11 GAS FIELD CONSTRUCTION

The extent and nature of the construction of the Gas Field Component is described in this chapter, *Chapter 11*. The type and methods of construction, construction equipment and resources, and items transported during construction are covered.

This chapter also outlines the Project staging and describes:

- well drilling
- well site development
- power supply
- water and gas gathering systems
- gas compression infrastructure
- road transport infrastructure
- development sequencing and timeframes.

The construction of engineering structures, for the storage, transport, treatment and use of Associated Water, is also described in this chapter. Estimated employment during the construction phase is detailed in *Section 11.6.4*.

11.1 CONSTRUCTION TIMEFRAME, STAGING AND METHOD

The key phases and activities associated with Gas Field construction are summarised in *Table 2.11.1*.

Table 2.11.1 Key Phases and Activities

Phase	Activity	
Pre-construction	Commercial well development	
		Selection of well sites, including land access
		Drill site preparation
		Drilling
		Site clean-up and rehabilitation
Construction	Associated surface equipment and gas gathering	
		Assembly of well site equipment
		Gas-gathering pipelines
		Field compressor stations (FCSs), including flares
		Central processing plants (CPPs), including flares, TEG units
	Associated Water infrastructure	
		Water-gathering pipelines
		Ponds
		Water treatment facilities
	Other Infrastructure, including:	
		Accommodation camps, administration buildings and warehouses
		Transport
		Waste
		Energy
		Storage

Phase	Activity
Commissioning	Construction testing, handover, system planning, transfer of custody and, scheduling
	Ramp-up gas

Operational activities are discussed in *Volume 2, Chapter 7* and rehabilitation and decommissioning works are discussed in *Volume 2, Chapter 15*.

To accommodate the gas demand of the LNG Facility, expansion of QGC's existing well development, in-field processing, Associated Water management, land access and infrastructure activities are required. The development and expansion of the Gas Field Component, including associated well construction activities, will continue for at least 20 years, for an operational Project life from 2013 to approximately 2033. The duration will depend on the long-term demand of LNG in both domestic and export markets.

11.2 STAGE 1 – PRE-CONSTRUCTION

11.2.1 Selection of Well Sites

The selection of well sites is primarily based on geological analysis completed as part of exploration works. Other factors considered in locating well sites include:

- landform and topography – a relatively firm and level pad is required
- environmental and cultural heritage constraints – avoiding environmentally and culturally sensitive areas and using previously disturbed areas to minimise potential environmental impacts
- landholder disturbance – the location of houses and existing land use will be considered to minimise impacts to landholders and ongoing land use
- existing site access – locating sites close to existing tracks and adjacent to fence lines, where practicable to minimise impacts associated with access and disturbance to primary production.

QGC will negotiate the well locations, connecting gas and water pipeline locations, works required on each property, restoration plans, and compensation arrangements with each relevant landholder. QGC will formalise arrangements through a Landholder Agreement which meets the requirements of the *Petroleum and Gas (Production and Safety) Act 2004* (Qld) (*P&G Act*), and which meets the practical needs of both QGC and landholders.

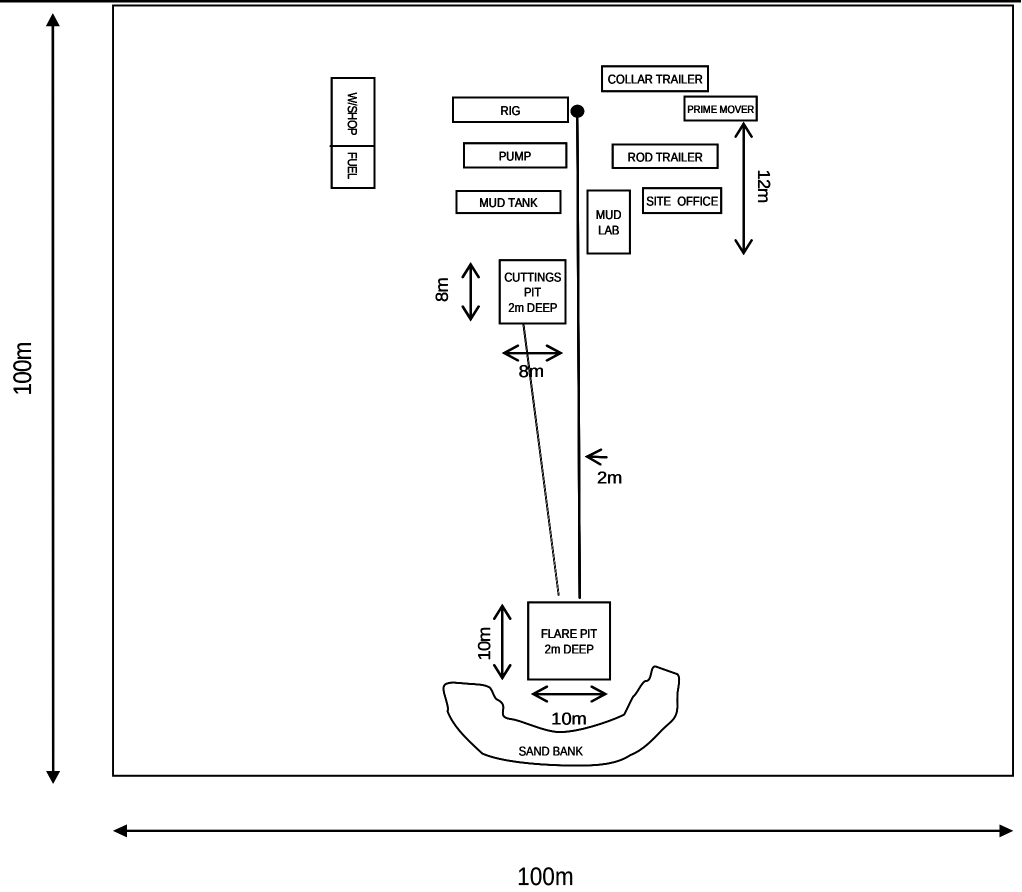
11.2.2 *Drill Site Preparation*

Depending upon the type of drill rig used pre-drill work may include installation of:

- a hardstand area of approximately 100 m x 100 m x 250 mm (i.e. 1 hectare) to facilitate all-weather activities on site
- a drill pit or sump (i.e. three lined pits approximately 7 m x 8 m x 1.5 m) required for storage of water for drilling, recirculation of water into the mud system and collection of drill cuttings
- water containment facilities for Associated Water extracted during exploration
- transportable buildings for drill equipment, storage, site offices and amenities
- loading bays and entry/exit points for vehicles.

After drilling is complete, semi-permanent fencing will be erected around the equipment. Appropriate signage relating to restricted entry, fire hazards and protective clothing requirements will be prominently displayed to warn landholders and the public of the dangers and required controls. *Figure 2.11.1* shows a schematic of a typical drill site.

Figure 2.11.1 Typical Drill Site Layout



Vegetation and topsoil will be graded from the area and stockpiled separately for use during site restoration. Where wells are constructed on slopes, some cutting may be required to establish a level base. The profile would be returned as near as possible to the original profile during site restoration.

The well sites will be located principally on flat ground clear of vegetation (i.e. trees and shrubs). Some vegetation may be cleared but tall trees (including hollow-bearing trees) will be avoided as far as possible. Where necessary, stormwater will be diverted around the drill pad via bunding with discharge directed onto either vegetated or stabilised areas. Any clearing will be in accordance with the relevant environmental authority (EA).

11.2.3 Drilling

Once a site has been prepared, a drill rig will be mobilised to commence the drilling process.

Plate 2.11.1 shows a typical drill rig.

Under pressure coal seam gas (CSG) is adsorbed on the surface of the coal in the seam and is released by lowering of the hydrostatic pressure in the well(s). Pumps will be used to dewater the wells, lowering the hydrostatic head and allowing the gas to escape. Wells can be drilled in a number of ways including vertically, horizontally, a combination of both, and with and without fracturing the coal seam.

The fracturing technique involves injecting, under pressure, a quantity of liquid and/or gas to fracture the coal seam, thereby enhancing gas extraction by allowing the gas to flow into the vertical well when the water is extracted. The exact quantity of liquid injected will vary according to each well, but will be of a quality similar to Associated Water. To date, QGC has drilled vertical wells to intersect the targeted coal seams. QGC will continue to trial the fracturing technique, known as “fraccing”, as an alternative means of gas extraction.

Water will be removed via a dewatering pump and inner tubing string with the gas being produced from the well through a surrounding annulus. The proposed dewatering method will use either a beam or hydraulic lift pump, driven by gas-powered surface units.

An indicative schedule of drill site activities for a single well and expected durations are given in *Table 2.11.2.* It may be possible to drill multiple wells from a single location.

Plate 2.11.1 Typical Drill Rig

Table 2.11.2 Indicative Drill Site Activity Schedule

Activity	Expected Duration
Site preparation, excavator, fencing, access tracks	up to two weeks
Pre-collar rig setup – drill and set conductor pipe (10 m)	one day
Drill surface hole to no less than 10% of predicted total depth	one day
Exploration wells : install drill rig, log test, set casing, drill and release Development well: install drill rig, set casing, drill and release	7 to 12 days five days
Total for development well (excluding site preparation) **Total for appraisal well (excluding site preparation)**	**~ seven days** **~ 9 to 14 Days**

Drilling will be carried out in stages. Each stage uses a different diameter drill with each stage reducing in diameter. A preliminary 10 m drill will be run and a conductor pipe installed. This will be followed by a smaller diameter drill of 100 m to 200 m in depth. Steel casing will then be installed in the hole and cement grout will be pumped in to fill the gap around the casing. A Blowout Preventer (BOP) will be installed at the surface and pressure-tested to verify the integrity of the casing cement. This will ensure there is no gas or water leakage around the casing.

Production well drilling will commence through the Walloon Sub Group to total depth. A casing string will then be run and cemented in place. Casing will be installed and cement-grouted, and horizontal drilling into the coal seam will then commence. *Volume 2, Chapter 7, Figure 2.7.2* shows a schematic of a typical well profile.

Water will be used for primary well control, transportation of cuttings and washing and conditioning of the well hole. This water will be sourced from treated Associated Water. The water will be delivered in tanker trucks or via the pipe-gathering network, with the delivered volume being in the order of 50,000 litres (50 m^3) per well.

The water will be stored on site either in water trucks, tanks or in constructed drill pits/sumps. Where drill pits are used they will be constructed with upslope drainage to divert stormwater run-off around the pit. The drill cuttings will be collected and stored on site either in lined drill pits or tanks integral to the drill rig.

Once the hole is completed by a workover rig, the production wellhead will be installed.

11.2.4 Site Clean-up and Rehabilitation

Depending upon the particular drill rigs available, drilling mud will be either contained within onsite pits or held within tanks on the rig. Where pits are used these will be dewatered and backfilled as soon as possible on completion of the drilling. Fine material will be settled and the excess water in the pit disposed of by irrigation to pasture where:

- the landholder agrees
- potassium chloride (KCl) concentration in the mud sump is less than 25,000 parts per million (ppm)
- other total dissolved solids (TDS) including sodium chloride (NaCl) is less than 2,000 ppm.

In other cases, the drilling fluid will be removed to a licensed waste disposal facility.

Only firm drill cuttings, with near neutral pH, and hardened cement slurry residue will remain in the drill pits, if used. The drill pits will be backfilled and any remaining cuttings covered with at least one metre of soil. Back-filled pits will be compacted into mounds to provide for future subsidence. A layer of topsoil will be spread across areas disturbed by pit excavation.

Final restoration of the area will occur once the well ceases production (refer to *Volume 2, Chapter 15*).

11.3 STAGE 2 – CONSTRUCTION

11.3.1 Assembly of Well Site Equipment

The assembly of well site equipment includes:

- the installation of the wellhead
- the drive unit
- separator and associated surface equipment such as wellhead pumps.

Wellheads and separators will be pre-fabricated by the supplier. Installation of a wellhead will consist of a Wood Group B-section with annular ball valves screwed onto the casing; and a Rod-Lock Composite and drive head for a pumping well; or an adaptor flange with a master valve for a free-flowing well. The separator will then be placed on the well lease and plumbed up between the wellhead and gathering system.

Facilities to be constructed for CSG production will be concurrent across QGC's lease areas and, as such, a number of discrete construction sites will operate across this area.

The following construction activities and sequence will be employed to establish new commercial production wells:

- establishment of temporary construction camp(s) (refer to *Section 11.6.4*) to accommodate construction teams and field support facilities
- installation of erosion and sediment controls, drainage works and other environmental controls as required
- installation of water transfer and gas-gathering lines and sumps
- development and construction of Associated Water evaporation ponds or water treatment facilities
- fracture stimulation of coal seam (where required)
- installation of the wellhead, separator, hardstand areas and other surface equipment (fenced), typically 1 ha reducing to approximately 5,000 m^2 once operational. Typical completed wells are depicted in *Volume 2, Chapter 7, Plates 2.7.1 and 2.7.2*
- connection of the wells to the infield gas-gathering system
- initial rehabilitation of areas disturbed during construction and drilling
- well commissioning, involving initial workover, dewatering and production testing to ascertain gas-flow quantities.

This EIS provides an overview of the environmental impacts of the Gas Field Component in *Volume 3*. The data will be used to develop a series of constraint maps that will be used to inform the well site-selection process over the life of the Project.

11.3.2 Gas-gathering Systems

The activities associated with the installation of the gas-gathering systems will vary depending upon the diameter of the pipe being installed. Small-diameter pipe (i.e. up to 110 mm) is supplied in coils and will be installed continuously while larger-diameter pipe is supplied in individual pipe lengths which will be welded together at site. Installation of small-diameter pipe will be typically carried out in a 10 m-wide corridor whilst larger-diameter pipe will require a construction corridor of 25 m[1]. This larger width ensures that there is enough space to lay out pipes for joining while providing space to store the excavated material, which increases with diameter. *Plate 2.11.2* shows a typical example of installation of a water- and gas-gathering system, using a trenching machine.

Plate 2.11.2 Typical Installation of Gathering Line

The following activities are involved in the construction of gas-gathering lines:

- The Right-of-Way (RoW) is cleared, including vegetation clearing, topsoil stripping and stockpiling.

1 These widths should be adequate for the installation of both the gas and water pipelines which are expected to be laid within the same construction RoW.

- Pipe is trenched by chain-type digger or small excavator direct to the ground. The trench width is only as wide as required. For the largest diameter pipe, this will be approximately 0.8 m wide and with a depth of up to 1.5 m.
- Pipe is laid. Small-diameter pipe is laid directly into the trench, whilst for larger-diameter pipe, pipe lengths of up to 20 m will be joined by fusion bonding (high density polyethylene – HDPE) or welding (steel). In general:
  - HDPE pipe will be used between wells and the field compression stations (FCS)
  - steel or fibreglass pipe between the FCSs and central processing plants (CPPs)
  - steel pipe between the CPP and Collection Header.
- Welds are cured. The pipe is left to cure to ensure the weld can reach maximum strength and will then be lowered into the trench. Pipe jointing will occur above ground as required. Each weld is registered and signed off by a trained poly (HDPE) welder. After 50 completed welds, sample welds are checked in a controlled laboratory environment on site to ensure a high standard of integrity in the gathering system. Both the welder's technique and the machine used by the welder are tested. All new welders and machines will be tested before they are allowed to work on the gathering system.
- Pressure and leak testing (hydrotesting using water or air pressure) is conducted.
- The trench is backfilled, which involves replacing all excavated material back in the trench over the pipe and wheel-rolling the trench line to ensure sufficient compaction. Topsoil is re-spread. The trench line is then hand-picked of any stones or debris and re-seeded to landholder requirements as appropriate.
- Given the soil has been disturbed, there will be regular communication with easement stakeholders and easement patrols will monitor any subsidence for repair.

The HDPE pipe will be laid at a depth of one metre, which is QGC's standard. The Australian Standard (AS NZS 2566.2-2002) only requires a depth of 750 mm.

During the process of laying the poly pipe, a trace wire is also laid into the ground. The trace wire allows detection of the pipe from the surface with a specialised instrument. Care is taken to lay the trace wire directly under the pipe so that it provides an accurate representation of the pipe's location.

Progressive construction of the gathering system will be undertaken by multiple crews of workers. It is expected that between 400 m to 2 km of pipeline will be laid per day in good conditions.

The gathering system route is selected in consultation with affected landholders and will use previously cleared or disturbed areas where possible.

Environmental constraints mapping, will be used to inform the gathering system route selection of areas of environmental, cultural or social significance, which will be avoided where possible.

Isolation valves may be required at strategic locations to enable the lines to be isolated in the event of an emergency. It is likely that water will collect at low points as the gas flows along the pipes. Thus, low-point water drains are likely to be required. Low-point water is a result of water vapour from entrained water in the gas collecting and pooling in low points. These drains will be pumped out periodically and the water transported by vehicle-mounted tank to the nearest Associated Water storage pond when water is above 2,000 ppm TDS.

It is also possible that gas may collect at high points in the water lines. When this affects the flow of water in the line, the gas will be vented direct to the atmosphere.

The gas-gathering system will be designed, constructed and operated in accordance with AS 3723-1989 *Installation and Maintenance of Plastic Pipe Systems for Gas* and AS 2885 *Pipelines – Gas and Liquid Petroleum*.

An estimated total of 6,000 wells will be required over the life of the Project to supply the LNG Facility. The EIS reference case has assessed these wells being supported by approximately 27 FCSs and nine CPPs. It is proposed to develop the Gas Field facilities in the stages set out in *Table 2.11.3*. The flow rate of gas from wells to FCSs will vary over the life of the Project. The rates required for delivery of 1,360 million standard cubic feet per day (mmscfd) to the LNG Facility necessitate the compression and processing facilities to be in place early in the Project life.

The number of CPPs should remain static from initial development throughout the life of the Project as their design capacity is sufficient to meet the LNG Facility requirements. FCS design will need to be flexible over the life of the Project. As gas from a development area depletes, replacement flows will be sourced from within subsequent development areas. Screw compressors will be relocated to minimise the capital outlay whilst maintaining delivery of gas to the CPPs. This sequencing of well development and field compression will be progressive over the life of the Project.

Table 2.11.3 Staging of Gas Field Development

Stage	Year	Cumulative Number of Wells	FCS	CPP
1	2010	600	2	2
2	2013	2,000	27	9
3	2020	4,300	27[2]	9
N[1]	2030	6,000	27[2]	9

1 Stages will be iterative from Stage 3 to Stage N.

2 Dependent on field performance

11.3.3 Field Compression Stations (FCS)

The following FCS specifications have been used as a reasonable representation of expected FCS design based on current field implementation. Each FCS will consist of banks of eight Ariel screw compressors. Each screw compressor will be powered by a CAT G3512 gas-fired reciprocating engine (or similar), capable of producing 705 bKw at 100 per cent load. Screw compressor units will be skid-mounted with the bulk of the construction work occurring off site.

The skids will be transported to site on semi-trailers. On-site installation will involve the connection of the compressors to an air cooler, the receiving and exporting pipelines and to the flare and water management system.

Plate 2.11.3 Installation of FCS components

Construction of each FCS requires the clearing and levelling of an area of approximately 5 ha with additional area required for laydown and assembly. Vegetation and topsoil will be removed and stockpiled separately for use in the final rehabilitation of the site.

Fabrication and installation of pipe work and equipment consists of:

- the lifting (on and off truck where applicable), transport, uncrating, assembly, and installation of all equipment
- installation of pipe supports on concrete footings with supports to include pipe clamps and saddles
- installation of all pipe work, flanges, blind flanges, spectacle blinds,

gaskets, plugs, fittings and other materials and consumables

- trenching for and coating of underground pipe work, backfilling and removal of surplus soil
- installation of magnesium anodes for cathodic protection (CP) of underground pipe work
- supply and installation of flares
- installation of all mechanical items
- levelling, shimming and grouting of all items being erected on concrete footings
- installation of instrument gas supply lines going to pneumatically-driven equipment, valves and instruments
- instrumentation and electrical installations.

11.3.4 Central Processing Plants (CPP)

Final design specifications for CPPs have not been completed at the time of compiling this EIS. The following specifications have been used as a reasonable representation of expected design based on current field implementation.

Each CPP will consist of banks of 10 compressors, consisting of a Caterpillar G3608TALE engine, Ariel JGD/4 reciprocating compressor and Air-X-Changer 132-F2 cooler (or similar).

Each reciprocating compressor powered by a gas-fired reciprocating engine, will be capable of producing 1,767 bKw at 100 per cent load. Each CPP will contain five tri-ethylene glycol (TEG) units. Reciprocating compressors and TEG unit components are pre-fabricated and transported to site as individual units. Only minor assembly occurs on site. *Plate 2.11.4* shows the installation of TEG units.

Construction of each CPP will require the clearing and levelling of an area of approximately 7 ha with additional area required for laydown and assembly. Vegetation and topsoil will be removed and stockpiled separately for use in the final rehabilitation of the site.

11.3.5 Flares and Vents

One flare will be constructed at each FCS and each CPP. The operation of flares is described in *Volume 2, Chapter 7*.

Plate 2.11.4 Installation of TEG unit at CPP

11.4 STAGE 3 – COMMISSIONING

Commissioning will involve the transfer of Project activities from construction personnel to operations personnel. This will involve planning, scheduling testing and inspection to demonstrate and document compliance with the engineering drawings and specifications. This will be achieved through a construction commissioning and handover plan. Commissioning will consider process, mechanical, electrical instrument and hydraulic systems.

Procedures will be developed for recording of the completion, checkout, testing, start-up, and initial operation activities for each system. A handover notice will be issued for the entire system prior to the handover to the operations personnel.

11.4.1 Ramp-up Gas

Due to the timing of well development, wells will be available to supply gas prior to gas being required by the LNG Facility. Between 2010 and 2013 as much as 450 petajoules (PJ) of ramp-up gas will be available for supply. For both economic and environmental reasons, QGC is considering strategies to manage ramp-up gas. These strategies include reinjection of gas to subsurface strata (i.e. underground reservoir), supply of gas to the domestic market and storage (linepacking) in existing pipelines or supply to gas fired power station(s).

11.5 ASSOCIATED WATER INFRASTRUCTURE

This section describes the activities involved in the construction of the preferred Associated Water management infrastructure. At the time of submission of this EIS, QGC had not committed to a final option for Associated Water management. The preferred infrastructure for management of Associated Water is described in *Volume 2, Chapter 7*.

All construction activities will be conducted in accordance with QGC construction and control procedures, Coordinator-General and EA conditions.

11.5.1 Pre-construction Activities

Pre-construction activities can be grouped into phases. Each of the phases is detailed below.

11.5.1.1 Phase 1

Site selection involves the assessment of local area constraints such as soil type and proximity to environmentally sensitive areas, sensitive receptors and watercourses. Once selected, a location must be approved by regulatory authorities before construction of infrastructure can proceed.

11.5.1.2 Phase 2

Phase 2 involves:

- making land access arrangements with the relevant parties
- surveying and marking the site
- a cultural and environmental assessment, where the site is assessed for protected species, matters of national ecological significance, and items and sites of cultural heritage significance.

11.5.1.3 Phase 3

Phase 3 involves pegging, clearing and grading. During clearing, machinery is brought in to remove vegetation from within the pegged area. Vegetation is piled at the perimeter of the site leaving clear access tracks. Once vegetation is removed a scraper is brought in to remove the topsoil. Topsoil is stockpiled for restoration purposes. A grader is used to create a level even surface prepared for sediment and erosion control.

11.5.2 Construction Activities

Construction activities will adhere to relevant Australian Standards and regulatory requirements. Project infrastructure construction will involve typical activities such as earthworks, hardstands, and safety, security and fibre-optics communication systems.

Equipment used during construction includes cranes, scrapers, front-end loaders, water trucks and back hoes.

Construction of the following water management infrastructure will occur:

- water-gathering pipelines
- treated and untreated water storage ponds
- desalination facilities
- brine processing and waste storage facilities
- quality assurance stations
- pumping stations
- roads
- beneficial use networks, including irrigation systems, pumps and pipeline networks.

11.5.2.1 *Water-gathering Pipelines*

Water will be transferred in a network of HDPE pipelines. The HDPE pipes will be installed in compliance with AS 2885 and QGC's construction procedures.

Table 2.11.4 details the approximate pipeline lengths required per region for water transfers.

Table 2.11.4 Pipeline Lengths for Associated Water Management

Development Area	Local Ponds to Untreated Water Storage and Treatment facilities (km)	Treatment Facilities to Treated Water Storage and Beneficial Use Network (km)	Total (km)
North West Development Area (NWDA)	25	60	85
Central Development Area (CDA)	105	30	135
South East Development Area (SEDA)	232	60	292
TOTAL	362	150	512

It is anticipated that water management for the Project will require the installation of approximately 500 km of 500 mm-diameter HDPE pipeline.

The locations of pipelines will be recorded with GPS as pipes are buried at least 1 m below the surface in accordance with AS 2885 and QGC's construction procedures. Construction procedures exist to cover trenching, positioning, welding, installation, testing, backfilling, placing surface markers as required and rehabilitation.

The following procedures are undertaken for the selection and installation of the water-gathering pipelines.

- Gathering-line pressures will be as low as practically possible for optimal well performance
- High-point vents and low-point drains will be included in the gathering system to assist in lowering pressures
- Engineering design of gathering systems will include isolation points and correct installation as per AS 2033-1980
- Changes occurring due to environmental or cultural heritage constraints will be communicated to engineering and production teams
- Quality assurance will be completed prior to handover to production
- As built drawings will be completed and distributed.

The conceptual design of the gathering system will identify well locations and determine the final destination of the gas and water. These specifications are detailed along with existing gathering systems, compressor stations and water storage facilities, and an initial design is completed by engineers. Initial design will consider satellite imagery, environmental and cultural heritage constraints and topography.

Modeling will use predicted flow rates of gas and water to determine the required line sizing. An initial field review will be conducted to verify whether engineering designs are appropriate for specific field conditions.

11.5.2.2 Water Storage Ponds

QGC has experience in the design, construction and operation of Associated Water storage ponds.

Design Principles

All ponds will be designed using the following criteria.

- At the start of the wet season (1 October) all pond water levels will be below the Mandatory Reporting Level (MRL). This level provides sufficient pond capacity to prevent the pond overtopping during a 1 in 100-year, 72-hour rainfall event.
- Ponds will have a Design Storage Allowance (DSA) to allow for a 1 in 100-year rainfall event.

In general, ponds less than 200 ML will include a seepage collection system beneath a HDPE geomembrane liner. Potential seepage will report to a seepage collection pond located adjacent to the pond.

Monitoring and control automation systems will be constructed for each pond to relay continuous information about water volumes.

The design of water storage facilities will be constrained by:

- landholder requirements
- cultural heritage requirements
- meteorological events, including allowance for increased storm intensity by predicted climate change data
- environmental compliance
- seismic loads
- wind allowances (wave action within the pond)
- humidity ranges
- temperature fluctuations
- site-specific hydrogeological data.

Construction

Associated Water ponds will be designed and constructed with a four-sided earthfill embankment from local soils that meet the required fill compaction specifications. Construction of the embankments will be in accordance with the construction and testing specification provided by design engineers, that meets EA conditions.

Ponds greater than 200 ML will be lined with clay to minimise seepage to groundwater. These ponds will be built using a clay embankment with a high-elasticity clay core. There are a number of different treatment options for the floor of large storage ponds however each result in the equivalent of two 150 mm layers of clay sealing on the pond floor. Construction or borrow material will be sourced from the pond footprint. Where suitable construction clay is not readily available HDPE liners will be installed. QGC invested in wide ranging studies and has extensive experience in the design and construction of ponds. QGC has previously gained Department of Environment and Resource Management (DERM) approval for this process. QGC is currently undertaking trials to investigate pond seepage minimisation in cooperation with the DERM at three test sites at one of its existing pond operations.

Ponds will have a spillway and outlet channel. Spillways will be sized according to pond requirements and rock-lined; and will flow into a grass-lined drain. A diversion channel (grass-lined) will divert run-on from upslope sides of the pond. Grassed diversion drains control external runoff around ponds. The Operating Water Level (OWL) and Mandatory Reporting Levels (MRL) will be clearly marked on pond walls adjacent to the spillway.

11.5.2.3 Desalination Facilities

Construction specifications have not been finalised and will depend largely on the selection of types of water treatment facilities. Facilities will have a minimum design life of 40 years.

Except for brine evaporation ponds, all other desalination treatment facilities would be constructed on a concreted hardstand area and located inside a building. The footprint of the hardstand area would be approximately 4 ha per facility with additional area for laydown and assembly. Water treatment components are likely to be delivered in modular units and assembled onsite.

11.5.2.4 Brine Processing and Waste Storage Facilities

Concentrated brine will be transferred to brine evaporation ponds to remove any remaining water. The solar evaporation process will require construction of multi-cell evaporation basins. These will be open-top earth ring dams which are double-lined with clay and HDPE to prevent seepage.

Because the evaporation basins are open, they will collect rainwater. The design of the basins will account for this by providing capacity within each cell for rainwater to be stored and evaporated over time.

Following evaporation, salt will remain in the evaporation ponds. If the salt cannot be sold, a suitable waste storage facility will be required for salt. If a landfill site for the purposes of salt storage is required, it will be selected on the basis of having all, or the majority of, the following characteristics:

- A deep natural groundwater table will minimise the risk of rising groundwater interfering with the integrity of the landfill sealing liner and the associated risk of salt leaching from the landfill into groundwater
- Suitable clay materials for sealing the landfill will be present onsite. These clays would ideally cover the landfill site to a depth at least 500 mm below the finished floor level
- The landfill will not be located on a surface watercourse or intersect a buried streambed
- Topography will be conducive to construction with minimum earthworks
- The site will have stable geology and landscape morphology
- The landfill will not be located on good quality agricultural land and will be accessible via all-weather roads
- The landfill will be located as close as possible to the water treatment facilities.

Subject to applicable approvals, the landfill will be constructed as a waste management facility and be engineered to applicable Australian and DERM standards.

Nominally, the design would consist of an excavation which would be sealed with a combination of double-layered liners. The landfill would be filled in segments. Once each segment is full, it would be capped with a double sealing system of similar impermeability to the excavation base.

The cell system of segmenting the landfill ensures that if a breach develops in any one of the cells, it will not compromise the integrity of the entire landfill. It also simplifies the process of identifying the location of the breach and simplifies the repairs.

QGC will install and maintain appropriate monitoring systems at the landfill site such as groundwater sampling bores. This information will provide early indications of any leak developing from the landfill site.

11.5.2.5 Pumping Stations

In general, pumping stations will be pre-fabricated off site before delivery and installation on site. Each pumping station will have a small footprint of approximately 25 m^2.

11.5.2.6 Roads

Road access tracks will be along established routes where possible. Where required, improvements will be made to access roads. Major roads will be sealed with bitumen or converted to all-weather access. At completion of operations local traffic users will be provided with the option to keep the road.

11.5.2.7 Beneficial Use Network

The construction requirements for the on-tenement beneficial use network will depend on the selection of the preferred beneficial use. Construction requirements for irrigation will include:

- water treatment facilities
- surface drip irrigation systems
- water balancing storages
- irrigation filtration systems
- soil and climate monitoring systems
- irrigation pump stations.

Supply of water to QGC petroleum activities and mining and industrial users will require the construction and operation of water pipelines.

Reinjection will require the construction of water transfer pipelines, water balancing ponds and deep wells. Investigation into reinjection is ongoing.

11.6 INFRASTRUCTURE REQUIREMENTS

11.6.1 Material and Equipment Requirements

Materials and equipment will be required for the development of the wells, associated surface equipment, installation of gas-gathering systems, gas compression and transportation infrastructure, and construction of Associated Water management infrastructure.

Table 2.11.5 details the major material requirements for construction activities and where these materials will be sourced from. It should be noted, that QGC has proposed to use local supplies where possible.

Table 2.11.5 Material Requirements

Material	Use	Volume	Source
Gravel/Soil/Fill	Hardstand areas – CPP and FCS	3.5 ha x 9 CPP + 2.5 ha x 27 FCS, at 0.15 m deep = 148,500 m^3.	Local quarries
Gravel/Soil/Fill	Hardstand areas – wells	6,000 wells x 50 m x 50 m x 0.15 m = 2,250,000 m^3	Local quarries
Road base	Road construction	2,000 km of road, 4 m wide, 0.15 m deep = 983,000 m^3	Local quarries
Sand	Infield gathering pipelines	3,500km x 0.2 m/km = 700,000 m^3	Local quarries
Cement/slurry	Well construction	10–16 m^3 per well x 6,000 wells = 60,000 m^3 to 96,000 m^3	Local manufacturer with sufficient capability
Clay	Lining for ponds	400 ha x 0.3 m depth = 1,200,000 m^3	Existing tenements
HDPE	Lining for ponds	100 ha = 1,000,000 m length	Local manufacturer with sufficient capability
Fencing	Maintenance/ replacement of rural fencing. Site infrastructure security	5% of 3,500 km gathering line = 175,000 m of fencing 1,000 m per FCS/CPP x 36 sites + 50 m per well x 6,000 wells = 336,000 m	Local manufacturer with sufficient capability
Water	Pond, well, road and hardstand construction		Treated Associated Water with < 2,000 TDS

11.6.2 Storage Requirements

Table 2.11.6 describes the types of plant, equipment, raw materials, product and wastes that will require storage during the construction phase and the arrangements for storage of these items.

Table 2.11.6 Storage Requirements

Items	Storage arrangements
Gravel/Soil/Fill	Localised storage as and when needed at construction sites
Road base	Localised storage as and when needed at construction sites
Sand	Localised storage as and when needed at construction sites
Cement/slurry	At warehouses or delivered to sites as per requirements
Clay	Localised storage as and when needed at construction sites. Clay is extracted from borrow pits within QGC tenures.
HDPE	Specially demarcated areas for the storage of HDPE pipe, with controls over

Items	Storage arrangements
	stack height and pipe movement
Plant	At warehouses or at the site of construction
Equipment	At warehouses, unless large enough to be stored at construction site
Raw materials	At warehouses

Due to the expansive nature of operations, there is limited opportunity for sharing of storage infrastructure with other proposed CSG extraction projects in the area.

11.6.3 Site Security

All Gas Field assets of QGC are subject to a full-security risk assessment conducted by suitably qualified professionals. This will be further reviewed by the BG Group global head of security and any recommendations will be implemented and audited as part of the Health, Safety, Security and Environment (HSSE) audit plan.

Access to Gas Field infrastructure will be via existing access roads and tracks, and use of access roads and tracks will be limited to authorised personnel.

11.6.4 Accommodation

Table 2.11.7 describes the approximate number of construction personnel during peak construction activities and proposed accommodation type.

Table 2.11.7 Construction personnel and accommodation type

Construction activity	Number of personnel	Nature of accommodation
Compressor construction for CPPs and FCSs	900	Temporary camps for about 250 to 300 people
Infield gas-gathering systems	350	Temporary camps for about 250 to- 300 people
Water treatment facilities	400	Temporary camps for about 250 to 300 people
Evaporation ponds	100	Temporary camps for about 250 to 300 people
Drilling and well establishment (wellhead and separator)	200	Highly mobile camps for about 25 people, shifting monthly
Supervision, administration and support[1]	150	Permanent camps for about 100 to 150 people
Total	**2,100**	

1 Includes staff to operate camps, offices and warehouses

There will be approximately 2,100 construction personnel of whom 350 will be involved in drilling and well establishment, supervision, administration and support. Approximately 1,750 construction personnel will be housed in temporary camps of approximately 250 to 300 personnel at six to seven locations between Woleebee Creek and Tara.

Drill rig and well establishment crews will be accommodated in mobile camps, catering for approximately 25 personnel, at the site of the well, for the duration of drilling and well establishment (about six to seven days). During peak drilling and well establishment, approximately 450 wells will be established per year. Thus, approximately seven to eight crews of 25 people (175 to 200 people) will operate simultaneously.

Supervision, administration and support staff will be accommodated in permanent, centrally located camps. These camps are described in *Volume 2, Chapter 7.*

Each temporary construction camp site will occupy around 7 ha of land and facilities will be air-conditioned, demountable-style units, including:

- 65 accommodation buildings (sleeves) housing four ensuite rooms per building, where one sleeve is approximately 14 m x 3 m
- ensuites with a toilet and shower with hand basins provided in each room
- rooms equipped with a bed, wardrobe, table and small fridge
- a messing unit with at least four sleeves for the kitchen and four sleeves for refrigeration and five sleeves for the dining room and a wet mess with recreation lounge
- a gym with four sleeves
- two central ablution blocks, with one sleeve per ablution block to be located around the camp for use by camp occupants
- four laundries with a minimum of six to eight washers and driers in each
- equipped recreational room with about three sleeves
- offices
- training/meeting room
- first aid room.

Approximately 12 to 14 people (catering, cleaning and management) will be required to operate each camp.

All food preparation and storage will be undertaken by a licensed contractor and meet all applicable health and safety standards.

Plate 2.11.5 View of Typical Camp Messing Units

Gas Field Component construction will occur across nine groups of tenements, with between one and two camps per group of tenements. Construction camps will be moved between these groups of tenements as required over the period of construction. It is likely that the camp will only be required once in each location during the construction activities.

The majority of accommodation will be single units as the workforce will operate on a 21-days-on-7-days-off basis. A fly-in, fly-out service between Brisbane and the Gas Fields Component area is currently under investigation for staff based outside of the local area.

Campsite power is likely to be supplied through gas-powered generators at major construction camps and diesel-powered generators at drilling camps.

Water for the camps, including potable water may be supplied from shallow aquifer bores and potentially treated Associated Water.

Disposal of camp waste, including solid and liquid wastes is described in *Section 11.6.9* and addressed in detail in *Volume 3, Chapter 16.* Pest control around the campsite will be conducted at least once every three months.

Fire safety audits will be conducted at least once every six months. Fire safety training would be conducted among staff, and a 15 m to 20 m-wide fire break will be maintained around each camp site.

Dust and noise will be controlled by constructing bitumen driveways and parking areas around the camp. Fencing and gardens around the camp will assist with dust control. Camps will be located in areas that do not experience night-time noise levels in excess of that recommended by the DERM (i.e. background +3 A-weighted decibels (dBa)). Camps will be located in consultation with relevant stakeholders.

11.6.5 Transport Requirements and Infrastructure

11.6.5.1 Transport requirements

A preliminary transport and logistics study has been carried out for Gas Field construction activities. The findings from this study are presented in *Volume 3, Chapter 14*. Traffic is expected from the transportation of:

- construction personnel, work-based and non-work based, trips
- drilling machinery
- well site equipment
- interconnecting pipes for gathering lines
- bore casings and wellhead equipment
- screw and reciprocating compressors
- TEG units
- campsite components (modular buildings)
- heavy plant for construction e.g. bulldozers, drill rigs, graders, trucks, scrapers, trenchers, rock cutters, excavators, loaders, side boom tractors, cranes, forklifts, generators, welders, compressors, wheel ditching machines and water trucks.

Table 2.11.8 describes the transport requirements for the Gas Field.

Table 2.11.8 Transport Requirements

Transported Item[1]	Vehicle Requirements	Approximate Vehicle movements
Personnel – work-based and non work-based	Predominantly 4WD vehicles; 690 trips per day per camp	1.6 million to 2.3 million vehicle movements per annum
Drilling machinery, bore casings, wellhead equipment and separators	6,000 wells at about four trucks per well	25,000 truck movements over the life of the Project
Gathering pipes (gas and water)	4,400 km of pipe	10,100 truck movements over the life of the Project
Each reciprocating compressor, comprising one compressor, one cooler and one 12 m container	One truck is required for each unit (thus three trucks in total per reciprocating compressor).	648 semi-trailer movements over the construction period
Each screw compressors, comprising one compressor, one cooler and one 12 m container	One truck is required for each unit (thus three trucks in total per screw compressor).	270 low-loader movements over the construction period
Each TEG unit	Three trucks per TEG unit	135 semi-trailer movements over the

Transported Item[1]	Vehicle Requirements	Approximate Vehicle movements construction period
Campsite components	257 trucks per camp	1,285 truck movements over the construction period
Heavy equipment	Semi-trailer or independent transported to, and remaining on site	84 vehicle movements over the construction period
Other – general supplies	One truck per day	365 truck movements per annum
Quarry materials	823,000 tonnes using 28 tonne trucks	294,000 truck movements over the life of the Project

1 Excluding water management infrastructure

11.6.5.2 *Transport routes*

The impact on the state-controlled and local government-controlled road networks for the duration of construction and operation of the Gas Field has been assessed in accordance with the Queensland Department of Transport and Main Roads (DTMR) "Guidelines for Assessment of Impact of Development Proposals". Affected routes are described in *Volume 3, Chapter 14*.

A traffic management plan will be implemented for the Gas Field Component infrastructure construction works. This plan will ensure an interface with the local authorities and law enforcement agencies in each relevant jurisdiction to ensure road user safety.

The nominated haulage regime used for the analysis was for all materials and equipment to be sourced from Brisbane, excluding quarry materials and hauled by road throughout the Gas Field Component. Compressors and other major facilities materials will most likely arrive in the Port of Brisbane from overseas suppliers for transportation to site by road. Any interstate material will be handled in a similar nature.

Access to the Gas Field Component is via existing roads and tracks wherever practicable. Access within the Gas Field Component area will be via existing internal property tracks, or on new tracks to be developed by QGC in accordance with individual landholder agreements. Actual access routes will not be determined until the final well sites have been chosen.

It is anticipated that approximately 2,000 km of new access tracks will need to be constructed over the life of the Project. Approximately 70 per cent of these access tracks will require some form of weather-proofing. Access tracks will be lightly formed and gravelled to a standard sufficient to allow for all field activities (i.e. typically 4 m wide x 150 mm thick) using graders.

The location of access tracks and upgrading of existing tracks will be completed in consultation with the relevant landholders, and/or councils, with a view to minimising impacts to agricultural land and remnant vegetation. As a result, these access tracks may potentially provide a beneficial use for the landholder by allowing additional access to and on the property. Where practicable, any new access tracks will be sited to avoid the need for clearing of large trees and remnant native vegetation.

11.6.6 Electricity/Energy

The energy demand for construction activities is significantly less than that required for operations. This is because the majority of energy (greater than 90 per cent) is consumed through the operation of compressors and water management infrastructure.

Gas-powered generators similar to those described in *Volume 2, Chapter 7* will supply energy required during construction, primarily for construction camps and for mobile and static construction equipment. Demand will be met by portable gas-powered generators. In addition, adequate diesel-powered backup generators will be in place to support critical activities and electronic equipment. Potential energy conservation measures are described in *Volume 7, Chapter 4.*

11.6.7 Water Supply and Management

The construction of the Gas Field Component, including temporary construction camps, will require a total volume of approximately 673,000 m^3 of water per year. QGC will endeavour to use Associated Water for all construction activities. This water will, where necessary, be treated to appropriate standard for the use. QGC is currently seeking approval to use water with TDS of less than 4000 mg/L for civil construction activities. Where Associated Water is not available due to the timing or location of construction activities relative to Associated Water production, shallow aquifers will be used for the short-term water requirements, until Associated Water use is possible. The impacts on groundwater will be monitored and QGC will consult with adjacent landholders throughout the usage period.

Camps will consume and treat approximately 200 L of water per person per day. Management of liquid waste streams is described in *Section 11.6.9*.

Table 2.11.9 summarises the water quantity and quality requirements, as well as the source of supply, treatment and storage requirements.

11.6.8 Stormwater

Stormwater generated from hardstand and other infrastructure areas around the site will be controlled to prevent contamination. However, it is not feasible to control all stormwater across the entire Gas Field, an area of 468,000 ha. Hardstand areas include compressor stations, wellheads, water treatment facilities and administration and accommodation areas. Other infrastructure includes ponds and RoW clearings.

In general, hardstand areas will be protected from stormwater runoff through the use of sediment control fencing. This fencing is used to detain water along natural drainage paths and to allow a period of settlement prior to water entering the natural drainage system.

11.6.8.1 Well sites

During construction, stormwater flow from undisturbed areas on the site will be directed around construction areas. This is expected to be insignificant because the site is generally flat terrain. Measures will be implemented to ensure that stormwater is not concentrated and that it is directed to stable areas. The route of the gas- and water-gathering systems will be managed in accordance with standard pipeline management techniques as set out in the "Australian Pipeline Industry Code of Environmental Practice". This will include ensuring that there are appropriate breaks to avoid concentration of flow.

11.6.8.2 Right-of-Way (RoW) and Pipelines

Stormwater management on the RoW and for pipeline construction will be managed via erosion and sediment control procedures as detailed in *Volume 9.*

11.6.8.3 Hardstand Areas

Hardstand areas include well lease areas, compressors, water treatment facilities camp and administration construction areas.

The stormwater system for the compression facilities will be designed to ensure that clean stormwater is kept separate from potentially contaminated stormwater runoff. A bund will divert overland flow from adjacent areas around the site. Clean stormwater on the site will be captured and directed to areas that will allow any sediment to settle out prior to release to natural waterways.

Areas that may be contaminated such as where engines, transformers, oil and chemicals are stored will be bunded and drains will be directed to an oily-water separator. Where practical, the bunded areas for chemical storage will be covered to minimise rainwater ingress.

Table 2.11.9 Indicative Water Requirements for the Gas Field during Construction

Activities, processes and facilities requiring water	Water quantity requirement (m^3)	Water quality requirement	Preferred source of water	Additional treatment requirements	Onsite water storage facilities (type and volume)
Construction Phase					
Drill rigs including slurry and concreting	Mean daily: 50 kL/well Annual total: 17,500	TDS < 2000	Associated Water	Treatment by RO[3] or other methods	Ponds
Dust control	Mean daily: 1,000 kL/day Annual total: 365,000	TDS < 4000	Associated Water	Treatment by RO or other methods	Ponds
Gathering lines drilling and pressure testing	Mean daily: 137 kL/day Annual total: 50,000	TDS < 2000	Associated Water	Treatment by RO or other methods	Ponds
Road construction[1]	Annual total: 16,000	TDS < 4000	Associated Water	Treatment by RO or other methods	Ponds
Well lease area and infrastructure hardstand areas[1]	Annual total: 13,300	TDS < 4000	Associated Water	Treatment by RO or other methods	Ponds
Pond construction[2]	Annual total: 33,000	TDS < 4000	Associated Water	Treatment by RO or other methods	Ponds
Washdown	Mean daily: 50 kL/day Annual total: 18,250	TDS < 2000			
Temporary construction camps	Mean daily: 0.2 kL/person/day Annual total: 160,000	Australia New Zealand Environment and Conservation Council (ANZECC) water guidelines for potable water	Groundwater Associated Water	Treatment by RO or other methods	Ponds
Fire-fighting and other emergency services	Annual total: as required	TDS < 2000	Associated Water	Treatment by RO or other methods	Ponds
Construction Phase Total	*Annual total: 469,800*				

1 Based on 0.5% of total volume of material required

2 Based on 0.5% of embankment volumes

3 Reverse Osmosis

11.6.8.4 Ponds

Pond stormwater management is built into the pond engineering design. Specifications of this pond design are detailed in *Volume 3, Chapter 9.*

11.6.9 Solid and Liquid Waste Management

A discussion of waste generated during both construction and operation is outlined in *Volume 2, Chapter 7* and described in detail in *Volume 3, Chapters 11* and *16.*

Construction of facilities will be planned so as to minimise the amount of vegetation clearing required. Waste vegetation will be mulched at the construction site where possible, and used to assist in site restoration and soil stabilisation. Alternatively, fallen timber may remain in the area as a habitat refuge for fauna.

During clear and grade activities at a construction site, the topsoil will be stripped and stored for restoration or decommissioning. If used for decommissioning, the topsoil stockpiles will be stabilised for longer-term storage.

During construction, portable bunding for chemical, fuel and waste storage units will be implemented to prevent site contamination. Regulated waste will be removed off site by a licensed waste transporter to a centrally located onsite waste transfer station or an appropriately licensed facility (as per *Volume 3, Chapter 16).*

Personnel required during the construction period will result in a maximum of approximately 750 kL per day of treated sewage effluent being generated. For the most part, this will be treated at the Gas Field Component in a similar method to that described in *Volume 2, Chapter 7*.

Domestic wastes generated by the construction workforce will be disposed of at existing council facilities.

11.6.10 Noise Emissions

As construction activities will be dispersed over a large area (468,000 ha) and for a limited duration, noise emissions during construction will be not be significant. Noise emissions and mitigation measures are described in detail and assessed in *Volume 3, Chapter 13.*

11.6.11 Air Emissions

The majority of air emissions will come from the commissioning of reciprocating and screw compressors. Emissions from operation of compressors are described in *Volume 2, Chapter 7* and *Volume 3, Chapter 12.* As construction activities will be dispersed over a large area (468,000 ha) and for a limited duration, air emissions during construction will be not be significant.