g. radium, uranium), and organic compounds.
Production	Production refers to the primary production phase, once wells have been connected to processing facilities. Hydrocarbons and waste streams are produced by wells during this phase.
Production casing	The final string of casing used to access the reservoir for extracting fluids. Production casing is placed inside other casings.
Production right	A right granted to the applicant in terms of section 84 of the MPRDA to the applicant to conduct any operation, activity or matter that relates to the exploration, appraisal, development and production of petroleum.
Production well	A well that is sunk for producing oil and gas.
Proppant or propping agent	Material, usually sand or ceramic particles, carried by the fracturing fluid into a fracture to keep it open when hydraulic pressure is released.
Proved reserves	The quantity of energy sources estimated with reasonable certainty, from the analysis of geologic and engineering data, to be recoverable from well-established or known reservoirs with the existing equipment and under the existing operating conditions.
PSI	Pounds per square inch — a unit of pressure (Imperial system).
Recharge	Process whereby some portion of the rainfall on a landscape infiltrates the subsurface to replenish groundwater resources. The quantity varies both spatially and temporally, depending on various factors such as vegetation cover, the nature of the soil profile and underlying geologic strata, the depth to water table, and the magnitude and intensity of rainfall. It is typically expressed as a per cent of the mean annual precipitation.
Reservoir (oil or gas)	A subsurface, porous, permeable or naturally fractured rock mass in which oil or gas has accumulated. A gas reservoir consists only of gas plus fresh water that condenses from the flow stream reservoir.
Reservoir pressure	The pressure within the reservoir rock.
Reservoir rock	A body or mass of rock that may contain oil or gas in appreciable quantity and that has sufficient porosity and permeability to store and transmit these products.
Reservoir stimulation	A class of activities intended to improve the productivity of oil and gas wells. This includes the injection of various chemicals (depending on the nature of the reservoir) at pressures below the fracture pressure of the rock to dissolve material that may be restricting flow from pore to pore, and as a separate subset, the fracturing of reservoirs to create new flow paths by the injection of fluids at pressures above the fracture pressure of the rock and at rates sufficient to sustain the propagation of the new fracture system (DMR, 2012).
Sandstone	A variously coloured sedimentary rock composed chiefly of sand-sized mineral grains (usually quartz) cemented by carbonate, silica, clay or other materials.
Scale inhibitor	A chemical substance which prevents the accumulation of a mineral deposit (for example, calcium carbonate) that precipitates out of water and adheres to the inside of pipes, heaters, and other equipment.

Glossary	Explanation
Sedimentary rock	Rock formed either from sediment transported in water (alluvial, fluvial), wind (aeolian) or ice (glacial) from its source and that accumulates by deposition and solidifies by cementation and compaction (e.g. sandstone, siltstone, mudstone), or from chemical precipitation of dissolved mineral constituents in water (e.g. limestone).
Seismic survey	A method of finding oil and natural gas by measuring the time it takes sound waves to travel through layers of the earth, reflect off of potential reservoir strata, and return to surface.
Shale	A fine-grained sedimentary rock composed mostly of compacted clay, silt or mud, and typically exhibits a laminated and cleavable appearance.
Shale gas	Natural gas that remains tightly trapped in shale and consists chiefly of methane, but with ethane, propane, butane and other organic compounds mixed in. It forms when black shale has been subjected to heat and pressure over millions of years, usually at depths of 1,500 to 4,500 metres below ground level.
Shale gas development	Refers to both exploration and production related activities; as well as downstream gas utilisation scenarios.
Siltstone	Rock in which the constituent particles are predominantly silt size.
Site remediation	Site remediation, i.e. efforts to restore the well site to its pre-drilling state, is performed after well closure (Branosky et al., 2012).
Square Kilometre Array (SKA)	Square Kilometre Array — internationally funded radio telescope to be constructed in the vicinity of Carnarvon, Northern Cape.
Stimulation	The act of increasing a well's productivity by artificial means such as hydraulic fracturing or acidizing.
Storage	Storage refers to the short- or long-term containment of natural gas either locally (in high pressure pipes and tanks), or underground in naturally occurring geological reservoirs which may include salt domes or depleted oil and gas fields (Branosky et al., 2012).
Storativity	The capacity of an aquifer to store water.
Stratigraphic well	A well that is sunk for determining the stratigraphy during oil and gas exploration.
Sustainable development	Generally defined as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Sustainable development is based on sociocultural development, political stability and decorum, economic growth and ecosystem protection, which all relate to disaster risk reduction. The National Environmental Management Act 107 of 1998 defines sustainable development as "the integration of social, economic and environmental factors into planning, implementation and decision-making so as to ensure that development serves present and future generations".
Target formation	The reservoir that the driller is trying to reach when drilling the well.
Tcf	Trillion cubic feet (approximately 28.3×10^9 m^3). A typical benchmark for initial assessments of the economic potential of a gas accumulation.
Technically recoverable reserves	The proportion of assessed in-place oil or gas that may be recoverable using current recovery technology, without regard to cost.
Thermal maturity	Of organic matter acting as source for the generation of hydrocarbons. Referenced to the reflectivity of particles of vitrinite amongst the organic matter. Progresses with time and temperature from immature to the 'oil window', then the 'gas window' to overmature. The 'windows' are named after the main type of hydrocarbon being generated. The boundaries/edges of the windows are gradational.
Tight reservoirs	Formations such as shales and some sandstones that do not have enough natural permeability to allow hydrocarbons to flow through the unstimulated rock mass.
Total dissolved solids	The quantity of dissolved material in a given volume of water.

Glossary	Explanation
(TDS)	
Transmission	The physical transferal of gas from single or multiple sources of supply, to single or multiple points of delivery (Branosky et al., 2012).
Transmissivity	Defines the rate of flow of water under a unit hydraulic gradient through a vertical strip of aquifer one unit wide and extending the full saturated thickness of the aquifer. The reporting unit is typically square metres per day (m^2/d). Increasingly smaller values represent increasingly impermeable conditions.
Unconventional gas	Unconventional gas refers to shale gas, tight gas and coalbed methane, which are gasses trapped in impermeable rock. These gasses are referred to as such due to the difficulty associated with extracting them and corresponding high production costs (IEA, 2012).
Upstream	Exploration for and extraction of oil and natural gas, and the construction and operation of the infrastructure necessary to deliver these hydrocarbons to the market or point of sale.
Venting	Venting denotes the process whereby methane is directly and intentionally released into the atmosphere (Barcella et al., 2011).
Vibroseis trucks	Trucks with mounted vibrator plates for acoustic measuring during seismic data acquisition.
Vulnerability	The conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.
Wastewater	A collective term used to describe all fluids generated in the course of shale gas development activities; it includes spent fracturing fluids, flowback and produced water destined for disposal or treatment and re-use.
Well	Term used in this study to distinguish between a bore drilled for producing groundwater (a borehole) and that drilled for producing oil or gas.
Well closure	Once the supply of gas from a well is exhausted, the well is decommissioned, the wellbore plugged and the equipment is removed (Branosky et al., 2012).
Well completion	Well completion involves readying a well after drilling for production. This involves clearing the well by recovering the base fluid that has been injected into it (i.e. flowback) (Allen et al., 2013).
Wellpad	A site constructed, prepared, levelled and/or cleared in order to accommodate the equipment, materials and infrastructure necessary to drill one or more natural gas exploration or production wells.
Wellbore	The hole created by boring into the subsurface using a drilling rig to power a drill bit. The wellbore might be completely fitted with casing, left open (uncased), or comprise a combination of these.
Wellhead	The equipment installed at the surface of the wellbore. A wellhead includes such equipment as the casing head and tubing head.
Wet gas	Natural gas that contains less methane (typically less than 85% methane) and more heavy hydrocarbons such as ethane and other more complex hydrocarbons. Wet gas may also contain water.
Workover	Refers to operations undertaken to remediate producing wells in order to increase hydrocarbon output levels (Branosky et al., 2012).