1 Introduction

1.1 Context

This Technical Appendix considers the potential impacts on groundwater resources and groundwater quality associated with the Proposed Development at Springs Road, Misson, Nottinghamshire. It does not consider the potential impacts on hydrology or flood risk and these are considered within Technical Appendix G, Hydrology and Flood Risk.

Please note, this Technical Appendix must be read in conjunction with the planning application which contains:

- Figures showing the development (Volume 1);
- a detailed description of the Proposed Development in the Environmental Statement (ES) (Volume 3) ;
- a summary of other assessments undertaken in relation to the Proposed Development which may be relevant contained in the Environmental Statement (Volume 3).

A full description of the Proposed Development is given in Chapter 4 of the ES in Volume 3

1.2 Scoping and Consultation

The EIA scoping and consultation process that has been undertaken for the Proposed Development is documented in Chapter 2 and Appendix A to the ES This assessment considers nearby SSSIs, source protection zones, aquifer designation, groundwater conditions and identifies proposed baseline monitoring.

2 Legislative and Policy Context

2.1 Legislative Background

2.1.1 European Legislation

Groundwater is defined in European legislation as *'all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil'* and the European Groundwater Daughter Directive (GWDD) 169 describes groundwater as: *'a valuable natural resource and as such it should be protected from deterioration and chemical pollution. This is particularly important for groundwater dependent ecosystems and for the use of groundwater in water supply for human consumption'*.

The Water Framework Directive (2000/60/EC) and the Groundwater Daughter Directive (2006/118/EC). The GWDD, implemented in England and Wales by the Environmental Permitting (England & Wales) Regulations 2010 (EPR), requires that the entry of 'hazardous substances' into groundwater should be prevented and the entry of 'non-hazardous pollutants' should be limited to prevent pollution or significant or sustained upward trends in pollutant concentrations in groundwater. 'Hazardous substance' and 'non-hazardous pollutant' are defined in the Water Framework Directive and Groundwater Daughter Directive and discussed further in the document Environmental Permitting Guidance: Groundwater Activities.

2.1.2 Environmental Permitting Regulations

Under the Environmental Permitting (England and Wales) Regulations 2010 (as amended) a range of activities proposed at the Site may require permitting including the following 'activities' defined by the regulations: groundwater activity, mining waste activity, radioactive substances activity, industrial emissions activity. The Water Resources Act 1991 requires operators to notify the EA of their intention to drill a well, such that the EA can review the proposals to ensure that they will be protective of water resources.

2.1.3 Environment Agency

The EA document *Groundwater Protection: Principles and Practice* (2013) includes a Position Statement (C6) on unconventional gas and confirms the regulator's approach to groundwater protection, as follows:

We wish to facilitate development of sustainable sources of energy, working in partnerships on initiatives where appropriate. However, we will object to UCG, CBM or shale gas extraction infrastructure or activity within Source Protection Zone 1 (SPZ1). Outside SPZ1, we will also object when the activity would have an unacceptable effect on groundwater. Where development does proceed, we expect BAT to protect groundwater to be applied where any associated drilling or operation of the boreholes/shafts passes through a groundwater resource. Elsewhere, established good practice should be followed. Groundwater that is currently used as a resource or provides flow to surface waters and wetlands, or may be used as a resource in the future must be afforded a high degree of protection. A high level of protection will also extend to some deep formations that contain groundwater that would be suitable for use following treatment if necessary, or that may be used for artificial storage and recovery. For other formations groundwater must also be protected but we would not seek to apply the same degree of protection.

2.2 National Planning Policy

2.2.1 National Planning Policy Framework

The National Planning Policy Framework (NPPF) (Department for Communities and Local Government (DCLG), 2012a) came into force on 27th March 2012 and outlines the government's economic, environmental and social planning policies for England.

Paragraph 143, requires that In preparing Local Plans, local planning authorities should set out environmental criteria, in line with the policies in the Framework, against which planning applications will be assessed so as to ensure that emitted operations do not have unacceptable adverse impacts on the natural and historic environment or human health, including from […] impacts on the flow and quantity of surface and groundwater and migration of contamination from the site.

2.3 Local Policy

2.3.1 Nottinghamshire County Council Minerals Local Plan Consultation Preferred Approach

The County Council is preparing a new Minerals Local Plan to provide the planning policy blueprint against which all proposals for new minerals development will be assessed. The current Minerals Local Plan was adopted in December 2005 and is now due for replacement. The Nottinghamshire Minerals Local Plan Submission Draft consultation document is currently being prepared and public consultation on this document is expected to take place in late summer/autumn 2015. Based on this consultation document relevant policies that may affect the site following adoption of the Plan include:

Policy SP6: The Built and Natural Environment – All mineral development proposals will be required to deliver a high standard of environmental protection and enhancement and ensure that new development does not adversely impact on the following unless it can be demonstrated that there is an overriding need for a development and any impacts can be fully mitigated and/or compensated for j) water quality.

Policy DM2: Water Resources and Flood Risk:

- Water Resources – proposals for minerals development will be supported where it can be demonstrated that:
  - surface water flows at or in the vicinity of the site are not detrimentally altered;
  - groundwater quality and levels, where critical, are not altered; and
  - there are no risks of polluting ground or surface waters.

2.3.2 Nottinghamshire County Council Nottinghamshire Minerals Local Plan

The Adopted Minerals Local Plan sets out the County Council's approach towards future mineral extraction in Nottinghamshire. It replaces the previous Minerals Local Plan adopted in 1997. The Minerals Local Plan was adopted in 2005 and extends to 2014. Policies outlined in this Plan will continue to be used until the New Local Minerals Plan (as detailed above) is adopted by the County Council.

Relevant policies include:

Policy M3.1: Information in Support of Planning Applications – Planning permission for minerals development will not be granted unless sufficient information is provided to enable a balanced assessment of all relevant factors. Such information should include as appropriate details of (h) surface drainage and hydrogeology.

Policy M3.8: Water Environment – Planning permission for minerals development will only be granted where (a) surface water flows are not detrimentally altered, (b) groundwater levels, where critical, are not affected; and (c) there are no risks of polluting ground or surface waters. Unless engineering measures and/or operational management systems can adequately mitigate such risks.

Policy M5.1: Mineral Exploration – Proposals for mineral exploration will be permitted, subject to satisfactory environmental, amenity and reclamation safeguards.

3 Assessment Methodology

3.1 Introduction

The assessment methodology identifies the potential sources of impact as well as the receptors that could potentially be affected. In addition, there needs to be a clear mechanism via which the source can have an effect on the receptor.

The identification of potential receptors has been undertaken through a study of baseline data. The sources and potential mechanisms for impact are identified through a review of the details of the Proposed Development, including the size and nature of the development, potential construction methodologies and timescales. This is undertaken in the context of local conditions that are relevant to groundwater and within a 5 km radius of the Proposed Development.

Once receptor sensitivities and potential impacts are identified, it is necessary to determine the effect on the receptor, so that potential mitigation measures can be identified to counteract any significant adverse effects. An assessment of the significance of each effect has been undertaken based on the methodology provided in the Web-based Transport Analysis Guidance; specifically the *Water Environment Sub-Objective WebTAG Unit 3.3.11*.

3.2 Receptor Sensitivity

The sensitivity of each receptor is based on its considered value (see Table 3.1).

Table 3.1: Sensitivity of Resources / Receptors

Sensitivity	Criteria	Examples
High	A groundwater or groundwater dependent receptor with an importance and rarity at an international level with limited potential for substitution.	• Principal aquifer providing potable water to a large population • A groundwater resource making up a vital component of a protected Special Area of Conservation (SAC) or Special Protection Area (SPA) under the EC Habitats Directive
Medium	A groundwater or groundwater dependent receptor with a high quality and rarity at a national or regional level and limited potential for substitution.	• Principal aquifer providing potable water to a small population • A groundwater resource designated or directly linked to a Site of Special Scientific Interest (SSSI).
Low	A groundwater or groundwater dependent receptor with a high quality and rarity at a local scale; or groundwater resource with a medium quality and rarity at a regional or national scale.	• Secondary A aquifer providing potable water to a small population or water for agricultural and industrial use • A groundwater dependent watercourse or water body used for national sporting events such as regattas or sailing events
Very Low	A groundwater or groundwater dependent receptor with a low quality and rarity at a local scale.	• A Secondary B aquifer that does not provide significant water supplies • A groundwater dependent non ‘main’ river or stream, or water body without significant ecological habitat

3.3 Magnitude of Impact

The magnitude of a potential impact is established based on the likely degree of impact relative to the character and extent of the Proposed Development (Table 3.2). The derivation of magnitude is carried out independently of the sensitivity of the receptor.

Table 3.2 Magnitude of Impacts

Magnitude of Impact	Criteria	Examples
High	Impact results in a shift in a groundwater or groundwater dependent receptor's potential attributes.	• Pollution of potable source of abstraction
Medium	Results in impact on integrity of attribute or loss of part of attribute.	• Reduction / increase in the economic value of the feature
Low	Results in minor impact on a groundwater or groundwater dependent receptor's water body's attribute.	• Measurable changes in attribute, but of limited size and / or proportion
Very Low	Results in an impact on attribute but of insignificant magnitude to affect the use / integrity.	• Physical impact, but no significant reduction / increase in quality, productivity or biodiversity • No significant impact on the economic value of the feature

3.4 Assessment of Effects

Once the magnitude of an impact is derived, the potential effect can be categorised by combining the assessments of both the sensitivity of the receptor and the magnitude of the impact in a simple matrix (see Table 3.3). As a general rule, major and moderate effects are considered to be significant (requiring mitigation), whilst minor and negligible effects are considered to be not significant. However, professional judgement can also be applied, including taking account of whether the effect is permanent or temporary, its duration/frequency and / or its likelihood.

Table 3.3: Classification of Effects

Sensitivity of Receptor	Magnitude of Impact			
	High	Medium	Low	Very Low
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Negligible	Negligible
Very Low	Minor	Negligible	Negligible	Negligible

4 Baseline Conditions

4.1 Information Sources

The following key data sources have been used to inform the groundwater assessment:

- Envirocheck Report
- British Geological Survey, 1969. Doncaster. England and Wales Sheet 88. Drift edition. 1:63,360.
- Gaunt, G.D, 1994. Goole, Doncaster and the Isle of Axholme. Memoir of the BGS, Sheet E79 & E88
- BGS GeoIndex borehole records published at http:www.bgs.ac.uk/geolindex
- AECOM, May 2015. Environmental Site Investigation – Springs Road, Misson.
- British Geological Survey, 1981. Hydrogeological map of the Northern East Midlands. 1:100,000.
- Environment Agency, April 2015. Groundwater level monitoring data provided by the Environment Agency for the study area.
- Environment Agency and Defra, December 2009. River Basin Management Plan. Humber River Basin District.
- BGS & EA 3-D hydrogeological characterisation of the superficial deposits between Doncaster and Retford[1]

A summary of the baseline conditions is described below.

4.2 Topography and Drainage

The topography at the location of the Proposed Development is around 2.50 – 2.75 m AOD with some localised areas of higher ground to the north west of the former missile pad layout. To the east of the Site the land slopes gently eastwards to Misson Training Area Site of Special Scientific Interest (SSSI) at 1 m AOD. Drainage is towards this woodland area via a series of artificial field bounding drains that are believed to discharge to Warping Drain or to North Carr Drain, both of which eventually discharge to the River Idle. The topography rises gently to the west of the Proposed Development, reaching 5 to 6 m AOD at Spring Hill Farm about 800 m away.

There are several small ponds in the vicinity of the Proposed Development. Their rectangular shapes indicate that these are manmade structures and are likely to be sandpits given the history of sand and gravel extractions in the area.

4.3 Current Land Use

The Site is located within the northern part of a 60 acre commercial premises for a business that specialises in the sale of ex-army trucks, vehicles, plant and equipment. Infrastructure associated with this business includes hardstanding, existing accesses to Springs Road, on-site workshops and storage buildings. Some of the vehicles are on hardstanding, with others parked directly upon the soil surface.

Much of the surrounding area is used for agriculture. However there are small areas of woodland along field boundaries and Misson Training Area SSSI, around 125 m to the east of the Proposed Development, comprises a more extensive area of woodland.

4.4 Artificial Ground

An environmental site investigation was undertaken by AECOM in May 2015 (see Technical Appendix H) and comprised a set of trial pits. This indicated the presence of made ground (artificial ground) at some locations within the Proposed Development. However no made ground was recorded in trial pits E1, E3, E4, E8 and E9.

[1] PRICE, S.J, BANKS, V, COOPER, A.H, WILDMAN, G, KESSLER, H, BURKE, H.F, TERRINGTON, R, BRIDGE, D & SHEPLEY, M. 2006. 3-D hydrogeological characterisation of the superficial deposits between Doncaster and Retford. *British Geological Survey Internal Report*, CR/06/027. 30pp.

In trial pit REA-1 the made ground comprised clayey, sandy, gravelly cobbles of dolomite to 0.3 m depth; in trial pits E5, E6 and E7 comprised similar lithology but to a greater depth of 0.5 m. In trial pit E2 the made ground comprised ashy, gravelly sand to 0.6 m depth.

4.5 Superficial geology

The BGS 1:63,360 scale mapping indicates that superficial deposits are extensive over the low-lying land in the wider study area. However at much of the site of the Proposed Development the mapping suggests there are no superficial deposits present and that the bedrock is exposed. This is consistent with the BGS 1:10,000 scale mapping within the Envirocheck Report (see Technical Appendix H).

Trial pit logs from the environmental site investigation undertaken by AECOM in May 2015 (see Technical Appendix H) may suggest the presence of superficial deposits in some parts of the Proposed Development with a thickness of up to around 2 m. The logs indicate a mixture of lithologies with a dominance of either sand or clay depending on the location. However it is possible these also represent weathered Mercia Mudstone.

To the north, west and southwest of the Proposed Development (including the land around Misson village) there are River Terrace Deposits comprising sand and gravel and outcrops of the Hemingbrough Glaciolacustrine Formation which comprises laminated clays, silts and sands. The fields to the west of Springs Road were investigated to explore sand and gravel deposits in 1955. These borehole records show 0.6 m of topsoil overlying around three metres of superficial deposits containing clay, marl, gravel or sand. A deeper coal exploration borehole[2] drilled in 1980 at a location just to the south of the Proposed Development recorded approximately 14 m thickness of superficial deposits, of which 1 m is brown and grey clay and the remainder brown and grey sand.

Peat is the youngest of the superficial deposits formed during the post-glacial period (Flandrian) and is found extensively in the area to the east of the Proposed Development and overlies the River Terrace Deposits and / or Hemingbrough Glaciolacustrine Formation deposits. It is usually not more than a few metres thick, although it reaches over 4 m thick along the River Idle east of Misson.

Alluvium is a post-glacial flood plain deposit comprising mainly fine-grained silt and clay laid down during flooding events. Alluvium is mapped in small localised areas to the south of the Proposed Development, although in the wider area these deposits form ribbons along surface water courses.

4.6 Bedrock Geology

The BGS 1:63,360 scale mapping shows that the Proposed Development is located on the western edge of the Triassic Mercia Mudstone Group outcrop. The western edge of the outcrop is marked on the geological map as being 500m west of the Proposed Development below superficial deposits. The trail pit logs from the May 2015 environmental site investigation record the presence of Mercia Mudstone (see Technical Appendix H). Mercia Mudstone was not identified in the coal exploration borehole to the south of the Proposed Development, although it is possible that part of the recorded 'Drift' (superficial deposits) represents weathered Mercia Mudstone. The full sequence of the Sherwood Sandstone Group will be encountered beneath the Proposed Development, followed by Permian and then Carboniferous strata.

The Mercia Mudstone Group strata are described as red silty mudstones with thin beds of fine-grained sandstone and siltstone and of gypsum. Only the lowest part of the Group is likely to be present at the Proposed Development. The underlying Sherwood Sandstone Group comprises reddish brown, evenly bedded, poorly cemented, locally pebbly sandstone with thin beds and lenses of dark red mudstone and siltstone. It can be divided into Nottingham Castle Sandstone Formation and the underlying Lenton Sandstone Formation. The Nottingham Castle Sandstone Formation consists of poorly cemented, medium coarse-grained sandstones containing abundant well-rounded pebbles. The sandstones are locally calcareous or pyritic, and iron staining is common. The Lenton Sandstone Formation comprises up to 45 m of fine to medium-grained, silty sandstones, with thin beds and lenses of mudstone and siltstone and occasional breccias. The lowest beds form a transitional sequence with the underlying Roxby Formation of the Zechstein Group, which comprises shale rich mudstones and siltstone with thin beds of fine-grained sandstone and seams of gypsum, anhydrite and halite.

The exploratory wells will penetrate older Carboniferous strata including the Pennine Coal Measures, Millstone Grit and the Craven Group of the Gainsborough Trough basin, but these are not considered to contain potable groundwater and they are not described in detail here. The geological sequence of strata is shown in Table 4.1, summarised from a borehole drilled just to the south of the Proposed Development in 1980.

[2] BGS reference SK79NW30 at 470410m east, 397369m north

Table 4.1: Bedrock geology according to borehole log SK79 NW/30

Classification	Depth3 (m)	Thickness (m)	Details
Superficial deposits (in part, this may represent weathered Mercia Mudstone)	17.0	17.0	peaty soil, brown and grey sand with some clay
Sherwood Sandstone (Nottingham Castle Sandstone and Lenton Sandstone Formations)	303.8	286.8	red sandstone with red marl bands
Upper Permian Marl (Roxby Formation)	337.8	34.0	Red marl with anhydrite layers
Upper Magnesian Limestone (Brotherton Formation)	354.0	16.2	Light grey-brown limestone
Middle Permian Marl (Edlington Formation)	396.8	42.8	Red and grey marl with gypsum
Lower Magnesian Limestone (Cadeby Formation)	475.6	78.8	Light grey-brown limestone
Lower Permian Marl (Cadeby Formation)	477.6	2.0	Mudstone
Basal Permian Breccia (Cadeby Formation)	478.3	0.7	Sandstone
Pennine Coal Measures	1139.1	660.8	Coal, sandstones, siltstones, mudstones, ironstones

4.7 Structural geology

A west to east geological section is shown on BGS map 88 and it runs approximately 2 km to the north of the Proposed Development. As described above, Carboniferous strata are present at depth beneath the Proposed Development and the wider area, and the section indicates that they dip gently to the west in this locality.

The younger Permian and Triassic strata lie unconformably on the Carboniferous strata and dip gently to the east with a gradient of about 1 in 40 (1.4° dip). The structural contours on the base of the Triassic Sherwood Sandstone Group illustrated on the regional hydrogeological map indicate there are no broad scale fold structures present and only slight changes in the direction of dip from due east.

Faulting affects the Carboniferous, Permian and Triassic strata, although the superficial deposits mask the fault positions and so they are mapped in most detail where the superficial deposits are absent or there are coal mines. There are no surface fault traces marked within 5 km of the Proposed Development. The nearest documented surface fault trace lies 6.5 km to the south and is aligned west-east and downthrows the Sherwood Sandstone Group approximately 10m to the north. A second fault lies to the north-north west at 8km distance with the 10 m throw of the fault to the south.

The data used to compile the structural map was that which existed prior to 1981; exploration holes and seismic investigations in the last 35 years may provide more resolution on the structural geology but these data are not available to this assessment.

4.8 Environment Agency Aquifer Designations

The Environment Agency classifies the River Terrace Deposits and Alluvium superficial deposits as Secondary A Aquifers. This type of aquifer contains *"Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers"*.

The Hemingbrough Glaciolacustrine Formation and Peat are classified by the Environment Agency as unproductive strata defined as *"rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow".*

[3] Depth given as below the driller's datum which was 3.03m above ground level. The ground level was at 4.31maOD.

The Environment Agency classifies the Mercia Mudstone Group as a Secondary B aquifer, defined as “predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers”. It has also defined this aquifer as a water body under the Water Framework Directive; GB40402G992200 (Idle Torne – Secondary Mudrocks).

The Environment Agency classifies the Sherwood Sandstone Group as a Principal aquifer, defined as “layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale”. It has also defined this aquifer as a water body under the Water Framework Directive; GB40401G301500 (Idle Torne – PT Sandstone Nottinghamshire & Doncaster).

The Permian and Carboniferous strata outcrop over 11 km to the west of the Proposed Development. Whist some of these strata are classified by the Environment Agency as aquifers at outcrop, they are present at depths of over 300 m beneath the Proposed Development and therefore do not support potable water supplies or provide river base flow within the study area. The focus of this assessment is therefore on the superficial deposits and the Triassic Mercia Mudstone Group and Permo-Triassic Sherwood Sandstone Group.

4.9 Groundwater Occurrence and Quality

Groundwater occurs in the granular superficial deposits and bedrock at the Proposed Development. There is expected to be a degree of hydraulic continuity between groundwater in the superficial deposits and the upper horizons of bedrock, with similar groundwater levels in both strata. However the layers of silt or clay within the superficial deposits and deeper horizons of mudstone within the Mercia Mudstone and Sherwood Sandstone Groups may provide layers of low permeability and impedance to vertical flow.

A map showing Environment Agency monitoring locations and groundwater contours for the Sherwood Sandstone Group is provided as Figure F1. A section line is shown on this map and the hydrogeological section is also shown on Figure F2. Groundwater flow direction in the Sherwood Sandstone Group is strongly influenced by the presence of multiple abstractions to the west and northwest of the Proposed Development. The three sources to which groundwater beneath the Proposed Development could flow towards are Finningley, Austerfield and Highfield Lane (public water supply) i.e. groundwater flow to the west or northwest. These sources and others in the Sherwood Sandstone Group east of Doncaster have lowered water levels in the area, resulting in convergence of groundwater flow towards these sources from the wider area.

Prior to large scale groundwater abstraction it is anticipated that natural groundwater flow in the Sherwood Sandstone Group would have been eastwards emerging near the boundary with the Mercia Mudstone Group in a series of springs or groundwater seepages that fed wetlands. The names “Misson Spring Road”, “Misson Springs” and “Springs Farm” could all be an indicator that in the past there were springs in the area.

Groundwater quality data for the Sherwood Sandstone Group was requested from the Environment Agency. Data for the closest monitoring locations around 3 km west of the Proposed Development is commercially sensitive. The nearest monitoring location with available data is over 5 km to the southwest of the Proposed Development site near Austerfield and this has not therefore been assessed. New monitoring boreholes are included as part of the Proposed Development and site specific baseline water quality data will be collected from these (see Section 6).

4.10 Groundwater Source Protection Zones

The Environment Agency mapping indicates that the wider regional outcrop of the Sherwood Sandstone Group is designated as a source protection zone (i.e. where it is not overlain by the Mercia Mudstone Group). Most of the area is Zone 3 representing the total catchment where groundwater flows to a source. The Proposed Development is not mapped as being within this protection zone (see Figure F1).

There are designated inner and outer source protection Zones 1 and 2 associated with the existing groundwater abstractions at Finningley, Austerfield and Highfield Lane (public water supply). Zone 2 is calculated based on a travel time to the source of between 50 and 400 days and Zone 1 is calculated based on a travel time to the source of less than 50 days. However these Zones are over 3 km from the Proposed Development and are not therefore considered as being at risk and are not considered to be potential receptors in this assessment.

As shown on Figure F1, the sub-surface works pass beneath the Source Protection Zone 3 but at considerable depth below the base of the Sherwood Sandstone Aquifer. Due to the significant thickness of strata between the sub-surface

works and the aquifer there is considered to be no potential for the sub-surface works to impact on water quality in the aquifer.

4.11 Anthropogenic Influences and Historical Land Uses

An Envirocheck Report that includes historical mapping and a 1 km search radius was obtained for the Proposed Development. The historic land use in and around the Proposed Development appears to be agricultural production, with little change between the 1886, 1899, 1921 and 1963-64 Ordnance Survey (OS) maps. It is possible that the historic agriculture use may have introduced chemicals to the ground (e.g. nitrate, phosphate, herbicides, pesticides and fungicides), which may have leached into the shallow groundwater table. At the time of the preparation of this assessment there are no nearby groundwater quality data which are available. A sand and gravel extraction site around 400m to the west of the Proposed Development is first shown on the 1990s OS maps (see Technical Appendix H), although current land use is agriculture.

The Proposed Development is located within former RAF Misson which was operational from 1960 to 1963. It first appears on the 1979-1987 historic OS map within the Envirocheck report. The compound comprises a series of large buildings and areas used for the storage of military vehicles, some of which are on hard-standing with others parked directly upon the soil surface. This location could provide a potential source of contamination to the environment of refined hydrocarbons / BTEX compounds and potentially heavy metals. However there was no visual or olfactory evidence of contamination during the ground investigation (see Technical Appendix H) and the site does not hold an Environmental Permit for the discharge of pollutants.

There are no landfill sites (Permitted or historic) within 2 km of the Proposed Development. The nearest sites all lie to the west and down hydraulic gradient from the Proposed Development. The sites mapped by the Environment Agency are listed in Table 4.2. These landfill sites are a potential source of contamination to groundwater in superficial deposits and the underlying bedrock. However it is unlikely that landfill sites have impacted water quality in groundwater beneath the Proposed Development owing to the direction of groundwater flow as indicated by the groundwater contours in Figure F2. The landfill sites are not therefore considered further within this assessment.

Table 4.2: Landfill Sites

Nr	Type	Site Name	Site address	Distance from Site (km)
1	Historic Landfill	Refuse Tip off Bawtry Road	Bawtry Road, Misson, Nottinghamshire	3.0
2	Historic Landfill	Refuse Tip off Bawtry Road	Bawtry Road, Finningley, South Yorkshire	3.0
3	Authorised Landfill	Finningley Landfill Site	New Lane, Finningley, Doncaster, South Yorkshire, DN9 3DF	3.5
4	Authorised Landfill	Bank End Quarry Landfill	Bank End Road, Blaxton, Finningley, South Yorks, DN9 3AN	3.0
5	Authorised Landfill	Tipping Services Construction Ltd	Rose Bungalow, Mosham Road, Blaxton, Doncaster, South Yorkshire, DN9 3BA	3.2
6	Authorised Landfill	Higgins Landfill Finningley	Greenbank House, Old Bawtry Road, Finningley, Doncaster, South Yorkshire, DN9 3BZ	3.5

There are no recorded pollution incidents with 3 km of the Proposed Development. The nearest pollution incidents as recorded by the Environment Agency[4] are to the west of the Proposed Development and are listed in Table 4.3. These incidents are a potential source of contamination to groundwater in superficial deposits and the underlying bedrock. However it is unlikely they have impacted water quality in groundwater beneath the Proposed Development owing to the direction of groundwater flow as indicated by the groundwater contours in Figure F2. The pollution incidents are not considered further within this assessment.

[4] http://maps.environment-agency.gov.uk/wiyby/wiybyController?topic=pollution&layerGroups=default&lang=_e&ep=map&scale=8&x=467470&y=397364#x=468699&y=398308&lg=5,1,6,&scale=8

Table 4.3: Pollution Incidents

Nr	Location coordinates	Year	Environmental impact to water	Pollutant	EA incident number	Distance from Site (km)
1	467503,399312	2002	Significant	Oils and fuel	128310	3.5
2	469090,400523	2009	Minor	General biodegradable materials, inert materials and wastes	72360	3.1

4.12 Ground Gas Sources

Possible locations/sources that might generate natural or anthropogenic ground gas are:

- methane, carbon-dioxide, carbon monoxide and radon are ground gases that are associated with the Coal Measures that underlie the site at significant depth (>450m). It is unlikely this provides a source of ground gas or dissolved gas in the Sherwood Sandstone Group because of the thickness of low permeability strata of Upper Carboniferous age which underlie the Permo-Triassic aquifer which would trap the gas. There is also an absence of faulting shown on geological maps that could provide a vertical pathway for ground gas at the Proposed Development;
- leaks from municipal gas mains. However there are no known gas mains in the vicinity of the Proposed Development; and
- peat and organic matter rich soils can be sources of methane and these are located immediately east of the Proposed Development.

The scope of the Proposed Development does not include hydraulic fracturing. However gas encountered during drilling is considered within this assessment.

4.13 Designated Sites

With respect to statutory sites which may, in part, be dependent on groundwater, Misson Training Area SSSI is located around 125 m to the east of the Proposed Development. Unit 2 (fen, marsh and swamp) and 3 (neutral grassland) were in unfavourable recovering condition and Unit 1 (broadleaved, mixed and yew woodland) was in favourable condition when last assessed by Natural England. The interior and boundary drains that dissect the site hold areas of standing water and support interesting aquatic plant communities according to the Natural England citation for this SSSI.

Misson Line Bank SSSI is located approximately 1.7 km to the southeast of the Proposed Development. Unit 1 (standing open water and canals) was in favourable condition when last assessed by Natural England. Unit 2 (fen, marsh and swamp) was in unfavourable condition owing to a lack of corrective works (inappropriate scrub control).

River Idle Washlands SSSI is also located approximately 1.9 km to the southeast (Unit 4) and 3km south (Unit 3) of the Proposed Development. Unit 4 (neutral grassland) was in unfavourable condition when last assessed owing to inappropriate water levels (management of water levels), lack of corrective works (inappropriate scrub control), and agriculture (undergrazing). Unit 3 (neutral grassland) was in favourable condition.

Haxey Grange Fen SSSI is around 2.9km to the east of the Proposed Development. Unit 1 (fen, marsh and swamp) was in unfavourable condition and declining when last assessed by Natural England owing to agriculture (undergrazing) and inappropriate water levels.

The SSSIs identified above are situated on superficial deposits of Hemingbrough Glaciolacustrine Formation, River Terrace Deposits, Alluvium and Peat. The bedrock at depth is expected to comprise Mercia Mudstone Group mudstones. The SSSIs are unlikely to be influenced by groundwater arising from the bedrock based on the existing conceptual model for the assessment area. However it is possible they are in part dependent upon groundwater conditions within superficial deposits.

Based on the existing conceptual model and the distance from (and nature of) the Proposed Development, the River Idle Washlands, Misson Line Bank and Haxey Grange Fen SSSI are not considered further within this assessment. However the Misson Training Area SSSI has the potential to be impacted by the Proposed Development.

4.14 Summary of Potential Groundwater and Groundwater Dependent Receptors

The baseline conditions described above provide a conceptual model for the Proposed Development and surrounding area. The receptors that are assessed to have the potential to be impacted by the Proposed Development are shown in Table 4.4.

Table 4.4: Sensitivity of Resources / Receptors

Receptor	Sensitivity	Rationale
Sherwood Sandstone Group Principal aquifer	High	Principal aquifer providing potable water to a large population
Groundwater abstractions from the Sherwood Sandstone Group	High	Abstractions for public water supply (i.e. potable water), which are located to the west and down gradient of the Proposed Development.
Misson Training Area SSSI	Low	The SSSI is not expected to be significantly dependent on groundwater conditions. However it is located near to Proposed Development and therefore included as a receptor.
River Terrace Deposits and Alluvium Secondary A aquifer	Low	Secondary A aquifer.
Mercia Mudstone Group Secondary B aquifer (sandstone horizons)	Very Low	A groundwater resource with a low quality and rarity at a local scale.

A sketch conceptual site model illustrating the relationship of these receptors to the Proposed Development and the pathways by which they may be impacted is shown as Figure 25 in the ES.

5 Environmental Design and Management

The description of the Proposed Development is provided in Chapter 4 of the ES. The key potential impacts as identified within the EIA scoping report and relevant to hydrogeology are:

- the possible pollution to groundwater from spillages and the handling/management of drilling fluids and cuttings.
- the adequacy of the well design and integrity to control the possible escape of drilling fluids, gas and formation fluids into the groundwater.

These potential impacts could affect the receptors in Table 4.4, either directly or indirectly through horizontal and vertical migration of pollution through the superficial deposits and bedrock. The sections below introduce the way that potential environmental impacts will be avoided, prevented, reduced or offset through environmental design and management. The measures are those that are standard (not new or untested) and where there is confidence that the measure is deliverable. An assessment of potential impacts on Hydrology is included separately at Technical Appendix G.

5.1 Management and Procedures

The management and procedures that will prevent or reduce impacts on the identified hydrogeological receptors are as follows:

- IGas Integrated Management System Manual, revision 03 dated 9 February 2015 (see Annex F1), sets out the standards and procedures to which IGas is committed to uphold at all sites.
- IGas will prepare a site specific Environmental Management and Monitoring Plan for the Proposed Development at Springs Lane, Misson. The document will record the monitoring locations, analytical suites, sampling frequency and sampling methods, set warning and trigger concentrations for selected determinands and incorporate an action plan to be followed should warnings and triggers be exceeded.
- IGas will undertake all statutory reporting obligations for the Proposed Development, including data collection and reporting to DECC, EA, HSE and the BGS.

Spill prevention and emergency management response measures are detailed in Chapter 4 of the ES.

5.2 Baseline Monitoring

A programme of Baseline Environmental Monitoring (BEM) will be agreed with the Environment Agency and implemented in advance of the Proposed Development. This is the subject of a separate planning application (see Chapter 3 of the ES). Up to four sets of boreholes including up to twelve boreholes in total are currently proposed:

- one set located on the eastern boundary of the Proposed Development. This will confirm baseline up-hydraulic groundwater conditions with respect to the Sherwood Sandstone Group (based on the current understanding of regional groundwater flow direction). It will also confirm baseline groundwater conditions in the superficial deposits if these are present and identify vertical hydraulic gradients;
- one set located around 110 m west of the exploratory wells of the Proposed Development. The will confirm baseline down-hydraulic groundwater conditions in the Sherwood Sandstone Group and superficial deposits;
- one set located around 130 m northwest of the exploratory wells of the Proposed Development. This will confirm baseline down-hydraulic groundwater conditions in the Sherwood Sandstone Group and superficial deposits; and
- one set located near the entrance of the Proposed Development from Springs Road. This will confirm baseline down-hydraulic groundwater conditions in the Sherwood Sandstone Group and superficial deposits. The potential to encounter superficial deposits is greater than at the other locations.

The proposed design of the monitoring boreholes will allow the installation of groundwater sampling equipment (to allow water quality analysis); allow representative ground gas samples to be collected and allow continuous gas monitoring equipment to be installed; and allow accurate manual groundwater level measurement and installation of data loggers. The frequency of the monitoring and the range of parameters (e.g. water quality, level, ground gas, dissolved gas) to be measured will be agreed with the Environment Agency.

The monitoring will continue beyond the baseline monitoring phase and into the construction, operation and abandonment phases. This will allow early identification of any impacts on groundwater from the Proposed Development, reducing the potential to impact the groundwater related receptors identified in Table 5.4.

5.3 Construction (Phase 1)

5.3.1 Staff Awareness/Training

The contractor(s) will ensure that Site personnel are fully aware of the potential impact to water resources associated with the proposed construction works and procedures to be followed in the event of an accidental pollution event occurring. This will be included in the site induction and training, with an emphasis on procedures and guidance to reduce the risk of pollution.

5.3.2 Pollution Plans

Plans to deal with accidental pollution will be drawn up and agreed with the Environment Agency prior to construction commencing and also be included within the CEMP. Any necessary equipment (e.g. spillage kits) will be held on-site and site personnel would be trained in their use. The Environment Agency would be informed immediately in the unlikely event of a suspected pollution incident.

Spill prevention and emergency management response measures are detailed in Chapter 4 of the ES.

5.3.3 Storage of Materials

The CEMP would incorporate measures set out in the Environment Agency PPG documents listed in Technical Appendix G.

5.3.4 Discharge/ Disposal of Potentially Contaminated Site Runoff/ Material

Plans and measures for the discharge and/ or disposal of potentially contaminated water during phase 1 are detailed in Technical Appendix G.

The well cellar would be designed and constructed to prevent the creation of pathways for the migration of contaminants and should be constructed of materials that are suitable for the ground conditions and designed use.

5.3.5 Temporary Drainage and Settlement

Temporary drainage facilities would be provided during phase 1, where necessary, to ensure controlled discharge of surface water runoff. It would be a contractual requirement of the contractor to ensure that runoff from the Site does not cause pollution.

5.4 Operation and Evaluation (Phases 2 and 3)

5.4.1 Well Pad Design and Surface Activities

The following environmental design and management is incorporated into the Proposed Development:

- the wellpad be will lined and incorporate a perimeter drainage system – as described in Chapter 4 of the ES.
- site drainage will be contained and will not be discharge to adjacent watercourses, drainage water will be stored on-site and then tankered off-site for disposal at an approved waste water treatment works (see Technical Appendix G for assessment of storage capacity during storm events);
- the design of the bunding around the wellpad incorporates an on-site surface storage volume sufficient to retain a failure of the largest of the fluid storage containers to be used on-site; and
- materials including drilling fluid, cuttings, fuel, waste will be stored in containers in designated locations on the pad. These will be sized to accommodate the volume of material to be used or generated with best practice allowance for additional volumes (secondary containment). Drilling muds and cuttings will be transported to a suitably permitted disposal facility.

The measures above will prevent or reduce potential impacts on groundwater and associated receptors from spillages and the handling/management of drilling fluids and cuttings.

5.4.2 Drilling and Well Integrity

The following environmental design and management is incorporated into the Proposed Development – as described at Chapter 4 of the ES:

- Loss of potentially polluting materials to groundwater during well drilling is minimised by good practice well design that is in accordance with the following recommendations / regulations:
  - Borehole sites and Operations Regulations (1995)
  - Offshore Installations and wells Regulation (1996)
  - Oil and Gas UK Well Life Cycle Integrity Guidelines (June 2014)
  - UKOOG UK Onshore shale gas well Guidelines (2013).
  - API Standards
- the well design programme has been prepared by IGas, in compliance with the above regulations and in accordance with industry good practice;
- the well design programme is approved by IGas Plc management, and submitted for review to an independent well examiner;
- during drilling the steel casing is cemented in the well in a series of stages to protect groundwater and maintain well integrity. The function of the casings and indicative sizes and depths are provided in Table 5.1. The final design of the vertical and horizontal wells is likely to differ according to the size and direction of the well and the geology that is encountered;
- the cement is pumped in a slurry form down inside the well casing and this then rises up through the annular space between the outer face of the casing and the well bore side wall. Once in place the cement then sets hard and seals the annual space'
- all casing strings installed will be pressure tested and will be subject to specific Quality Assurance procedures in order to ensure its integrity;
- no hazardous substances (as defined under the Groundwater Directive) will be used in the drilling fluid in all strata above the Zechstein Formation. The drilling mud will be a water based polymer mud;
- below the deep conductor, and after the adequate isolation by casing and cement grout, a low toxicity oil based mud (LTOBM) will be used. The LTOBM used will be subject to approval from the Environment Agency through the site's Environmental Permit;
- to provide control on pressure and retain potentially pollutant materials within containment the following is incorporated:
  - an adequate pressure wellhead will be installed onto the surface casing and if possible onto the deep conductor
  - a Blow-Out Preventer (BOP) will be installed whilst drilling operations are undertaken on strata below the Sherwood Sandstone Group to provide secondary well control.
- to ensure that the wells do not act as a pathway for future contaminants when the containment of the well is compromised:
  - Abandonment/ Suspension will be undertaken in accordance with regulatory requirements that are in force at the time of abandonment.
  - Abandonment/suspension will be undertaken using the industry best practice and as approved by regulators in advance of undertaking the works (DECC, EA and HSE, Oil & Gas UK Guidelines for the suspension and abandonment of wells).

The measures above will prevent or reduce the potential impacts of escape of drilling fluids, gas and formation fluids on groundwater and associated receptors.

Table 5.1: Indicative well casing design

Name	Diameter Range (inches)	Installation location	Function
Shallow conductor	30 or 42	surface to circa 60 m depth	The steel conductor is fixed in place to stabilise the surface wall of the hole. It is also designed to isolate any shallow groundwater and shallow unstable sand. This conductor casing may be installed either prior to mobilisation of the drilling rig, with a specialised truck mounted rig, or by the drilling rig itself.
Deep conductor	13-$^{3}/_{8}$ or 20	surface to circa 300 m depth	This deep conductor will extend down to the Sherwood Sandstone Group and will be landed in the upper section of the Zechstein formation. This casing will be cemented in place, and cement is also design to isolate any groundwater from the bore itself.
Surface casing	9-$^{5}/_{8}$ or 13-$^{3}/_{8}$	surface to circa 1200 m depth	This casing will be installed with the drilling unit and cemented in place.
Intermediate casing	7 or 9-$^{5}/_{8}$	surface to 2000 – 2500 m vertical depth	This casing could be optional in the horizontal well and would be extending down to the Bowland section in the vertical well. This casing will be installed with the drilling unit. This casing will be cemented, but not to the surface. A section of the casing may be left uncemented in order to monitor the external pressure around the casing
Production casing	4½ or 5½	extended from either the surface or into the bottom of the intermediate casing to total depth/ or as required.	This casing will be installed with the drilling rig. It will be cemented in place, but will not be cemented back to surface. It should be noted that a section will on purpose be left uncemented in order to monitor the external pressure around the casing.

6 Assessment of Effects

This section presents the findings of the hydrogeological assessment for the phases of the Proposed Development in line with the assessment methodology described in section 3. The potential receptors have been identified following a review of available baseline data. The Proposed Development, potential impacts and pathways are outlined in Section 4. The sections below describe the effect of the potential impacts on the receptors and a summary of the effects is provided in Table 6.1.

6.1 Construction (Phase 1)

There is the potential for spillages during phase 1 (the construction phase) in the wellpad and parking area. The likelihood of pollution occurring (taking into account the embedded mitigation measures will be very low (see Technical Appendix G). The potential impacts and assessment of effects is discussed below.

6.1.1 Pollution (via spillages) of the River Terrace Deposits and Alluvium Secondary A Aquifer

There is the potential for spillages during phase 1 in the wellpad and parking area that could infiltrate and pollute the superficial deposits, which is a **low sensitivity** receptor. Given the temporary nature of this phase (estimated at 3 months), the footprint of the Proposed Development and the nature of the activities, the potential impact on this receptor is assessed as **very low** with a **negligible adverse effect** (not significant).

6.1.2 Pollution (via spillages) of the Mercia Mudstone Secondary B Aquifer

Where superficial deposits are not present or where there is potential for vertical migration of pollution through the superficial deposits, there is potential for spillages to pollute the Mercia Mudstone Group, which is a **low sensitivity** receptor. For the same reasons as above, the potential impact on this receptor is assessed as **very low** with a **negligible adverse effect** (not significant).

6.1.3 Pollution (via spillages) of the Sherwood Sandstone Group Principal Aquifer and supported public water supply abstractions

Where there is potential for vertical migration of pollution through the superficial deposits and Mercia Mudstone Group, there is potential for spillages to pollute the Sherwood Sandstone Group. The aquifer and supported abstractions are **high sensitivity** receptors. For the same reasons as above, the potential impact on these receptors is assessed as **very low** with a **minor adverse effect** (not significant).

6.1.4 Pollution of the Misson Training Area SSSI

The inclusion of this **low sensitivity** receptor is conservative because it is unlikely to be particularly dependent on groundwater conditions. There is also unlikely to be a meaningful groundwater pathway from the Proposed Development to the SSSI based on BGS mapping. Nonetheless, given the temporary nature of this phase, the footprint of the Proposed Development and the nature of the activities, the potential impact on this receptor is assessed as **very low** with a **negligible adverse effect** (not significant).

6.2 Operation and Evaluation (Phases 2 and 3)

Drilling of two exploratory wells is estimated to require 9 months. There is the potential for spillages during this phase owing to surface activities on the well pad. There is also potential for the escape of drilling fluids, gas and formation fluids into groundwater (Sherwood Sandstone Group) via the drilling of the well.

6.2.1 Pollution (via spillages) of the River Terrace Deposits and Alluvium Secondary A Aquifer, Mercia Mudstone Group Secondary B Aquifer and Misson Training Area SSSI

Spillages may occur on the well pad during this longer phase and pollute superficial deposits **(low sensitivity)** and Mercia Mudstone Group **(very low sensitivity)**. Where horizontal flow pathways exist in shallow aquifer horizons, there is also potential for pollution to migrate towards the Misson Training Area SSSI. However the potential impacts are prevented or reduced by the environmental design and management (embedded mitigation measures) outlined in section 5 (including

wellpad and drainage design). Therefore the potential impact on these receptors is assessed as **very low** with a **negligible adverse effect** (not significant).

Pollution (via spillages) of the Sherwood Sandstone Group Principal Aquifer and supported public water supply abstractions

Where there is potential for vertical migration of pollution through the superficial deposits and Mercia Mudstone Group, there is potential for spillages to pollute the Sherwood Sandstone Group. The aquifer and supported abstractions are **high sensitivity** receptors. For the same reasons as above, the potential impact on these receptors is assessed as **very low** with a **minor adverse effect** (not significant).

Pollution (via escape of drilling fluids, gas and formation fluids) of the Sherwood Sandstone Group Principal Aquifer and supported public water supply abstractions

Drilling activities and well integrity issues have the potential to introduce pollution into the **high sensitivity** Sherwood Sandstone Group and supported **high sensitivity** groundwater abstractions to the west. The potential impacts are prevented or reduced by the environmental design and management outlined in section 5 (including well design, on-going groundwater monitoring and statutory reporting). Therefore the potential impact on these receptors is assessed as **very low** with a **minor adverse effect** (not significant).

6.2.2 Suspension of Wells and Assessment of Drilling Results

Activity on Site during this 3 to 6 month phase will be reduced compared to phase 2 and there are no additional activities that have the potential to pollute groundwater and groundwater dependent receptors. Therefore the assessment of effects is the same as the drilling phase i.e. not significant.

6.3 Decommissioning, Abandonment and Restoration (Phase 4)

The Site decommissioning and Site restoration phase has the potential to introduce pollution to the groundwater and groundwater dependent receptors via spillages. There is also potential for well abandonment to introduce new pathways for contamination.

6.3.1 Pollution (via spillages) of the River Terrace Deposits and Alluvium Secondary A Aquifer, Mercia Mudstone Group Secondary B Aquifer and Misson Training Area SSSI

Spillages may occur on the well pad during decommissioning and restoration of the site, polluting superficial deposits **(low sensitivity**) and Mercia Mudstone Group **(very low sensitivity)**. Where horizontal flow pathways exist in shallow aquifer horizons, there is also potential for pollution to migrate towards the Misson Training Area SSSI. Given the temporary nature of this phase, the footprint of the Proposed Development, the nature of the activities and the environmental management, the potential impact on these receptors is assessed to be **very low** with a **negligible adverse effect** (not significant).

6.3.2 Pollution (via spillages) of the Sherwood Sandstone Group Principal Aquifer and supported public water supply abstractions

Where there is potential for vertical migration of pollution through the superficial deposits and Mercia Mudstone Group, there is potential for spillages to pollute the Sherwood Sandstone Group. The aquifer and supported abstractions are **high sensitivity** receptors. For the same reasons as above, the potential impact on these receptors is assessed as **very low** with a **minor adverse effect** (not significant).

6.3.3 Pollution (via escape of drilling fluids, gas and formation fluids) of the Sherwood Sandstone Group Principal Aquifer and supported public water supply abstractions

Abandonment of the boreholes has the potential to introduce pollution into the **high sensitivity** Sherwood Sandstone Group and supported **high sensitivity** groundwater abstractions to the west. The potential impacts are prevented or reduced by the environmental design and management outlined in section 5 (regulatory requirements, regulator approval and industry best practice). Therefore the potential impact on these receptors is assessed as **very low** with a **minor adverse effect** (not significant).

Table 6.1: Assessment of Effects

ID	Phase	Potential Impact Source	Receptor	Sensitivity of Receptor	Magnitude of impact (incorporating environmental design and management)	Effect
C1	Phase 1: Construction (well pad and parking area)	Pollution from spillages	Sherwood Sandstone Group Principal aquifer	High	Very Low	Minor Adverse (Not Significant)
C2			Public water supply abstractions (Sherwood Sandstone Group)	High	Very Low	Minor Adverse (Not Significant)
C3			River Terrace Deposits and Alluvium Secondary A aquifer	Low	Very Low	Negligible Adverse (Not Significant)
C4			Mercia Mudstone Group Secondary B aquifer (sandstone horizons)	Very Low	Very Low	Negligible Adverse (Not Significant)
C5			Misson Training Area SSSI	Low	Very Low	Negligible Adverse (Not Significant)
D1	Phases 2 and 3: Drilling and assessment phase	Pollution from spillages and the handling / management of drilling fluids and cuttings	Sherwood Sandstone Group Principal aquifer	High	Very Low	Minor Adverse (Not Significant)
D2			Public water supply abstractions (Sherwood Sandstone Group)	High	Very Low	Minor Adverse (Not Significant)
D3			River Terrace Deposits and Alluvium Secondary A aquifer	Low	Very Low	Negligible Adverse (Not Significant)
D4			Mercia Mudstone Group Secondary B aquifer (sandstone horizons)	Very Low	Very Low	Negligible Adverse (Not Significant)
D5			Misson Training Area SSSI	Low	Very Low	Negligible Adverse (Not Significant)
D6		Escape of drilling fluids, gas and formation fluids via drilling of the well and well integrity	Sherwood Sandstone Group Principal aquifer	High	Very Low	Minor Adverse (Not Significant)
D7			Public water supply abstractions (Sherwood Sandstone Group)	High	Very Low	Minor Adverse (Not Significant)
R1	Phase 4: De-commissioning and restoration	Pollution from spillages	Sherwood Sandstone Group Principal aquifer	High	Very Low	Minor Adverse (Not Significant)
R2			Public water supply abstractions (Sherwood Sandstone Group)	High	Very Low	Minor Adverse (Not Significant)
R3			River Terrace Deposits and Alluvium Secondary A aquifer	Low	Very Low	Negligible Adverse (Not Significant)
R4			Mercia Mudstone Group Secondary B aquifer (sandstone horizons)	Very Low	Very Low	Negligible Adverse (Not Significant)
R5			Misson Training Area SSSI	Low	Very Low	Negligible Adverse (Not Significant)
R6		Escape of drilling fluids, gas, formation fluids via decommissioning and restoration.	Sherwood Sandstone Group Principal aquifer	High	Very Low	Minor Adverse (Not Significant)
R7			Public water supply abstractions (Sherwood Sandstone Group)	High	Very Low	Minor Adverse (Not Significant)

7 Assumptions and Limitations

The hydrogeological assessment is based upon interpretations of groundwater and geological conditions in published information sources. It is possible that there is undocumented, undetected or unrevealed groundwater or geological conditions at, below, or in the vicinity of the Site, below the site or in the vicinity of the Site that are different to those that are assumed to exist.

8 Mitigation Measures and Residual Effects

The assessment of effects has identified that no mitigation measures are required over-and-above the environmental design and management measures covered previously i.e. the effects are not significant. Therefore an assessment of residual effects is not required.

9 Cumulative and Combined Effects

Cumulative effects are those that could arise as a result of impacts from several different schemes. Applications in the study area that are relevant to groundwater are as follows:

- Newington Sand Quarry - planning application for additional sand and gravel extraction with restoration to nature conservation at Newington Quarry (around 3.8 km southwest of the Proposed Development); and
- Finningley Quarry – extension and re-phasing of existing sand and gravel extraction (around 2.8 km west of the Proposed Development).

Given the distance of these other schemes from the Proposed Development, the presence of existing sand and gravel extraction at these locations and the conceptual model for the study area, they are assessed as being unlikely to give rise to significant cumulative effects and are not considered further.

10 Conclusions

This Technical Appendix has considered the potential impacts on groundwater resources and groundwater quality associated with the Proposed Development at Springs Road, Misson, in Nottinghamshire. It does not consider the potential impacts on hydrology or flood risk and these are considered within Technical Appendix G.

The Proposed Development includes the construction of the wellpad and Site/office parking, drilling of two exploratory wells and the eventual decommissioning and restoration of the Site. The key potential impacts as identified within the EIA scoping report and relevant to hydrogeology were:

- the possible pollution to groundwater from spillages and the handling/management of drilling fluids and cuttings; and
- the adequacy of the well design and integrity to control the possible escape of drilling fluids, gas and formation fluids into the groundwater.

The key potential receptors of any pollution have been identified as the high sensitivity Sherwood Sandstone Group and the supported groundwater abstractions for public water supply. Other potential receptors include superficial deposits, Mercia Mudstone Group and the Misson Training Ground SSSI.

The assessment of effects has identified that when taking into account the environmental design and management of the Proposed Development, there are no significant effects on groundwater and groundwater dependent receptors. No additional mitigation measures are included and therefore an assessment of residual effects is not required. It has also been assessed that there are no other schemes in the study area that will result in significant cumulative effects.

IGas Energy PLC

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Integrated Management System Manual

CONTENTS

FOREWORD

IGas Plc Group ("The Company") recognises that effective health, safety and environmental management contributes significantly to its long-term business success.

This document sets out The Company's Integrated Management System. It emphasises the systematic approach in the way we manage our business activities and our belief that our performance can always be improved over time. The integration of health, safety and environmental protection into our day-to-day activities is the key to successful health and safety management.

The application and success of this system requires the participation and commitment of management, employees and contractors at all levels.

This Policy and Integrated Management System has the Board's full support but we require your commitment through a personal understanding of this document and full participation in the effective implementation of the system.

It is imperative that everyone involved in the business of IGas Plc Group familiarise themselves with their roles and responsibilities in this document. Only by total commitment by everyone we can ensure the best possible protection of our personnel, contractors, the public, our assets and the environment.

1. INTRODUCTION

This document is the Manual of the IGas Integrated Management System (IMS). It describes the structure and content of the IMS, and is associated with the top level procedures (Elements). It includes the Statement of Principles (IMS Policy) and a description of how it is implemented throughout IGas. The IMS core process and expectations are described with further references to other supporting procedures and sub-processes.

The IMS has been developed to effectively manage IGas business processes and activities associated with the exploration and production of oil and gas in an environmentally responsible, protective and safe manner. The Integrated Management System ensures that stakeholder requirements are understood throughout the organisation and met when delivering energy products, resulting in enhanced customer satisfaction.

1.1. Scope

The IMS and this Manual applies to all activities within the business across all phases of the work, which involves exploration and production in the Oil and Gas sector. The product is energy in the form of oil and gas. The IMS applies to the activities performed by any member of IGas plc and subsidiaries. Where IGas works in partnership with other operators, the scope of the project that relates to IGas will comply with the intent of the IGas IMS. Contractors working for IGas are not required to work under the IMS but use their own compatible systems that comply with the intent of this IMS.

IGas is committed to conducting its business in a way that ensures the minimisation of risks to Health, Safety, Environment, Social, Quality and Security performance. IGas manages risks through compliance with the company IMS, which is reviewed and improved to ensure continued effectiveness. The IMS enables IGas activities and services to comply with company expectations, as contained in the Statement of Principles (policy).

1.2. Normative References

For all IGas locations, activities, products and services, the following standards apply:

- BS EN ISO 9001:2008 Quality Management Systems – Requirements
- BS EN ISO 14001:2004 Environmental Management Systems – Requirements

In the future, the requirements of another standard will be addressed: OHSAS 18001:2007 Occupational Health & Safety Management Systems – Requirements.

1.3. Terms and Definitions

Integrated Management System (IMS) - Integrated Quality, Environmental, Occupational Health and Safety, Social and Security Management System.

Output - The actions and documents that result from process requirements.

Process - Documented Management System approach. References in this Manual are italicised, to differentiate from outputs.

Product - The oil and gas (energy) delivered to customers.

Responsibility - The obligation to carry forward an assigned task to a successful conclusion whilst having the authority to direct and take the necessary action to ensure success.

2. IGAS ENERGY PLC

2.1. The Company

IGas Energy plc is the UK's leading onshore oil and gas exploration and production business with licences to explore for oil and gas in a number of locations, including the North West, East Midlands and the Weald Basin near the south coast.

The business has more than thirty years' experience of successfully extracting oil and gas onshore in the UK, which has one of the most stringent regulatory regimes in the world.

We are a British business and employ more than 160 staff at over 100 sites around the country, who largely live and work in the areas in which we operate.

IGas is committed to the environment and the communities in which we operate and we have a long track record of engaging with local residents. IGas operates its own Community Fund which has committed to distribute several hundred thousand pounds a year to projects that are charitable, educational or benevolent in purpose.

2.2. Our Activities

The Group's conventional resources include 28 oil and gas fields in the Weald Basin and East Midlands areas of the UK.

The Weald Basin is located onshore in southern England, north of the Isle of Wight, and is the source of approximately 50 per cent. of the Group's current production. The area under licence is inclusive of 11 fields within which there are 18 production sites. The Group owns a 100 per cent. interest in all but three of the licences held covering this area. Oil is collected by tanker from sites and is

transported to the Group's processing facility at Holybourne which has storage for 20,000 barrels and a rail terminal. The Group also transports and stores oil from other operators in the area, providing a further revenue stream.

The East Midlands area stretches from the East Midlands Shelf to the Gainsborough Trough and the Widmerpool Gulf. Hydrocarbons have been produced in this area since 1959 and current production from this area accounts for approximately 50 per cent. of the Group's total current production. The area consists of 17 oil fields and 80 sites. The East Midlands area is comprised of two primary production centres: Welton and Ganisborough/Beckingham. The Welton area is made up of six fields and a gathering centre where the produced oil, gas and water are separated. The produced oil is transported to Conoco Immingham via road tanker; gas is used for power generation; and produced water is pumped for reinjection. The Gainsborough/Beckingham area is made up of 11 fields and a processing facility.

IGas acquired Caithness in December 2013 which includes a 100% interest in the Lybster Field which is drilled from onshore to offshore. The field was discovered in the 1996 by Premier Oil plc, at well 11/24-1 which tested 36 API oil at over 2,000bopd from the Beatrice Formation.

The field was put into production in May 2012 and, prior to being temporarily shut-in for a routine workover, was producing approximately 200bopd gross and in excess of 2mscf/d of associated gas. The oil is currently transported and sold to facilities at Nigg.

On 16 October 2014, IGas acquired Dart Energy Limited by way of a Scheme of Arrangement. This created the largest onshore UK oil and gas company with over 1 million net acres including all major UK shale basins. The enlarged company has a work programme of over US$80m over a total of 15 licenses funded by GDF and Total."

The Group's shale gas and CBM assets are in nine onshore licences and one offshore licence located in the counties of Cheshire, Flintshire and Staffordshire. The total area currently under licence in this area is 1,252 km2 (approximately 310,000 acres), with the Group owning 100 per cent. of the working interest in all of the licences.

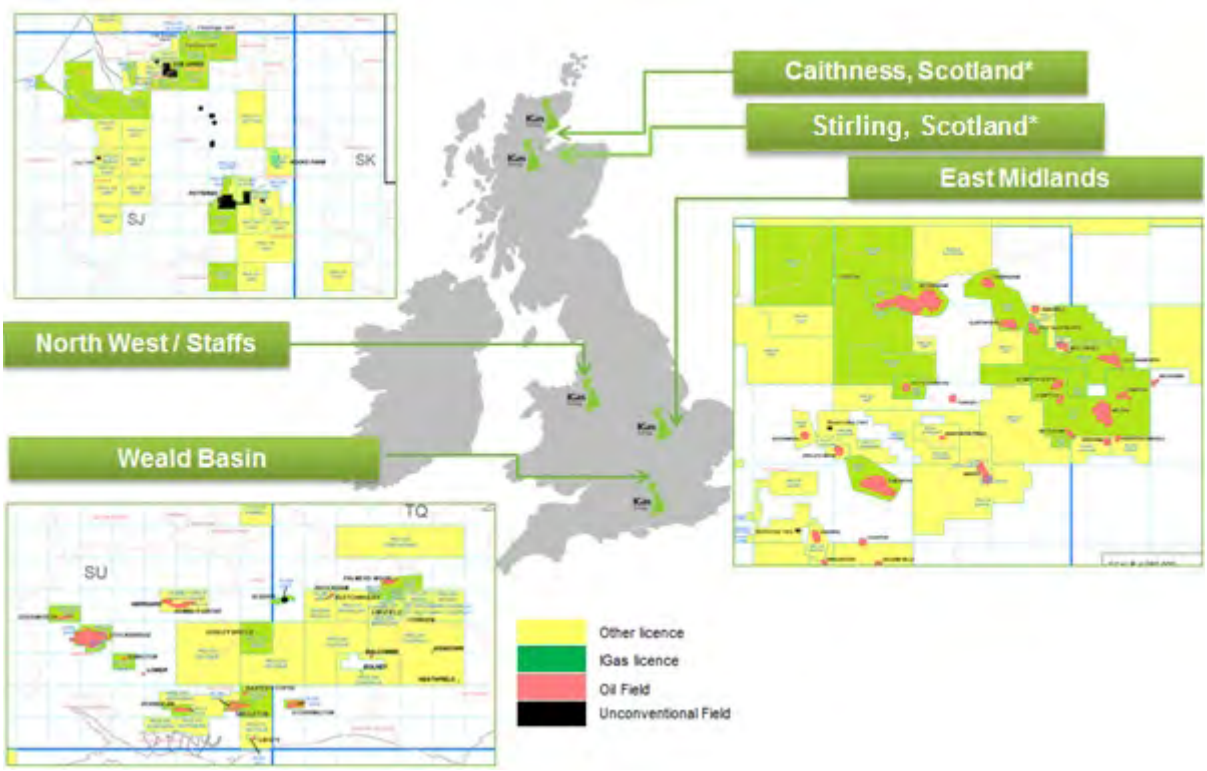


Figure 1: Where IGas Operate

3. INTEGRATED MANAGEMENT SYSTEM

3.1. General requirements

The IGas IMS described in this Manual is designed to comply with the requirements of ISO 9001:2008 and ISO 14001:2004. This IMS consists in a series of documented inter-related processes, procedures and work instructions applied across IGas corporate functions and non-corporate departments to ensure customer requirements are met and their satisfaction is enhanced. Resources, including personnel, infrastructure, knowledge and any other necessary information are provided for the proper functioning of the IMS in order for its planned results to be achieved. On-going monitoring, measurement and analysis of the IMS processes not only provide confirmation of performance but also provide the foundation for continuous improvement.

Where IGas outsources activities or processes that can affect the achievement of IGas, customer or other stakeholder requirements, such activities or processes are controlled to an extent necessary assuring conformance with requirements.

3.2. Drivers & Requirements

The IGas Management Team establishes and approves documented measurable objectives and targets which support the vision, Statement of Principles and business plans. The objectives and targets are covered by the IMS, and may include but are not limited to topics such as:

- Customer feedback on performance;
- Preventive actions implemented;
- Increase in lessons learned recorded and communicated;
- Reduction in non-conformances;
- Reduction in resource usage; and
- Reduction of incidents.

The objectives, targets and associated actions are captured in annual Objectives and Targets and Management Programme Plan (see current version). These are regularly monitored for progress, applicability and are updated annually or at times of material changes to the business.

Changes to the IMS typically as a result of changing business activities or continuous improvement activities are planned and managed through the Integrated Management System Element (IMS.E.002) and the Audit & Review standard (IMS.S.011).

3.3. IMS Policy Statement

IGas adopts a management approach designed to promote safety and environmental protection. This follows the conventional management system hierarchy (Figure 2): Policy; Planning; Implementation; Corrective Action; Management Review; and Audit and Continual Improvement.

IGas is progressively developing a number of policies to provide clear 'ground rules' for the way in which the company will conduct its business. The company's combined Statement of Principles for the Integrated Management System is provided (Figure 3). This and all other policies will be revised and supplemented as the need arises, as they drive and support the Elements and Standards. The Statement of Principles may be made available to the public, on request.

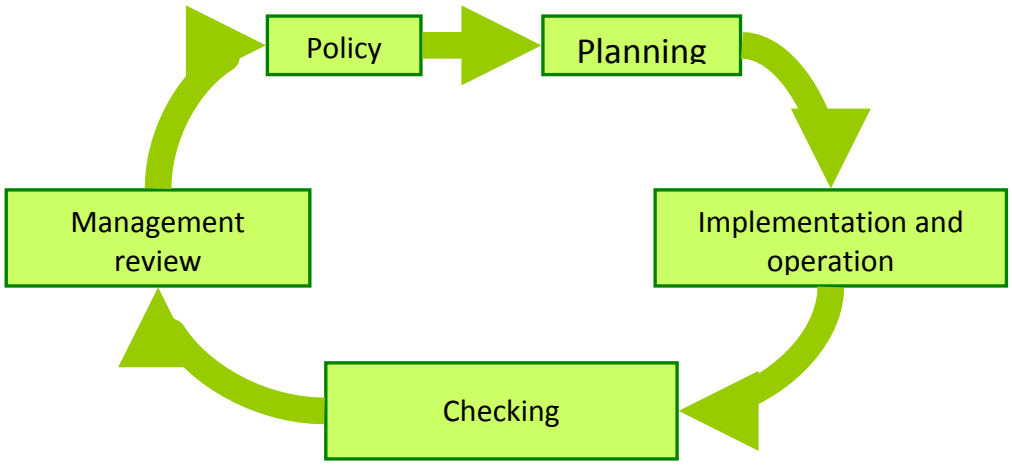


Figure 2: Plan-Do-Check-Act Circle

IGas is committed to conducting its business in a manner that protects the environment, the health and safety of all employees and the public. IGas' commitment is to maintain a culture that fosters the development of a safe, efficient and environmentally sound workplace. IGas complies with all applicable laws and regulations, and applies high standards where laws and regulations do not exist.

IGAS ENERGY GROUP

IMS POLICY STATEMENT

IGas Energy Group companies produce and market domestic oil and gas from conventional and unconventional hydrocarbon sources. IGas is committed to conducting its business in a way that ensures the minimisation of risks to Health, Safety Environment, Social, Quality and Security. IGas will manage risks through compliance with the company Integrated Management System (IMS), which will be reviewed and improved to ensure continued effectiveness. The IMS enables IGas activities and services to comply with agreed company principles, these being:

GENERAL PRINCIPLES:

- Maintain the IMS, seeking continual improvement.
- Measure the effectiveness of the IMS, in order to monitor and meet progression towards targets.
- Comply with all applicable requirements including regulations, legislation, permits, codes of practice, contract terms, and stakeholder expectations.
- Engage with stakeholders, proactively communicating and addressing concerns.

ENVIRONMENT, HEALTH AND SAFETY MANAGEMENT PRINCIPLES:

- Regularly seek out and review Environment, Health and Safety risks so that potential hazards are identified at an early stage and mitigated where necessary.
- Implement Elements, Standards, Work Instructions, Guidance and other process requirements to ensure that EHS risks from projects, offices, facilities and functions are controlled.
- Prevent pollution by the appropriate storage, transfer, handling, disposal and use of materials.
- Ensure continual improvement by setting and meeting performance objectives and targets.
- Ensure staff and contractors meet the IGas expectations for EHS practices, conducting operations in a safe, healthy and environmentally sensitive manner.

QUALITY MANAGEMENT PRINCIPLES:

- Establish improvement objectives, and monitor performance and progress towards these objectives to ensure the desired quality is achieved and retained.
- Check that staff and contractors are competent to a level that allows them to meet the required standards.

SECURITY MANAGEMENT PRINCIPLES:

- Encourage a culture that promotes security as everyone's responsibility to minimise risk to/from employees, business functions, projects, contractors, suppliers and other stakeholders.
- Implement measures under the IMS that will minimise and control security risks including threats to data and information, personnel, company reputation and physical assets.

IGas Energy Group will encourage compliance with this Policy through the operation of the IMS. Non- conformances will be identified and corrected. The requirements of the IMS will be communicated widely so that all staff and contractors are aware of it and thus able to conform.

Signed:  **Date:** **18th August 2013**

Figure 3: IMS Policy Statement

4. ORGANIZATION AND RESPONSIBILITIES

4.1. IGAS Organization

The IGas company scope covers exploration and production activities undertaken onshore and offshore in the UK. The IGas CEO has overall responsibility for IMS performance. Responsibilities are delegated as required, and details are contained in local level procedures and work instructions. The company organisation chart is shown below in Figure 4.

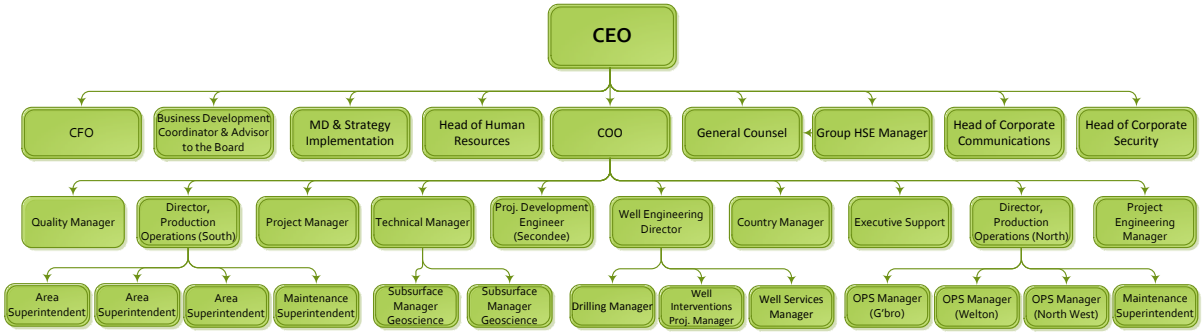


Figure 4: IGas Organisation Chart[1]

4.2. Responsibilities

The IMS includes reporting arrangements to ensure that the CEO is aware of company-wide IMS performance and is actively involved with setting strategic policy and performance evaluation processes, which are fundamental parts of the IMS. The CEO is responsible for ensuring that sufficient resources are made available to enable compliance with the IMS and for ensuring that the IMS is subject to management review and improvement updates where appropriate.

The other key responsibilities for Integrated Management System are as follows:

- The COO and CFO report to the CEO and are responsible for ensuring that the IMS is implemented and communicated in their areas of responsibility.
- The COO is the nominated IMS Representative for the IGas management team, and is responsible for providing advice, assistance and assurance in order to promote and improve IMS performance.
- The company Group HSE Manager is responsible for the implementation and maintenance of the HSE aspects of the IMS, and the Quality Manager is responsible for the implementation and maintenance of the of the Businesses Assurance aspects of the IMS.

[1] HRR.PL.001 – IGas Organization Chart, to consult the full company organogram version.

4.3. Management Commitment

The activities of the IGas Management Team ensure that the Integrated Management System is established, developed and implemented, and that the effectiveness of the Integrated Management System is continually improved.

The Management Team's activities include:

- Open communication of IGas commitment to meeting customer and other relevant stakeholder requirements and expectations to the entire organisation via the Statement of Principles.
- Measuring and communicating organisational performance through the establishment of objectives and targets.
- Conducting management reviews of the IMS ensuring continual effectiveness and evaluating the need for changes to achieve improvement.
- Ensuring adequate resources are identified, planned and provided in order to deliver the continuing effectiveness of the IMS and its continual improvement.

4.4. Customer Focus

The Management Team realises that IGas success relies on a proactive approach to understanding and meeting the requirements and expectations of our customers and other relevant stakeholders, and subsequently enhancing their satisfaction.

The Management Team is committed to meeting these requirements and expectations and realises this through the establishment of processes that clearly determine customer needs and translate these into a product that meets their requirements.

Analysis of these processes, their outputs, continual review of customer requirements, and monitoring of customer feedback validates that the requirements have been met and also provide the foundation for continual improvement of the IMS.

5. PLANNING AND IMPLEMENTATION

5.1. IGAS Business Process

The IGas Core Business Processes (figure 5) is based in three groups of processes that ensure the identification of the ISO requirements, the compliance with these requirements and the main sequence and interactions.

The Management Process sets all the company strategy orientations and reflect the management commitment that ensures the Integrated Management System is established, developed and implemented, and that the effectiveness of the Integrated Management System is continually improved.

The Business Processes defines the activities required for proactively identifying, understanding and meeting the requirements and expectations of our customers and other relevant stakeholders, and subsequently enhancing their satisfaction.

The Support Processes contribute to the efficient development of the business and management processes, ensuring all the necessary support activities.

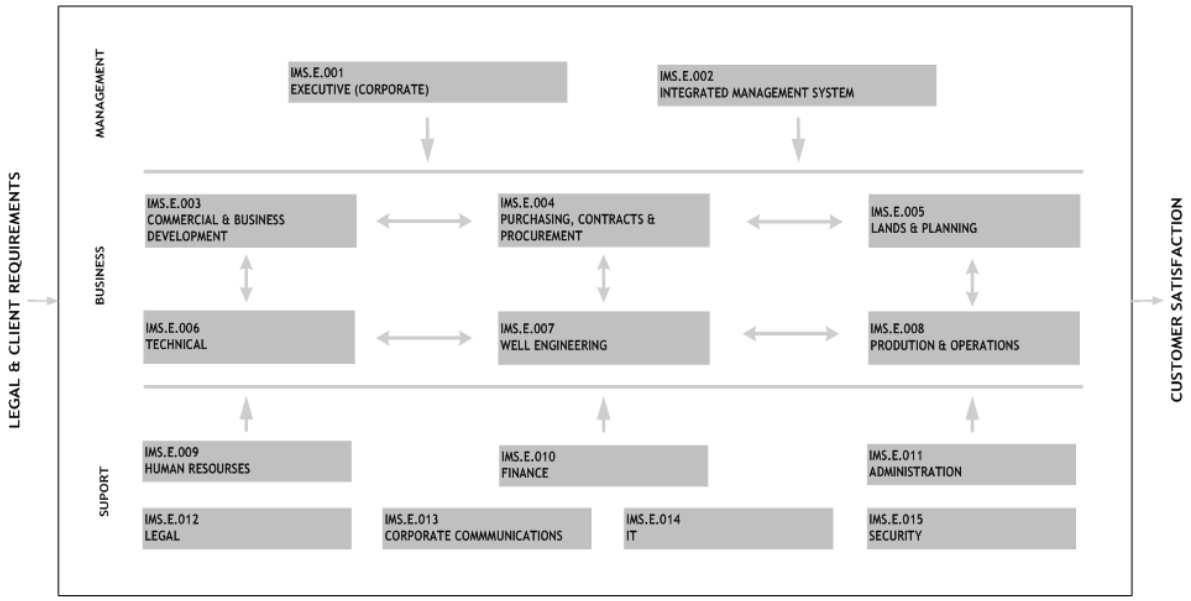


Figure 5: IGas Core Business Processes Chart

The performance monitoring and review is consistent with the requirements of the Integrated Management System. Expectations are, but not limited to, that:

- Performance of the Integrated Management System, asset and project development, and compliance with legal and other requirements is continuously monitored and measured; and
- Performance against objectives and targets is regularly reviewed for suitability and effectiveness and proactive steps are taken to continually improve the Integrated Management System.

The IGas Core Business Process defines the fourteen elements of the Integrated Management System, see appendix 1.

5.2. Hazard and Risk Management

IGas has implemented a process for the management and mitigation of risks at company/corporate, local office, asset and project level, in accordance with Risk Management & Business Continuity standard (IMS.S.001). The process includes the following activities:

i. **Identify the Hazards -** A hazard is defined as something with the potential to cause harm. The techniques used to identify hazards depend on the nature and complexity of the operation or activity and could range from observation and recording to the use of specialist techniques such as HAZOP, HAZAN, HAZID, ENVID, etc.

ii. **Assessing the Risks -** Risk is defined as the likelihood that harm from a particular hazard may occur. The level of risk is dependent on many factors such as the frequency of exposure to the hazard, the potential severity and the probability that the hazard will be realised.

iii. **Managing the Risks -** Eliminating the risk is the preferred option (i.e. removing the hazard by using alternative materials, technologies, working practices, etc.). If the risk cannot be eliminated, then reducing the risk to an acceptable level is achieved through the identification and implementation of control measures e.g. written procedures, training, containment etc., Safe Systems of Work and/or management programmes developed based on the risk assessments. These are made available to relevant managers/departments for reference, approval and implementation.

The identification of hazards, assessing risks associated with those hazards and implementation of control/mitigation measures are managed in accordance with the IMS Policy and Production & Operations procedures. Periodic management system audits are undertaken to ensure that implemented controls remain up to date and effective.

In accordance with IMS Policy, IGas ensures identified environmental and safety sensitivities and required control measures are effectively communicated to contractors and other interested parties.

5.3. Resource Management

The Management Team ensures adequate resources are identified, planned and provided for the continuing effectiveness of the Integrated Management System and its continual improvement.

i. Selection

The Company has procedures in place to ensure that all approved vacancies are filled by individuals with the appropriate qualifications and experience to fulfil the requirements of the position. All recruitment and selection is undertaken in accordance with the relevant legislation.

IGas personnel or contractors executing duties affecting product conformity to requirements and customer satisfaction, are selected based on competency, capability, experience, training and subsequent ability to carry out the activities, evidenced by appropriate documented records in accordance with Competency Assurance and Training standard IMS.S.004. Contractors are selected according to Contractor Selection and Management standard IMS.S.009.

ii. Competence, Training and Awareness

The company recognises the importance of the training and development of its entire staff in order to maintain and improve standards of performance and to maximise individual employee development.

Competency requirements are identified through business plans, annual personnel performance appraisal process and specific needs of assets and projects. Requirements are met through recruitment, training or other development actions achieving appropriate levels of competency, experience and capability etc. appropriate for the effectiveness of the Integrated Management System, in accordance with the Competency Assurance and Training standard IMS.S.004.

Evaluation of the effectiveness of training and / or other development actions aimed at achieving required levels of competency is carried out by individual departments, responsible for business plans, and development of assets and projects.

Personnel are provided with inductions covering the IGas Statement of Principles and the Integrated Management System. The induction communicates the importance of each individual's function and how they contribute to achieving objectives and targets.

iii. Infrastructure and Work Environment

The Management Team ensures that adequate facilities are provided and maintained in order to achieve product conformity with customer requirements including but not limited to:

- Workspaces and welfare facilities;
- Equipment and hardware including IT equipment;
- Software including that required for the website and server files;

- Safety and environmental facilities and equipment e.g. PPE, spill kits and first aid kits;
- Information such as regulations and design codes; and
- Supporting services such as travel.

IGas manages the work environment required to achieve conformity to product requirements through the Integrated Management System. Aspects relating to human and physical factors are considered such as temperature, hygiene, lighting and desk ergonomics for personnel welfare and to meet the legal requirements at all times.

Safety and security of personnel is given the outmost priority and is reflected in the Integrated Management System processes and procedures.

5.4. Communication

Efficient communication, both up and down the organisation, is essential for the IMS to function effectively. The communication structure is designed not only for the passage of information but to motivate people through their involvement and understanding. It is recognised that well motivated employees will contribute more towards the overall success of The Company.

Communication process is defined through the PR Corporate Communication element (IMS.E.013), and Communications standard (IMS.S.005).

5.5. Internal

All employees are encouraged to actively participate in the implementation of, and compliance with, the requirements of the IMS. The Statement of Principles, objectives, targets, HSE plans and changes are communicated through both formal and informal means e.g. email bulletins, town hall meetings, and team discussions.

Effectiveness of the IMS is communicated to personnel via Management Review minutes, audits findings, corrective actions, preventive actions and continuous improvement initiatives, inductions and training and through town hall meetings and emails.

5.6. External

IGas fosters openness and dialogue with Government agencies and the public on environmental matters and aims to anticipate and respond to their concerns about potential hazards and impacts of operations, products, wastes or services including those of local or global significance. The appointed HSE Manager oversees the dissemination of information to interested parties, informing

them of changes to IMS policy, environmental and health & safety initiatives and compliance with environmental permits, consents and licences.

5.7. Document Structure and Hierarchy

The IMS involves a top level Manual and set of policies (including the main Statement of Principles), as well as overarching Elements aligned to fourteen key business processes (see Figure 5). The Elements establish the management framework within which the company works, and define who within the organisation is accountable and responsible for executing each activity. The IMS interfaces with external requirements including project specific plans and procedures, as is shown in Figure 5.

The Elements are supported by a suite of IMS procedures (Standards) which provide definition on specific requirements of the company and elaborate on IMS issues and processes. The Elements and Standards are organised to reflect the operation of the company and to ensure consistent implementation of Integrated Management System and assurance across the company.

Additional documents support the functioning of the Integrated Management System. Some of these focus on IMS issues e.g. Auditing, while others address the execution of the business e.g. HR and Operations. The overall structure of IMS documentations is show in Figure 6.

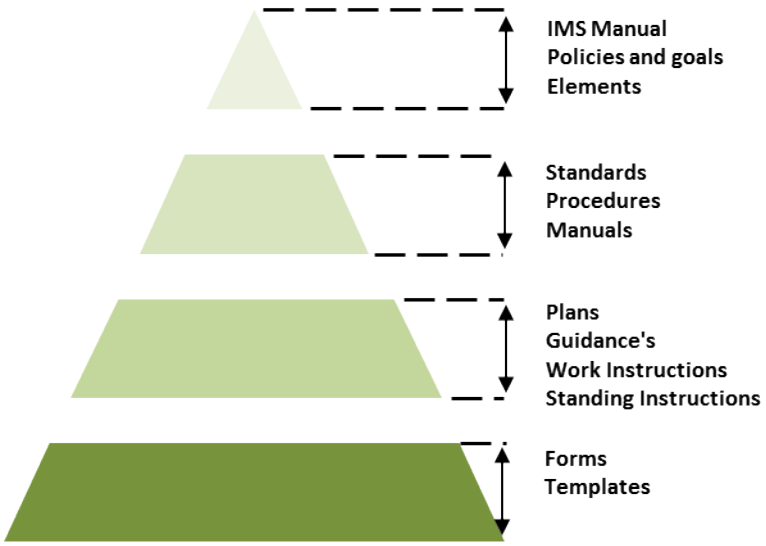


Figure 6: Integrated Management System Document Hierarchy

The Elements and Standards establish the management requirements of the company. Specific detail on how these will be executed at the local level will be contained in local procedures and operational work instructions including those of contractors and sub-contractors.

The Elements and the supporting Standards define 'WHAT' the requirements are and what must be actioned/done, whereas the lower level local procedures and operational work instructions within IGas or the contractors, describe 'HOW' the IMS requirements are to be achieved.

All IMS documentation is subject to document and data control, in accordance with IMS Document Control & Records standard (IMS.S.006). The controlled documents are maintained as electronic master copies available on the Document Management System (M-Files).

5.8. Operational Control

Procedures and instructions are developed for all activities that may have the potential to have an effect upon human health and the environment and where the absence of such procedures and instructions could result in infringement of the IGas Policy and procedures. The requirement for operational control procedures primarily arises from hazard identification and risk assessment studies undertaken prior to the installation of new, or amendment to, plant and equipment. However, procedures may be revised following incident investigations, non-conformance reports, or suggestions for improvement.

5.9. Emergency Preparedness and Response

IGas recognise that even with the implementation of an effective Integrated Management System there is the potential for incidents to occur. Emergency planning and response procedures have therefore been developed, in accordance with the Incident & Emergency Response Procedure (HSE-PR-002), to identify risk scenarios, assess environmental and Health & Safety consequences and implement appropriate controls. Emergency procedures and contingency plans are regularly updated and exercises carried out in order to maximise their effectiveness and to comply with appropriate legislation. Separate emergency plans are prepared for major operations that involve a significant change to normal site operations.

A corporate emergency response procedure will also be in place to ensure that emergency communications can be established with senior management as describe in the Crisis Management Procedure (HSE.PR.001).

Emergency response information is provided to employees and contractors during induction. Specific training is given relating to the employee's/contractor's place of work or when new emergency response plans are issued or amended.

6. MEASUREMENT, ANALYSIS AND IMPROVEMENT

6.1. Monitoring and Measurement

IGas monitoring, measurement, analysis and continual improvement processes are designed to ensure that IGas products conform to customer and other relevant requirements, result in enhanced customer satisfaction, that the Integrated Management System performs as intended and is continually improved.

IMS verification activities are undertaken in accordance with IMS Monitoring and Measurement standard (IMS.S.008).

Control plans are established for all verification activities. The plans detail the checks to be performed, frequency of checks, acceptance criteria, reaction if non-conformances are found and analysis methods. The planned inspections are carried out at each site in accordance with the pre-prepared schedule and inspection checklist, with the condition of equipment measured against pre-determined standards. Non-compliance with the standards generates non-conformance reports, which are prioritised for action.

Where relevant, statistical techniques are used in the analysis of Health, Safety, Environmental, Security, Quality and Social data.

6.2. Customer feedback and satisfaction

Customer feedback and satisfaction is continuously measured via regular customer contact and Integrated Management System processes such as, but not limited to:

- Asset and project development progress meetings and reporting,
- Schedule and budget performance,
- Handling of non-conformances,
- Internal and external audits, and
- Customer feedback and complaints.

IGas analyses the feedback and satisfaction level, so the level of performance in meeting and exceeding customer requirements is determined. Performance is reviewed through Management Review process in accordance with Audit & Review standard (IMS.S.011).

6.3. Evaluation of compliance

IGas reviews the operational compliance with legal and other requirements are undertaken, as defined in Compliance Management standard (IMS.S.002).

These reviews, which consider legal and other requirements applicable to operations sites, should include new projects and operations, which evidence objectively compliance with planning arrangements.

6.4. Nonconformity, Correction & Preventative Action and Continual Improvement

IGas continually improves the Integrated Management System through the systematic use and review of Statement of Principles, objectives and targets, audits, analysis of data, corrective and preventive actions, lessons learned during Management Reviews and subsequent amendment of processes and documentation, as describe in Audit & Review standard (IMS.S.011).

a. Preventive actions

Preventive actions are undertaken to eliminate the causes of potential non-conformances (product, process, near misses or customer comments etc.) in order to prevent their occurrence. The requirements for preventive actions can be identified through audit findings, by anyone within IGas, through improvement suggestions or through data analysis etc. Once identified, the probable cause should be determined and preventive action established, evaluated and implemented, appropriate to the risk and impact of the issue encountered. Effectiveness of preventive actions are reviewed and validated.

b. Corrective actions

Corrective actions are undertaken to eliminate the causes of non-conformances (product, process or customer complaints etc.) identified through audit findings, by anyone within IGas, through observations or client complaints etc. in order to prevent their re-occurrence. Once non-conformances are identified, immediate action (corrections) to correct the non-conformance should be implemented in a timely manner. The probable cause of the non-conformance should be determined and corrective action established, evaluated and implemented, appropriate to the risk and impact of the issue encountered. Effectiveness of corrective actions are reviewed and validated.

c. Incidents

The IGas Integrated Management System contains a documented system to report and investigate incidents in order to identify the root causes and implement preventive or corrective actions, mitigating any adverse impacts. Incidents are reported and investigated based on their potential impact in accordance with Incident Investigation & Reporting standard (IMS.S.010) and any findings are shared with personnel and other relevant stakeholders.

6.5. Internal Audit

Auditing is a structured and formal process for the evaluation of the implementation and effectiveness of the overall IMS against the laid down objectives, goals and performance standards.

IGas conducts internal process assurance audits at planned intervals, in accordance with an annual audit plan, to determine compliance with ISO9001:2008 and ISO14001:2004, verify conformance to this Manual and whether the Integrated Management System has been implemented and maintained effectively. When warranted, e.g. due to poor performing processes, additional process assurance audits can be conducted as a direct result of the Management Review process.

IGas also conducts project and asset assurance audits based on the importance and risk profile of the development, at intervals defined in quality plans or upon departmental request.

Process, asset and project assurance audits are conducted in accordance with the Audit & Review standard (IMS.S.011), and these audits are performed by trained personnel, impartial of the area being audited.

Audit area, non-conformities, recommendations, improvement suggestions, corrections, corrective actions and preventive actions etc. are recorded and any resulting actions shall be taken in a timely manner by responsible stakeholders.

7. MANAGEMENT REVIEW

The Management Team hold a Management Review at least annually, to assess and evaluate the Integrated Management System in its entirety, to ensure its continued effectiveness and suitability of satisfying the requirements of the Statement of Principles, the business, customers and other stakeholders.

More frequent Management Reviews and Management Team meetings are conducted where deemed necessary in order to enable quicker response time for addressing problems and capitalising on opportunities.

During Management Reviews, the relevance of the Statement of Principle is reviewed and legal compliance status is confirmed by the Management Team, and topics discussed during the Management Review and resulting actions are documented in minutes of meetings and communicated to stakeholders as appropriate.

Management Reviews are conducted in accordance with Audit & Review standard (IMS.S.011). The Management Review input includes but is not limited to:

- Results of internal and external audits;
- Customer feedback or complaints;
- Performance statistics;
- Legal compliance statement;
- Status of preventive and corrective actions or improvement initiatives;
- Objectives, targets and actions;
- Lessons learned;
- Assignment evaluations;
- Previous management review minutes of meeting;
- Statement of Principles; and
- Health, Safety, Environmental, Security, Quality and Social statistics and performance.

The output of the Management Review includes, but is not limited to:

- Actions to implement preventive and/or improvement actions for the Management System;
- Actions to improve products in relation to customer requirements;
- Additional training or communication requirements / actions;
- Identification of additional resources for the operation / improvement of the Management System;
- Identification of additional process or product assurance audits;
- Actions to improve IMS performance; and
- Setting of revised objectives and target.

APPENDIX 1 – INTEGRATED MANAGEMENT SYSTEM DOCUMENTS

Elements

The fourteen Elements form separate documents, and are listed below:

Element Number	TITLE
IMS.E.001	Executive (Corporate)
IMS.E.002	Integrated Management System
IMS.E.003	Commercial & Business Development
IMS.E.004	Purchasing, Contracts & Procurement
IMS.E.005	Lands & Planning
IMS.E.006	Technical
IMS.E.007	Well Engineering
IMS.E.008	Productions & Operations
IMS.E.009	Human Resources
IMS.E.010	Finance
IMS.E.011	Administration
IMS.E.012	Legal
IMS.E.013	Corporate Communications
IMS.E.014	IT
IMS.E.015	Security

Table 1: List of the Elements

OSPAR Approval of the Environmental Aspects of the Management System

A number of Standards are to be used for the OSPAR approval of the environmental aspects of the IGas IMS. These eleven Standards are listed below:

Standard Number	TITLE
IMS.S.001	Risk Management & Business Continuity
IMS.S.002	Compliance Management
IMS.S.003	Facility Information Plan (FIP)
IMS.S.004	Competence Assurance & Training
IMS.S.005	Communications
IMS.S.006	Document Control & Records
IMS.S.007	Emergency Preparedness and Response
IMS.S.008	Monitoring and Measurement
IMS.S.009	Contractor Selection Management
IMS.S.010	Incident Reporting & Investigation
IMS.S.011	Audit & Review

Table 2: List of the Standards

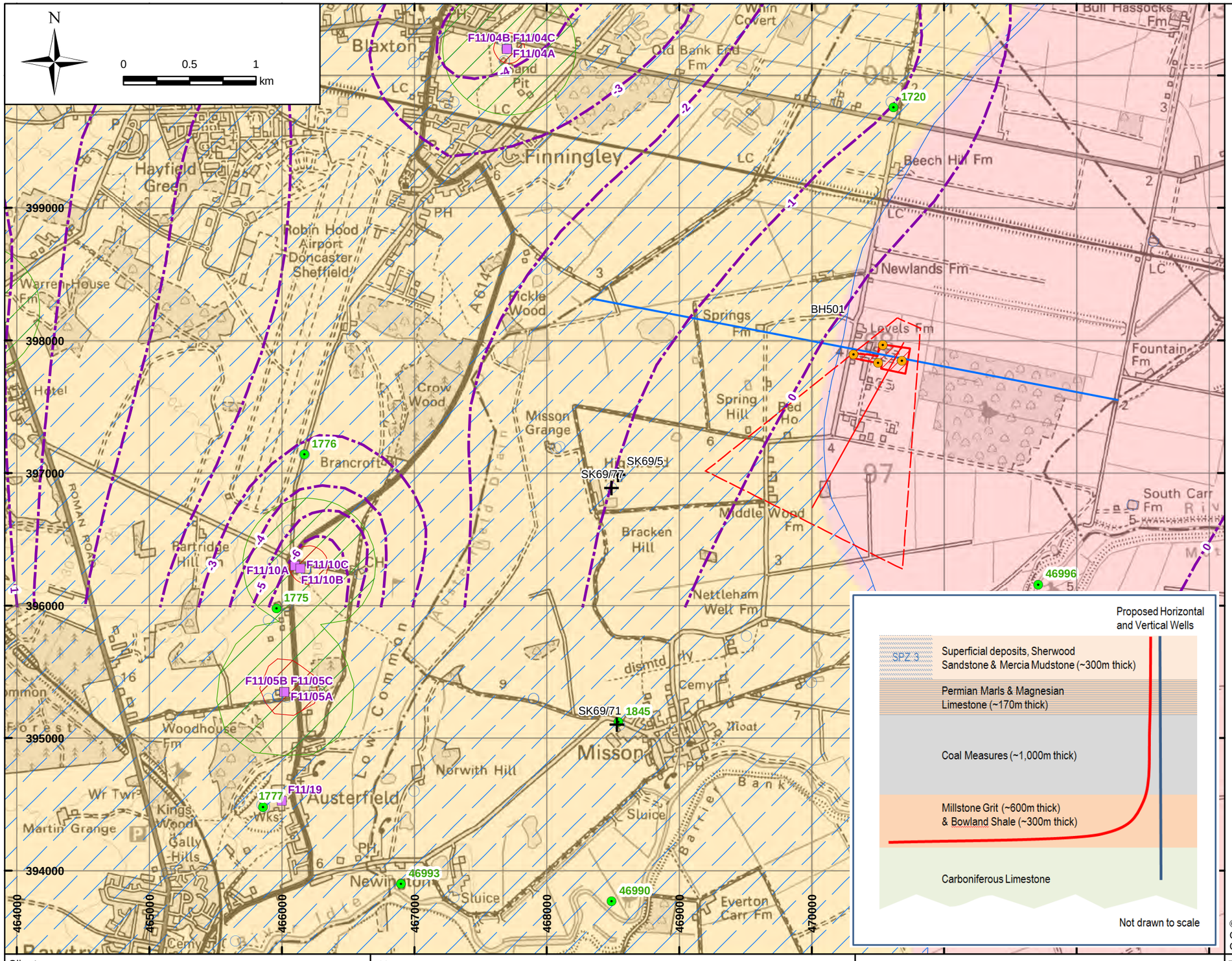
Interpretation of the required procedure documents by ISO

In terms of document organization, the IGas Integrated Management System defined all the documented procedures (standards) required by the ISO 9001:2008 and 14001:2004 as below:

- Control of documents – as describe in the standard IMS.S.006 – Document Control & Records;
- Control of records – as describe in the standard IMS.S.006 – Document Control & Records;
- Internal Audit – as describe in the standard IMS.S.011 – Audit & Review;
- Control of non-conforming product – as describe in the standard IMS.S.011 – Audit & Review;
- Corrective actions – as describe in the standard IMS.S.011 – Audit & Review;
- Preventive actions – as describe in the standard IMS.S.011 – Audit & Review;

All the documents owners are responsible to identify additional documents to support the functioning of Integrated Management System.

Figures



LEGEND

Proposed Development

- Planning Application Boundary
- Horizontal Well Trajectory
- Horizontal Well Cone

Proposed Monitoring Structure

- Proposed Monitoring Location
- Existing Borehole (Sandstone)
- EA Monitoring, Groundwater Level
- EA Monitoring, Groundwater Quality
- Water Well Record (British Geological Survey)
- Section Line (see Figure 47070055-GW-802-002)
- EA Groundwater Contours (2015)

Source Protection Zones (SPZs)

- Zone 1 (Sherwood Sandstone Group)
- Zone 2 (Sherwood Sandstone Group)
- Zone 3 (Sherwood Sandstone Group)

Pink area = Mercia Mudstone Group
Beige area = Sherwood Sandstone Group

Client: ISLAND GAS LTD	Title: REGIONAL MONITORING LOCATIONS	Design:	Drawn: SJC
Project: IGAS EXPLORATORY WELLSITE, SPRINGS ROAD, MISSON		Chk'd: TRH	App'd: PJSladen
		Date: 6/24/2015	Scale at A3: 1:30,000
		Drawing Number: FIGURE F1	A3

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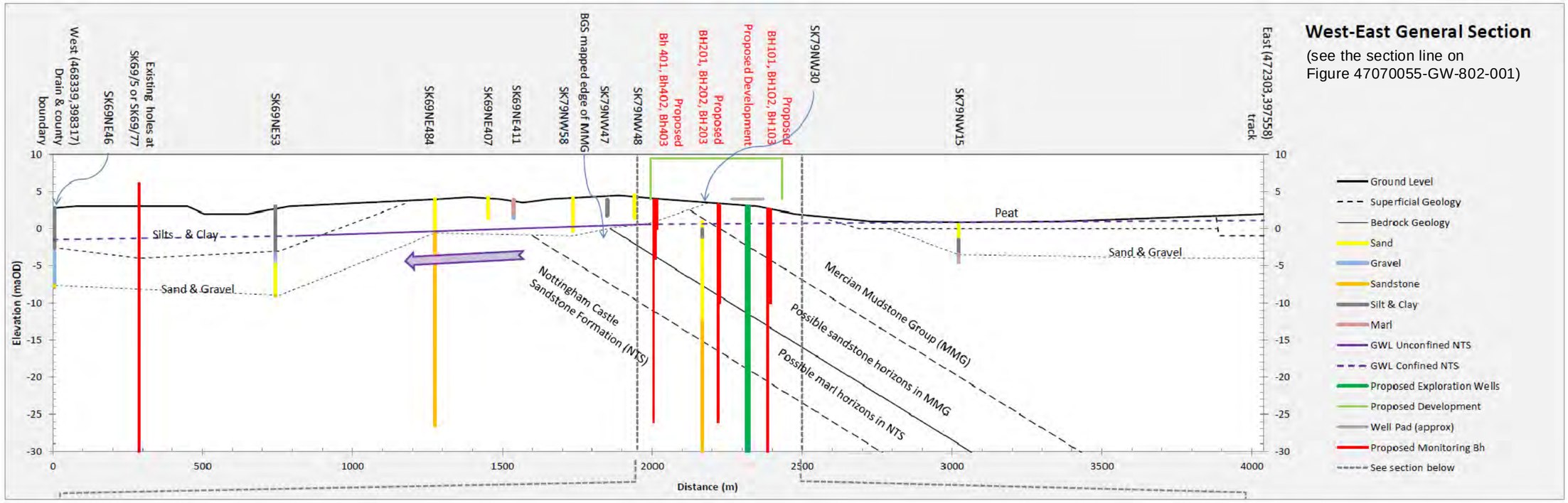

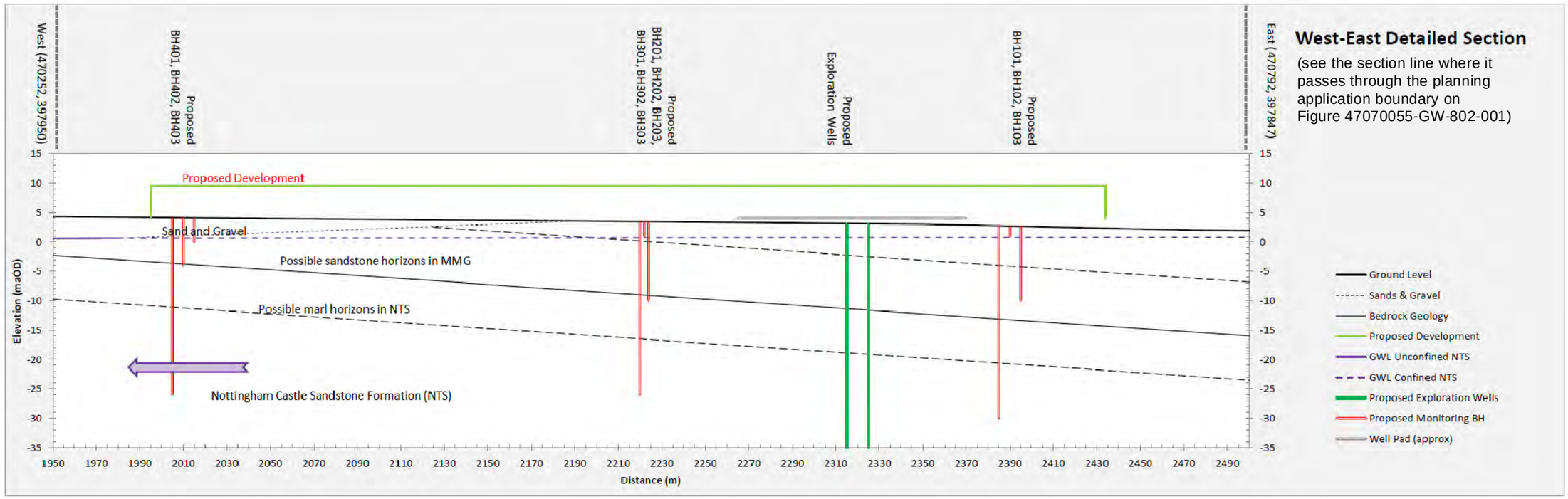

Client: ISLAND GAS LTD	Title: CONCEPTUAL REGIONAL AND SITE SECTIONS WITH PROPOSED MONITORING BOREHOLES	AECOM	Design: TRHargreaves	Drawn: TRHargreaves
Project: IGAS EXPLORATORY WELLSITE, SPRINGS ROAD, MISSON		Scott House, Alençon Link, Basingstoke, Hampshire, RG21 7PP Telephone +44 (0) 1256 310200 Fax +44 (0) 1256 310201 www.aecom.com	Chk'd: CWoolhouse	App'd: PJSladen
			Date: 6/18/2015	Scale at A3: Not to scale
			Drawing Number: FIGURE F2	A3