Appendix 10 – Preliminary Risk Assessment

Appendix 10.4	Site Plan and tables of sources/receptors/complaints/borehole logs
Appendix 10.42	Hazard Identification groundwater/surface water/ leachate
Appendix 10.4.3	Hazard identification groundwater/surface water/ leachate
Appendix 10.5.1	Tables of non gas pathways on and off site
Appendix 10.52	Tables of designated receptors on and off site
Appendix 10.6A	Detailed conceptual site model for all pollutant linkages
Appendix 10.6B	Tables of secondary non gas potentially complete pollutant linkages
Appendix 10.7.2	Risk estimation and evaluation for human health risk pollutant linkages associated with contaminants contained in soils and landfill waste.
Appendix 10.7.3	Lines of Evidence and Justification for Risk Analysis of Radioactivity Pollutant Linkages Associated With Risks to Human Health
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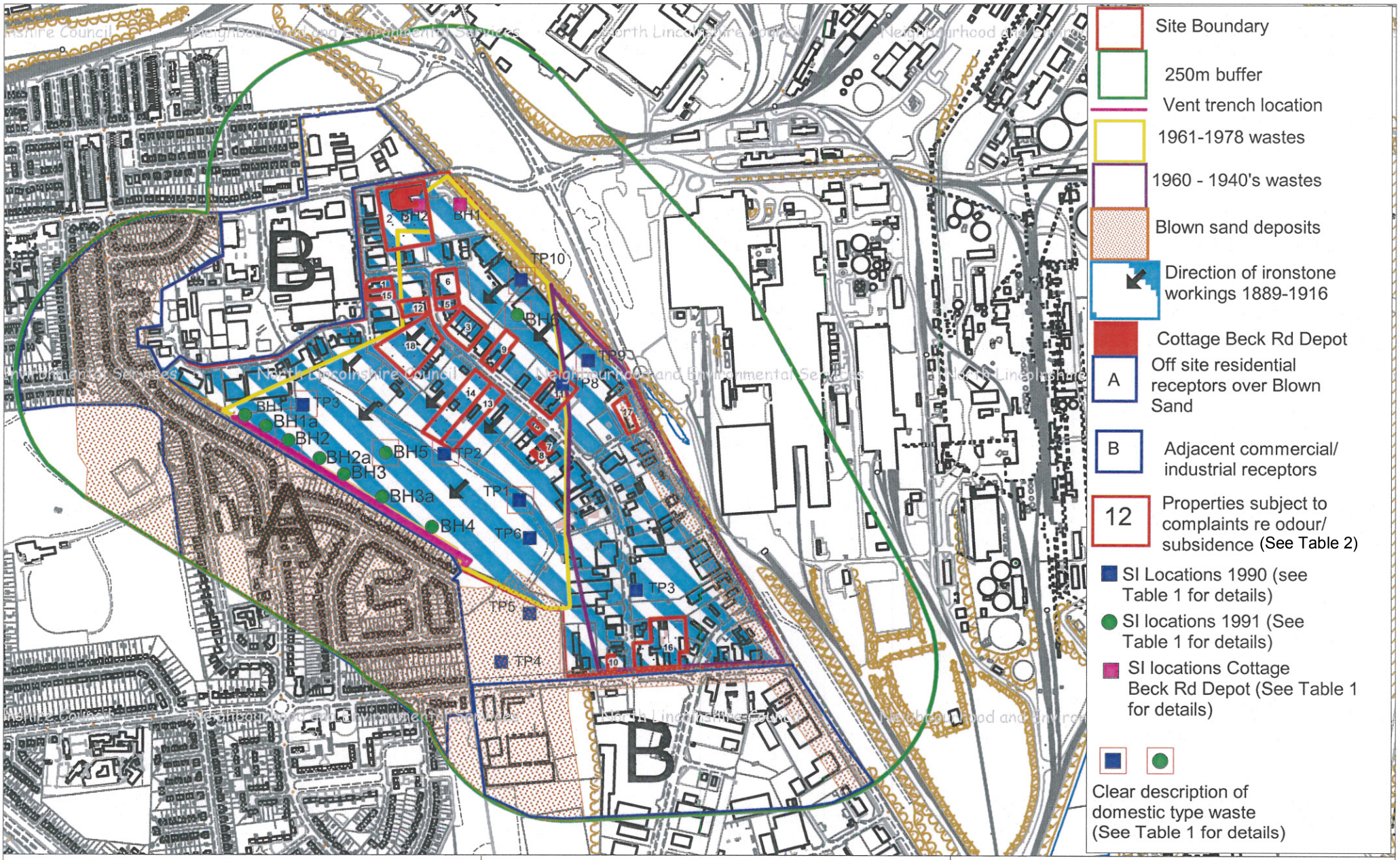
Appendix 10.8	Uncertainties and level of confidence in site conceptual model
Appendix 10.9	Non Gas Secondary Potential Unacceptable Risks
Appendix 10.13	Scope of Works and detailed costs



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NORTH LINCOLNSHIRE COUNCIL

Neighbourhood and Environmental Services

Head of Service,

Keith Ford BA(Hons), MCIEH, MRSH, MInstWM

Table 1 - Historical Site Investigation Borehole and Trial Pit Findings

Site Investigation 1990

Symbol	Borehole No.	Log Description	Comments
	BH1	Waste (inert?) GL to 4m+	
	BH2	Waste (inert) GL to 3.2m. Limestone/mudstone 3.2m+	

Site Investigation 1990

	TP1	Waste (Domestic) to 3m+	Wet
	TP2	Cap to 0.5m Waste (Domestic) 0.5 - 3m+	
	TP3	Cap to 0.3m Waste (Domestic) 0.3m - 2m+	
	TP4	Natural	
	TP5	Natural	
	TP6	0.1m cap Waste (Industrial) 0.1 - 2.5m Clay 2.5m - 3m	
	TP7	0.1m Cap Waste (no organic material) 0.1-3m+	
	TP8	Cap to 0.5m Waste (Pulverised domestic) 0.5m-2.5m Waste (Inert) 2.5-3m+	
	TP9	Cap 0.1m Waste (Pulverised domestic) 0.1-2.8m+	
	TP10	Cap 0.1m Waste (Inert) 0.1-1.6m Sand 1.6m+	
	TP11	Abandoned	

Site Investigation 1991

	BH1	Waste (inert?) GL - 2.7mm Ironstone - 2.7m - 3.5m Mudstone 3.5m - 3.75m+	
	BH1A	Waste (inert?) GL - 1.7m Ironstone 1.7 - 2.5m Mudstone 2.5m+	
	BH2	Waste (Domestic?) GL - 3.2m Ironstone 3.2 - 4m+	
	BH2A	0.1m CAP Waste (Inert?) 0.1-1.5m Sandstone 1.5m - 2.2m+	Odour
	BH3	0.5m CAP Waste (Inert?) 0.3 - 3.3m+	Chemical odour; wet
	BH3A	0.1m CAP Waste (inert?) 0.1 - 1.4m Sandstone 1.4 - 2.25m+	
	BH4	0.4m CAP Waste (inert?) 0.4 - 3.0m+	
	BH5	Waste (Domestic) GL - 4m+	
	BH6	0.4m CAP Waste (Domestic?) 0.4 - 4.0m+	Strong Chemical Odour
	BH7	Waste (Inert?) GL - 3.9m	Chemical odour

Table 2

No.	Property	Location	Easting/Northing	Odours	Subsidence	Gas bubbling	Drainage	Wastes Found
1	NL Components	Plot 6 Colin Rd	490,410 410,521	After being closed up for weekend odours have been found which are not the drains. Described as an odd smell				
2	NLC Depot	Cottage Beck Rd	490,556 410,637	Gas Board raised alarm after an elevated level of CH4 was recorded outside the building. Monitoring indoors 1 unexplained CH4 result				
3	Viking Hardware	39-45 Midland Rd	490,645 410,466	Strong gas smell in summer 2010, gas board called none detected				
4	Compart 2011 Ltd	Units 10-11 Albion Park	490,784 410,279	Can sometimes smell something on opening up and during the day.				
5	Automech Ltd	49-51 Midland Rd	490,630 410,488		Issues with floor subsidence, sorted by LAS Metals. External subsidence investigated			
6	NLC Depot	53-55 Midland Rd	490,628 410,526		Floor subsidence, Offices pulled away from garage, cracks in walls etc. External subsidence.			
7	Scunthorpe Radiators	Unit 4 Albion Park	490,794 410,245	Alleged tap water often smells gassy or of sewerage				

No.	Property	Location	Grid reference	Odours	Subsidence	Gas bubbling	Drainage	Wastes Found
8	Peter's Garage	Unit 7 Albion Park	490,709 410,397				Twice in 2 years has smelt odour near toilet/drains	
9	BJW Crane Hire	35 Midland Rd	490,709 410,397	.	Evidence of subsidence – building in poor state of repair	Gas bubbling in puddles seen.		
10	J & M Machining Services	East Common Lane	490,910 409,871		Owner said the leg of a Hi Ab broke through tarmac and into a void below.			
11	Easimix Ltd Pogsons Ltd & Brumby Wood Motors	23/25 Midland Rd	490,797 410,339		A lot of external undulations in hard surface which have required repairs.			
12	M Gould Scunthorpe Ltd	46 Midland Rd	490,585 410,484		some subsidence externally		Odour around sewer cover worse recently	
13	Murphy Ltd	Plot 36 Midland Rd	490,672 410,305		Some subsidence seen			
14	P & H Construction & GPS Crushing	36-38 Midland Rd	490,639 410,316		Some subsidence seen			
15	D Beacroft Joinery	Plot 7 Colin Rd	490,508 410,509			Gas bubbles in puddles		
16	Jack Tighe	East Common Lane	490,975 409,904					Stated before site was hard standing they would find bottles coming up to the surface.

No.	Property	Location	Grid Reference	Odours	Subsidence	Gas bubbling	Drainage	Wastes Found
17	Engineering & Welding Ltd	Nostell Road	490,942 410,290					When they dug up the yard they found rubbish at about 2 metres
18	LAS Metals	44 Midland Road	490,579 410,397					During SI found dry cloth, (garment making quality) still new, no loss of colour or degradation

Appendix 10.4.2

Hazard Identification groundwater/surface water/ leachate

Due to the lack of a properly constructed surface cap on the site and evidence gathered from the site walkover which indicates poor surfacing on exterior areas of many industrial units, elevated contaminants in the waste deposits and shallow surface soils may present a risk to human health. The recreation ground has a limited cap in place (from 0.1 -0.4m) and therefore contaminants in the shallow surface soils/waste may also present a risk to human health.

The following documents have been referred to when drawing up the list of potential contaminants set out in Table 10.4.2 below that are likely to be associated with waste, soils and sludge's on the site:

- The surrender of permits for the permanent deposit of waste (EA V1 September 2010)
- Guidance on the sampling and testing of wastes to meet landfill waste acceptance criteria (EA V1 2005)
- Waste Management Paper 26A Landfill Completion (DOE 1993) Table 3.2 and 3.3

Table 10.4.2

Metals:	Aluminium (Al), Arsenic (As), Barium (Ba), Beryllium (Be), Boron (B), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Lead (Pb), Magnesium (Mg), Manganese (Mn), Mercury (Mg), Molybdenum (Mo), Nickel (Ni), Potassium (K), Antimony (Sb), Selenium (Se),Tin (Sn), Vanadium (V), Zinc (Zn)
Salts:	Bromide, Chloride (Cl), Floride (F) Sulphate (SO4)
Non Metals:	Nitrate, Nitrite, Chloride, Ammoniacal Nitrogen, Phosphate, Phenol, Cyanide
Organics:	Organophospherous and Organochlorine Pesticides
Others	Poly Chlorinated Biphenols (PCB's), Furans (PCDF), Dioxins (PCDD), Radioactivity, Asbestos

10.4.3 Hazard identification groundwater/surface water/ leachate

The following documents have been referred to in compiling Table 10.4.3 below which lists potential contaminants that might be impacting upon controlled waters.

- Joint Agencies Groundwater Directive Advisory Group (JAGDAG) Hazardous Substances List 2010 and interim list of determinations.

- Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water Table 6.5 and 6.6 (EA 2003).

- The surrender of permits for the permanent deposit of waste (EA V1 September 2010)

- Guidance on the sampling and testing of wastes to meet landfill waste acceptance criteria (EA V1 2005)

- Waste Management Paper 26A Landfill Completion (DOE 1993) Table 3.2 and 3.3

Table 10.4.3

Metals:	Aluminium (Al), Arsenic (As), Barium (Ba), Beryllium (Be), Boron (B), Cadmium (Cd),Calcium(Ca), Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Lead (Pb), Magnesium (Mg), Manganese (Mn), Mercury (Mg), Molybdenum (Mo), Nickel (Ni), Potassium (K), Antimony (Sb), Selenium (Se),Tin (Sn), Vanadium (V), Zinc (Zn)
Salts:	Bromide, Chloride (Cl), Fluoride (F) Sulphate (SO4)
Non Metals:	Nitrate, Nitrite, Chloride, Ammoniacal Nitrogen, Orthophosphate, Phosphate, Phenol, Cyanide
Organics:	Phenols, Mineral Oils and Hydrocarbons, Chlorinated Solvents, Organophospherous and Organochlorine Pesticides
Others	Poly Chlorinated Biphenols (PCB's), Furans (PCDF), Dioxins (PCDD), Radioactivity, Asbestos, Dissolved methane

Appendix 10.5.1

Table 1 Non gas pathways on site

	Pathway	Recreation Ground	Industrial/commercial units
1	Inhalation of dust (indoor)	No	Yes
2	Inhalation of dust (outdoor)	Yes	Yes
3	Dermal contact (indoors)	No	Yes
4	Dermal contact (outdoors)	Yes	Yes
5	Ingestion of soil	Yes	Yes
6	Ingestion of indoor dust	No	Yes
7	Consumption of home-grown vegetables	No	No
8	Consumption of drinking water (permeation of plastic pipes)	No	Yes
9	Dermal contact with water whilst showering	No	No
10	Downward migration of contaminants/leachate	Secondary A Aquifer	
		Yes	

Table 2 Non Gas pathways off site

	Pathway	Secondary A Aquifer	Adjacent Surface Waters
1	Migration of contaminants/leachate in the vadose zone via preferential pathways	Yes	Yes

Appendix 10.52

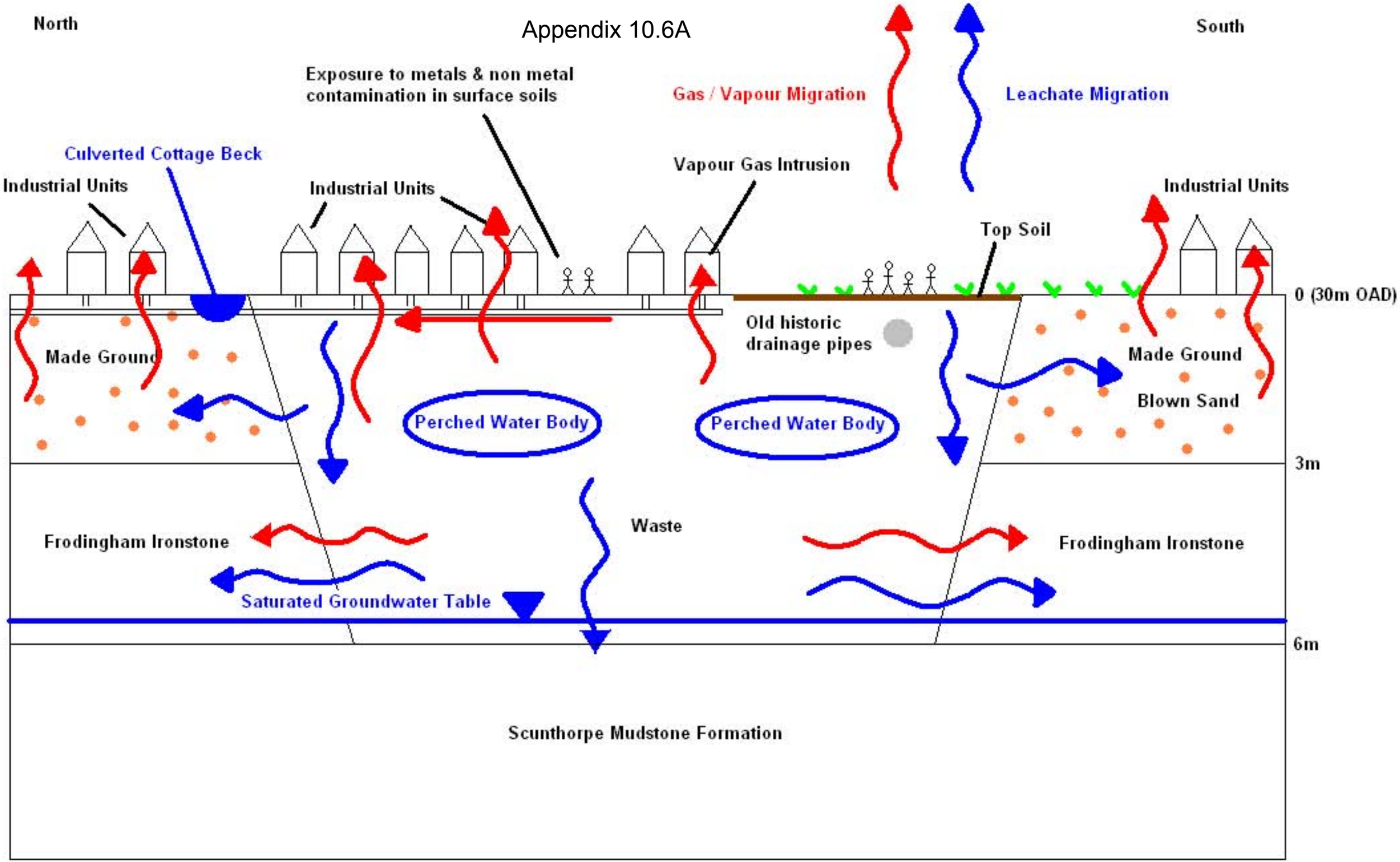
Table 1 On site designated receptors

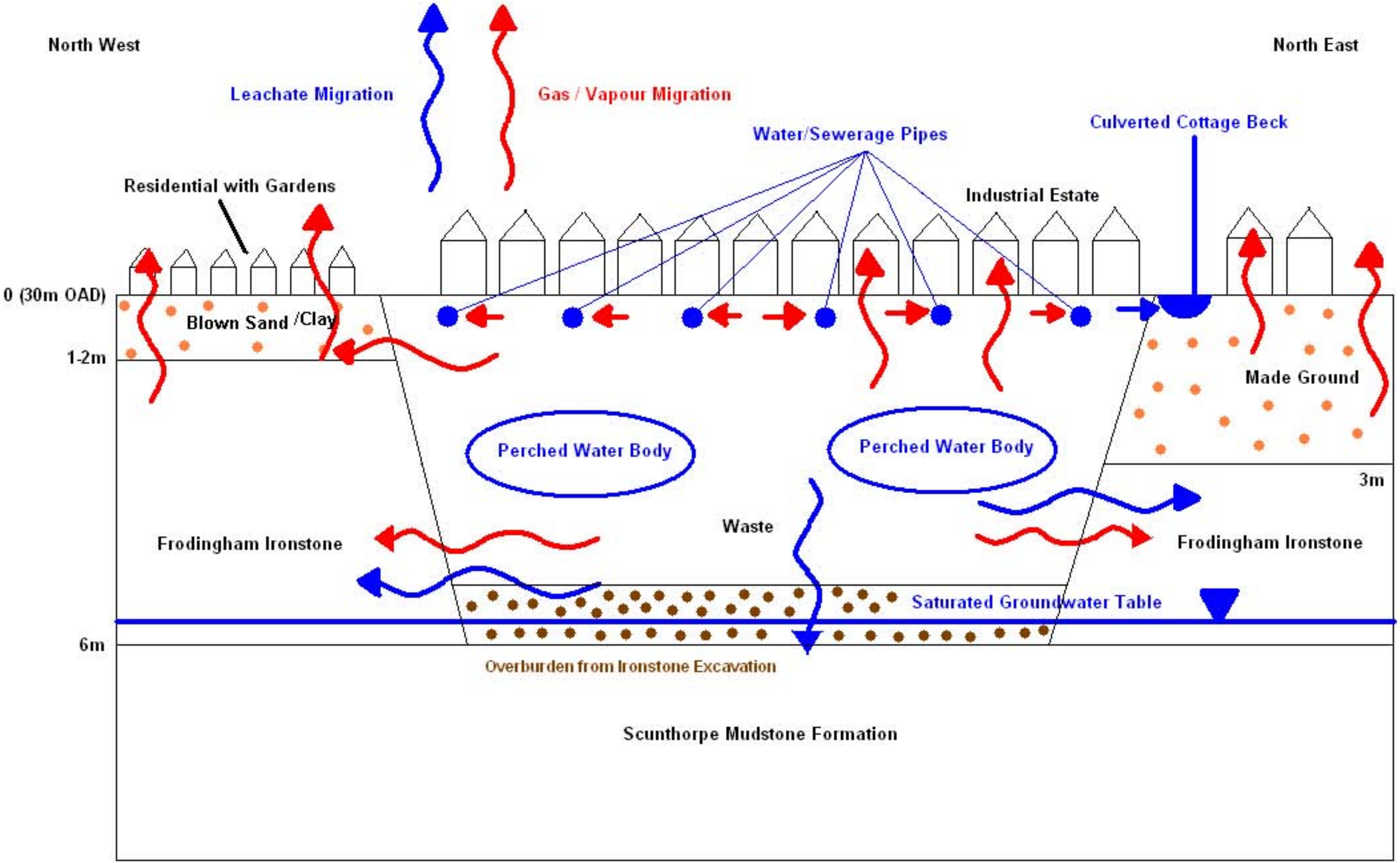
	Type of Receptor	Present	Recreation Ground/Playground	commercial/industrial units
1	**Human Beings**	Yes	Adults and children	Adults and children
2	**Designated Ecological System**	No	None	None
3	**Property in the form of crops**	No	None	None
4	**Property in the form of domestic produce**	No	None	None
5	**Property in the form of allotments**	No	None	None
6	**Property in the form of livestock**	No	None	None
7	**Property in the form of owned or domesticated animals**	Yes	Pet dogs	None
8	**Property in the form of wild animals subject of shooting or fishing rights**	No	None	None
9	**Property in the form of buildings**	Yes	None	Commercial industrial units
10	**Property in the form of Scheduled Ancient Monuments**	No	None	None
11	**Surface Waters**	No	None	None
12	**Groundwater's**	Yes	Blown Sand drift deposits to the south west and west of the site and underlying Scunthorpe Mudstone Formation containing Limestone bands	Underlying Frodingham Ironstone Formation and Scunthorpe Mudstone Formation containing Limestone bands.

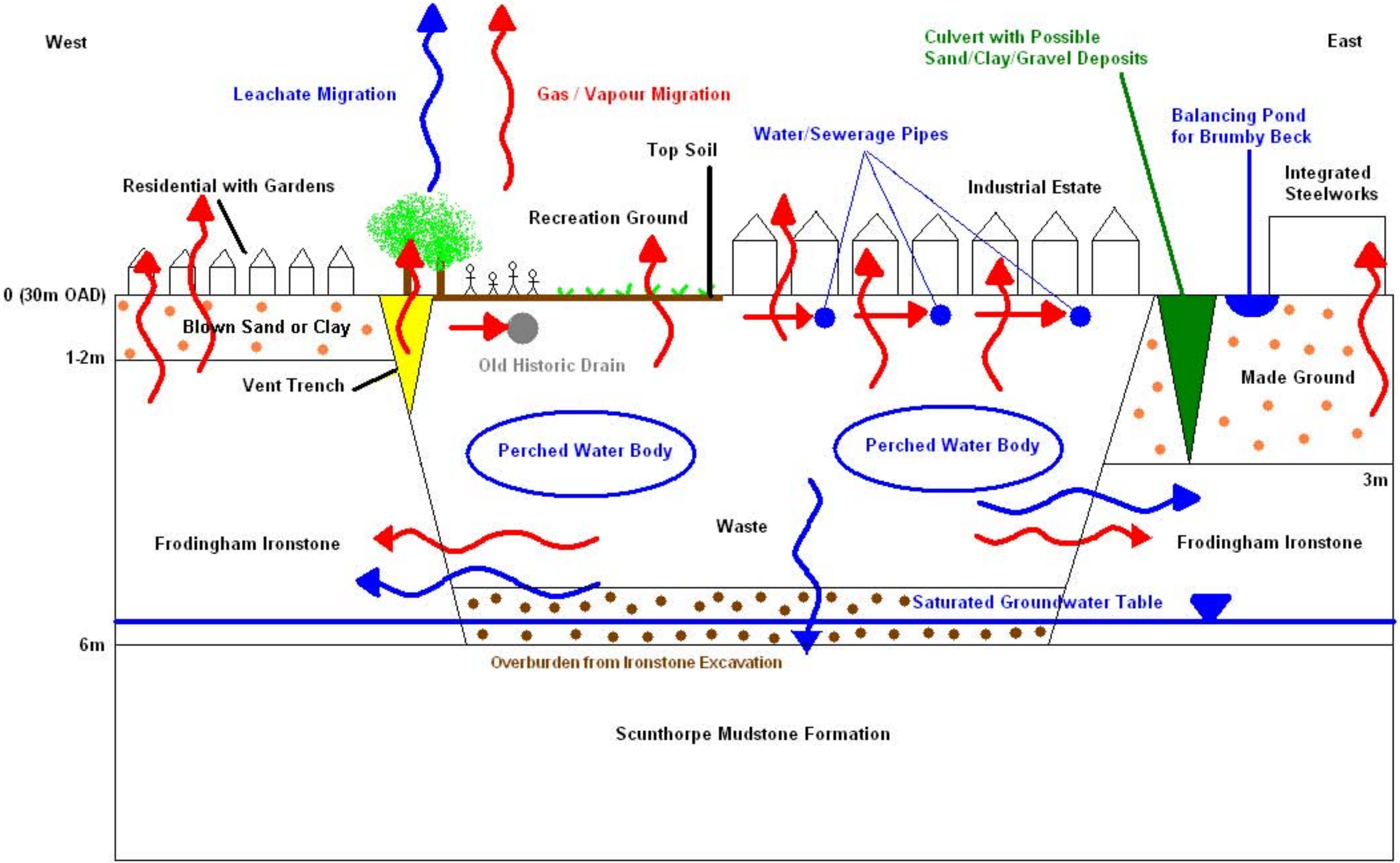
Table 2 Off site designated receptors

	Receptors	Present	Industrial commercial units	Public Open Space	Golf Course/Bowling Green	Recreation ground/playground	Housing
1	**Human Beings Adults**	Yes	Adults	Adults/children	Adults/children	Adults/children	Adults/children
2	**Designated Ecological System**	No	None	None	None	None	None
3	**Property in the form of crops**	No	None	None	None	None	None
4	**Property in the form of domestic produce**	Yes	None	None	None	None	gardens
5	**Property in the form of allotments**	No	None	None	None	None	None
6	**Property in the form of livestock**	No	None	None	None	None	None
7	**Property in the form of owned or domesticated animals**	Yes	None	Pet dogs	None	Pet dogs	Domestic pets such as cats/dogs /rabbits
8	**Property in the form of wild animals subject of shooting or fishing rights**	No	None	None	None	None	None
9	**Property in the form of buildings**	Yes	Commercial /industrial units	None	Pavillions	None	Semi-detached housing
10	**Property in the form of Scheduled Ancient Monuments**	No	None	None	None	None	None
11	**Surface Waters**	Yes	Surface waters culverted. Small lake used to sample outfall of Cottage Beck before it is culverted again				
12	**Groundwater's**		Blown Sand drift deposits to the west and south west. Underlying Secondary A Aquifers.				

Appendix 10.6A




North West
North East
Leachate Migration
Gas / Vapour Migration
Water/Sewerage Pipes
Culverted Cottage Beck
Residential with Gardens
Industrial Estate
0 (30m OAD)
Blown Sand /Clay
1-2m
Made Ground
Perched Water Body
Perched Water Body
3m
Waste
Frodingham Ironstone
Frodingham Ironstone
Saturated Groundwater Table
6m
Overburden from Ironstone Excavation
Scunthorpe Mudstone Formation


West
East
Leachate Migration
Gas / Vapour Migration
Culvert with Possible
Sand/Clay/Gravel Deposits
Balancing Pond
for Brumby Beck
Water/Sewerage Pipes
Top Soil
Residential with Gardens
Industrial Estate
Integrated
Steelworks
Recreation Ground
0 (30m OAD)
Blown Sand or Clay
1-2m
Old Historic Drain
Vent Trench
Made Ground
Perched Water Body
Perched Water Body
3m
Waste
Frodingham Ironstone
Frodingham Ironstone
Saturated Groundwater Table
6m
Overburden from Ironstone Excavation
Scunthorpe Mudstone Formation

Appendix 10.6B Secondary Non Gas Potentially Complete Pollutant Linkages

Table 1 Human Health Pollutant Linkages Associated with Contaminants in Soils and Landfill Waste

SPL No'	Source	Pathway	Receptor	Likelihood	Consequence	Overall Risk
1	Asbestos in waste	Inhalation of dust outdoor	1 Adult and child users of recreation ground on site	Low	Medium	Medium
2			2. Workers of commercial and industrial units on site	Low/Medium	Medium	Medium
3		Inhalation of dust indoor	3. Workers of commercial and industrial units on site	Low/Medium	Medium	Medium
4	Metals and non metals,	Inhalation of indoor dust	1. Workers of commercial and industrial units on site	Low/Medium	Low	Medium
5		Inhalation of outdoor dust	2. Workers of commercial and industrial units on site	Low/Medium	Low	Medium
6			3. Adult and child users of recreation ground on site	Low	Medium	Medium
7		Dermal contact indoors	4. Workers of commercial and industrial units on site	Low/Medium	Low	Medium
8		Dermal contact outdoors	8. Workers of commercial and industrial units on site	Low/Medium	Low	Medium
9			9. Adult and child users of recreation ground on site	Low	Low	Low
10		Direct ingestion of soil	10. Workers of commercial and industrial units on site	Low/Medium	Medium	Medium
11			11. Adult and child users of recreation ground on site	Low	Medium	Medium
12		Direct ingestion of indoor dust	12. Workers of commercial and industrial units on site	Low/Medium	Medium	Medium
13		Permeation of drinking water supply pipes and consumption of drinking water	10 Workers of commercial and industrial units on site	Low/Medium	Medium	Medium

Table 2 Pollutant Linkages Associated with Radioactivity

SPL No'	Source	Pathway	Receptor	Likelihood	Consequence	Overall Risk
1	Radioactivity	External whole body irradiation (outdoors/indoors)	27. Workers of commercial and industrial units on site	Low	Low	Low
2			28. Adult and child users of recreation ground on site	Low	Low	Low
3		Soil ingestion (outdoors/indoors)	29. Workers of commercial and industrial units on site	Low	Low	Low
4			30. Adult and child users of recreation ground on site	Low	Low	Low
5		Dust Ingestion (Outdoor/indoors)	31. Workers of commercial and industrial units on site	Low	Low	Low
6			32. Adult and child users of recreation ground on site	Low	Low	Low
7		Skin external irradiation from dermal contact n	33. Workers of commercial and industrial units on site	Low	Low	Low
8			34. Adult and child users of recreation ground on site	Low	Low	Low
9		Dust Inhalation (indoors/outdoors)	35. Workers of commercial and industrial units on site	Low	Low	Low
10		Inhalation gas indoors	36. Workers of commercial and industrial units on site	Low	Low	Low

Table 3 Potential Pollutant Linkages Associated with Risks To Controlled Waters

SPL No'	Source	Pathway	Receptor	Likelihood	Consequence	Overall Risk
1	Metals and Non Metals	Leaching of contamination to perched groundwater's and migration of leachate through waste/made ground	Blown Sand Drift Deposits	Medium	Low	Medium
2			Sand/Clay/Gravel Drift Deposits	Medium	Low	Medium
3			Groundwater in Ironstone Formation	Medium	Low	Medium
4			Groundwater in Scunthorpe Mudstone Formation Limestone Bands	Medium	Low	Medium
5			Surface Waters in Brumby Beck and Cottage Beck	Low	Low	Low
6		Leaching of contaminants to perched groundwater's and migration along preferential flow pathways such as historic drains	Blown Sand Drift Deposits	Medium	Low	Medium
7			Sand/Clay/Gravel Drift Deposits	Medium	Low	Medium
8			Groundwater in Ironstone Formation	Medium	Low	Medium
9			Groundwater in Scunthorpe Mudstone Formation Limestone Bands	Medium	Low	Medium
10			Surface Waters in Brumby Beck and Cottage Beck	Low	Low	Low

Appendix 10.7.2

Risk estimation and evaluation for human health risk pollutant linkages associated with contaminants contained in soils and landfill waste.

Table 1 of Appendix 10.6B summarises possible significant pollutant linkages associated with contaminants that might be present in the waste and surface soils on the site and which might present a risk to human health for receptors both on site. The likelihood and consequence of their presence has been ranked high to low in order to derive an overall risk score for each pollutant linkage. Justification and evidence for the final risk score is presented below.

SPL 1/2/and3 Inhalation of asbestos waste outdoors and indoors MEDIUM RISK

The landfill site is known not to have had a proper cap put in place during restoration of the site. Anecdotal evidence supports this view with some businesses describing how they have covered up waste which was exposed on their site and that shallow excavations on the site reveal the underlying waste deposits. The site walkovers confirmed that many of the sites had no hard surfacing and therefore no pathway management is in place in such circumstances and as such it is possible that mixing of asbestos waste/fibres has taken place in the surface soils. This being the case and taking into account that construction and demolition waste was deposited under licence it is considered that exposure to asbestos via inhalation outdoors and indoors for occupants of commercial and industrial units on the site is to be of low/medium likelihood.

The site walkover of the recreation field identified that the site has relatively thick vegetation including thick overgrown grass, bushes and trees. The site appears to have some covering of top soil. The use of the recreation ground is primarily for dog walking only. There is a playground to the south west of the site, but the site walkover presented no evidence of exposed waste. Limited mixing asbestos waste in the soil cap is possible and therefore it is considered that the likelihood of exposure to asbestos via inhalation outdoors for users of the recreation field is low.

The consequence of exposure via this route is not an immediate risk to human health but as asbestos is a non threshold contaminant it has been rated as medium.

SPL 4/5/6 Inhalation of metals and non metals attached to outdoor and indoor dust MEDIUM RISK

Due to the expected thin capping layer on many the commercial and industrial units it is expected that mixing of metal and non metal contaminants may have resulted in elevated levels in the surface soils on site. The type of activities that take place in many of the units can give rise to elevated dust levels (i.e. movement of plant and equipment) and on many sites there is no hard standing. The likelihood of exposure via this pathway has been predicted as low/medium risk. At this stage however there is no direct evidence of high levels of contamination due to the absence of sampling results and the commercial end use is not highly sensitive, additionally exposure via this

pathway is very low as a contribution to total exposure and therefore inhalation outdoors is considered to be of a low consequence.

Dust tracking back into commercial and industrial units on the site is considered to be likely as many of the units visited had a very poor level of housekeeping. Exposure via inhalation outdoors for occupants of commercial and industrial units is considered to be of a low/medium likelihood. At this stage however there is no direct evidence of high levels of contamination and the commercial end use is not highly sensitive, additionally exposure via this pathway is very low as a contribution to overall total exposure and therefore inhalation indoors is considered to be of a low consequence.

On the recreation ground the level of activities giving rise to exposure to dust is considered to be low as the activities carried out on the site are not so high impact and limited top soil is in place on the site. The thick vegetation also reduces the likelihood of exposure via this pathway. The type of activities that take place on the recreation ground (dog walking) are not likely to give rise to high levels of dust. The playground area of the site is located on a land raise which is expected to be clean fill. Exposure via this pathway is considered to be of low likelihood. Exposure via this pathway has a very low contribution to the overall risk however due to the sensitive end use the consequence of exposure via this route is considered to be of a medium risk.

SPL 7/8/9 Dermal contact outdoors and indoors MEDIUM RISK and LOW RISK

Due to the thin capping layer it is likely soil mixing has resulted in metal contaminants being present in the surface soils on some commercial and industrial units. Poor regard to health and safety such as wearing protective gloves is likely to be high on many of the units, and poor levels of housekeeping will increase the likelihood for exposure indoors. Most metals are non toxic via this route of exposure and therefore the consequence of the exposure has been ranked as low for metals and medium for non metals. Therefore dermal contact both indoors and outdoors for occupants of commercial and industrial units is considered to be of low/medium likelihood.

Users of the recreation ground are less likely to be exposed to dermal contact with metal contamination. This is due to the low level activities carried out on the field (i.e. dog walking) and the thickness of the vegetation cover and top soil. The playground area of the recreation field is elevated in height compared with the rest of the recreation area and is expected to have a significant covering of top soil therefore reducing exposure via this route. Exposure to metal contamination via dermal contact for users of the recreation field is considered to be of low likelihood. As the consequence of exposure via this route is not an immediate risk to human health and dermal contact outdoors for the recreation field has been predicted as a low consequence.

SPL 10/11/12 Direct ingestion of soil and indoor dust metals and non metals MEDIUM RISK

Due to the expected thin capping layer on the commercial and industrial units, it is considered likely that mixing of metal and non metal contamination has taken place in the surface soils on sites where there is no hard surfacing. Poor levels of health and safety identified on many sites will increase the risk of direct ingestion outdoors due to issues such as the absence of protective gloves. Poor levels of housekeeping will increase the risk of backtracking of soil indoors. The likelihood of exposure for ingestion of soil and indoor dust has therefore been assigned a medium risk. There is no direct evidence of elevated metals in the surface soils due to the absence of sampling data and the commercial end use is non sensitive, however this route of exposure is often the main risk driver in the contribution to total exposure when deriving soil guideline values and therefore the consequence of this exposure is considered to be of low/medium likelihood.

Users of the recreation field are less likely to be exposed to direct ingestion of soil due to the low level of activity taking place on the site (dog walking). The grass is too long to allow dirt track riding by children. The playground land raise is expected to have a significant cover of clean fill. Therefore the likelihood of exposure via this route is considered to be low. Due to the sites sensitive end use and this rout of exposure being the main risk driver the consequence of exposure via this route is considered to be of a medium risk.

SPL 13 Permeation of drinking water supply pipes MEDIUM RISK

Plans obtained from Anglian water show that main water supply pipes run through the former landfill site on the industrial and commercial estate around Midland Road. Subsequent discussion held with Anglian Water have identified that the majority of the mains pipes on this area of the site are old cast iron pipes which have been laid at a depth of 750-900 mm. A small section of Midland Road (south of Nostell Road) has been replaced with High Density Polyethylene approximately 10 years ago. The replacement took place due to a burst main.

The composition of drinking water supply pipes from the mains supply in the road to the industrial and commercial units is unknown, however due to the age of the industrial estate it is unlikely that the pipes were laid in properly protected trenches of clean fill. It is possible that the water supply pipe materials might consist of cast iron, copper, galvanised steel or a range of plastics such as polyethylene, polyvinyl chloride, and polypropylene.

Landfill sites are high risk sites for the use of plastic pipes

- Cast iron is susceptible to corrosion in soils containing high levels of chlorides and sulphate and is also at risk of mechanical overloading. Therefore it is possible that if water pipes are constructed of this material cracking and corrosion may have taken place if laid in the landfill waste.

- Copper pipes are at risk from attack in grounds which are found to be high in acids, sulphates, chlorides and also grounds containing cinders. If water supply pipes are constructed of this material it is possible that corrosion may have taken place if the pipes have been laid unprotected in the waste.

- Plastic materials are generally at risk from being degraded by acids and petroleum products. The plastic polymer structure can degrade and swell and can be at risk of environmental stress cracking. Microbial degradation can also cause some cracking of plastics. Plastic resistance to degradation and cracking reduces with increases in temperature. Due to the industrial and commercial nature of the area it is possible that on site spillages on petroleum products might have occurred which were then not cleaned up. Similarly the aggressive nature of the landfill leachate and the increased temperatures of the landfill will increase the degradation potential of plastic materials when laid unprotected in this type of ground.

Based upon the information presented above it is therefore considered to be of low/medium likelihood that permeation of metals and non metals from the landfill leachate and waste into the water supply pipes will take place.

The consequence of ingestion of drinking water contaminated with metals and non metals is considered to be of a medium risk as it is not an immediate risk to human health.

Appendix 10.7.3

10.7.3 Lines of Evidence and Justification for Risk Analysis of Radioactivity Pollutant Linkages Associated With Risks to Human Health

Table 2 of Appendix 10.6B summarises the potential pollutant linkages which have the potential to present risks to human health associated with radioactivity contamination. The likelihood and consequence of their presence has been ranked high to low in order to derive an overall risk score for each pollutant linkage. Justification and evidence for the final risk score is presented below.

The Defra *Industry Profile for Industrial Activities Which Have Used Materials Containing Radioactivity* (March 2006) has been referred to in order to assess the likelihood and consequence of the presence of radioactive materials in the landfill site. In addition advice has been sought from Richard Lee and Peter Burrell of the Midlands Region Non Nuclear Radioactive Substances Regulation Team of the Environment Agency which is based at Nottingham.

Risk estimation and evaluation or pollutant linkages associated with radioactivity LOW RISK

SPL 1,2,3,4,5,6,7,8,9 and 10
External whole body irradiation (outdoors/indoors)
Soil ingestion (outdoors/indoors)
Dust Ingestion (Outdoor/indoors)
Skin external irradiation from dermal contact n
Dust Inhalation (indoors/outdoors)
Inhalation gas indoors: It is possible that volatile radionuclide's are associated with landfill gas emissions

Currently there is no direct evidence in the form of historical records to indicate that deposition of radioactive material took place and evidence at present is based upon information about known historical practices that are likely to have taken place as described above.

Based upon known historical practices it is considered likely that sinter dusts, medical establishment wastes, incinerator wastes and wastes associated with gamma radiography used for castings and weldings, might have been deposited at the landfill site prior to the Radioactive Substances Act 1963 as the site is thought to have been operational around 1948. As there is no direct evidence of these practices taking place the likelihood of radioactivity being present in the landfill has been ranked as low for all routes of exposure.

Discussions held with the Midlands Region Non Nuclear Radioactive Substances Team of the Environment Agency have confirmed that the wastes described above are not thought to be capable of giving rise to an effective dose of 3 millisieverts/year and therefore the consequence of exposure has been assessed as low for all routes of exposure.

Appendix 10.7.4

10.7.4 Risk estimation and evaluation of controlled water pollutant linkages associated with contaminants contained in the landfill waste.

Table 11 below summarises possible pollutant linkages associated with contaminants that might be present in the waste on the site and which might present a risk to controlled waters. The likelihood and consequence of their presence has been ranked high to low in order to derive an overall risk score for each pollutant linkage. Justification and evidence for the final risk score is presented below.

SPL 1/2/3/4 & 11/12/13/14 Leaching and migration of metals and non metals through waste and made ground to the saturated zone in drift deposits and underlying solid geology

Due to the lack of any significant cap on the landfill site there will be percolation of rainwater through the waste and possibly groundwater inflows to the site. Water movement through the unsaturated zone is predominantly downwards (gravity driven) however not all leachate stored in the waste is fully available to drain to the base and sides of the site as some is absorbed by the waste and some may remain perched above low permeability layers at higher levels in the waste.

Anecdotal evidence seems to suggest that the waste deposits are quite dry, and as there is no properly constructed liner at the base and sides of the landfill and no management system in place to contain the leachate, it is likely that leachate will seep through the base of the site into the underlying Frodingham Ironstone and Scunthorpe Mudstone Formation which contains shelly limestone bands and through the sides of the site into the adjacent drift deposits of Blown Sand and Sand Clay and Gravel drift deposits. It is therefore considered of medium likelihood that leaching and migration of contaminants will take place via this pathway to identified sensitive controlled water receptors.

Due to the low sensitivity of the aquifer designation (Secondary A formally a minor aquifer) both for the underlying geology and drift geology the consequence of the pollution has been ranked as low.

SPL 5 & 15 Leaching and migration of metals and non metals through waste and made ground to surface waters.

The surface waters of Brumby and Cottage Beck are culverted underground along their length and therefore the likelihood of contaminants migrating laterally through the unsaturated zone to these culverted surface waters has been ranked as low.

The water quality of Brumby Beck is poor to bad with high levels of phosphates and nitrates, the consequence of pollution reaching the surface water has therefore been assessed as a medium consequence.

SPL 6/7/8/9 & 16/17/18/19 Leaching of metals and non metals to perched groundwater's in the unsaturated zone and migration along preferential flow pathways such as historic drains, fissures or conduits to drift deposits and underlying solid geology and adjacent surface waters.
The presence of preferential flow paths can dominate leachate egress from the site to the underlying Scunthorpe Mudstone Formation and the adjacent drift deposits of Blown Sand and Clay/Sand and Gravel. Preferential flow paths in the form of old drains, cracks/jointing in the Frodingham Ironstone along with high permeability layers in the waste have been identified at the site. Migration along these pathways are likely to result in leachate migrating along these preferential pathways to the underlying Scunthorpe Mudstone Formation, adjacent drift deposits and surface waters of Brumby and Cottage Beck.

SPL 10 & 20 Leaching of metals and non metals to perched groundwater's in the unsaturated zone and migration along preferential flow pathways such as historic drains, fissures or conduits
Preferential flow paths in the form of old drains, cracks/jointing in the Frodingham Ironstone along with high permeability layers in the waste have been identified at the site, however the surf ace waters of Cottage and Brumby Beck are both culverted along their length and therefore the likelihood of pollution of the surface waters has been ranked as low.

The water quality of Brumby Beck is poor to bad with high levels of phosphates and nitrates, the consequence of pollution reaching the surface water has therefore been assessed as a medium consequence.

Appendix 10.7.5

10.7.5 Risk estimation and evaluation of pollutant linkages associated with the building effect

The commercial properties on the Midland Road Industrial Estate which sit on top of the former landfill site are and have the potential to be affected by subsidence of the landfill waste. This was demonstrated by evidence collected from the site walkover (section 4.2.3).The likelihood of the subsidence resulting in structural failure, substantial damage or substantial interference with any right of occupation, to the extent that the building ceases to be capable of being used for the purpose for which is was intended is considered to be low.

The properties in many cases have been present on the site since 1960 -1971 and it is likely that such interference with the right of occupation would have presented itself by this data.

The consequence of such an occurrence has also been ranked as low.

Appendix 10.8 Uncertainties and level of confidence in site conceptual model

No'	Landfill Site Design	Waste Conditions	Ground Gas Production/Migration	Controlled Waters	Buildings and Services	Contaminants
1	The age of the wastes in different areas of the site	The nature of the biodegradable material (ratio's of lignin/cellulose/hemicelluloses in the wastes)	The nature of the ground gas regime on the site (gas flow rates and volumes and spatial resolution)	The level of leachate containment within the landfill	Floor slab construction of residential dwellings located to the west of the site and the vent trench	The potential/ nature and range of gases/vapours in the waste body
2	The nature and type of wastes deposited in different areas of the site	Levels of Degradable Organic Carbon (DOC) in the waste	The sites potential to replenish the gas source and create a concentration gradient to allow diffusive flow to sensitive receptors	The nature of the landfill water balance in the unsaturated zone	Floor slab construction and condition for commercial/industrial premises	The nature concentration and range of contaminants in the waste body/leachate and or groundwater/surface water
3	Lateral and horizontal extent of the waste	The Biological Methane Potential (BMP) of the waste	The influence of the groundwater regime on gas production and migration	The amount of leachate absorbed by the waste	The significance of on site commercial building subsidence/cracks in allowing gas/vapour ingress	The mobility of contaminants within the waste body/leachate and groundwater
4	The nature of the rock/material forming the base and sides of the landfill	The temperatures of the wastes	Main mechanisms for gas and vapour migration on the site(pressure driven flow/diffusive flow through soil pores/migration along preferential pathways	The rate of infiltration of groundwater through the waste	The construction of drinking water supply pipes on commercial and industrial properties	The actual nature and concentration of contamination in the surface soils at the site and their risks to human health

No’	Landfill Site Design	Waste Conditions	Ground Gas Production/Migration	Controlled Waters	Buildings and Services	Contaminants
5	The lateral and vertical composition of the waste	pH value of the wastes	The volume of gas on site able to migrate within the site and off site to receptors	The presence of perched water bodies		The unreasonable presence of contaminants/vapours/gases in the drinking water supply for commercial and industrial properties on the site.
6	The volume of degradable material within the site	Inhibition of degradation due to high levels of metals toxic to micro-organisms	Whether floor slab construction in commercial and industrial properties are robust enough to prevent vertical migration of ground gases and vapours via pressure driven flow.	The level of the saturated groundwater table		Presence of trace gases with the potential to present unreasonable risks to human health
7	The presence, nature, extent and depth of made ground underlying residential properties on the western boundary of the site	The moisture content of the wastes	The influence of temporal changes on the ground gas regime	Leachate impact upon the saturated groundwater		Presence of vapours with the potential to present unreasonable risks to human health
8	The nature and depth of made ground adjacent to the landfill site on its northern, southern and western boundaries	Retardation of biodegradation due to lack of moisture	The presence of natural preferential pathways in the base and sides of the landfill that will allow gas/vapour migration	The prevailing groundwater flow		The presence of contaminants continuing to enter controlled waters such that pollution occurs.

No’	Landfill Site Design	Waste Conditions	Ground Gas Production/Migration	Controlled Waters	Buildings and Services	Contaminants
9		Risks associated with future moisture changes	The location and extent of historical pipework that will allow migration of gases/vapours	The impact of landfill leachate upon the poor water quality of Cottage and Brumby Beck		
10		Stabilisation of the waste in terms of decomposition	Effective functioning of the vent trench in allowing vertical gas migration			
11		The permeability of the wastes and surrounding rock/soils and made ground	The length and depth of the vent trench is sufficient to prevent gas/vapour migration to residential properties on the west			
12		The presence and/or vertical lateral extent of drift deposits relevant to the site.				

The degree of confidence associated with the uncertainties identified has been rated as follows:

High uncertainty: Red
Medium uncertainty: Amber
Low Uncertainty: Green

Appendix 10.9

Non Gas Secondary Potential Unacceptable Risks

Secondary MEDIUM risks to human health from shallow surface soils/waste and to controlled waters from leachate production have also been identified and are summarised in Table 1 below:

Source	**Pathway**	**Receptor**
Contaminants in shallow surface soils and waste deposits	1 Inhalation indoor/outdoor dust 2 Direct Ingestion of Soil and Dust 3 Dermal Contact	1 On site receptors commercial/industrial units 2 public open space
Contaminants in leachate/sludge's	Migration through water supply pipes and ingestion of drinking water	On site occupants of commercial/industrial premises
Contaminants in waste	Production and migration of leachate	Secondary A Aquifers
Contaminants in waste	Production and migration of leachate along preferential pathways	Secondary Aquifers

Appendix 10.13

Detailed Costed Scope of Works

The details and costs of detailed inspection have been itemised into 3 separate costed components as detailed below:

1 Details and costs associated with the investigation and assessment of ground gas pollutant linkages (Urgent investigation required to assess acute risks to human health).

2 Details and costs associated with the climate change mitigation assessment (investigation required to clarify the predicted chronic risks to human health and risks to controlled waters)

3 Details and costs associated with the investigation and assessment of secondary non ground gas pollutant linkages

The costs have been itemised in this way in order that the council's bid for grant funding is not prejudiced in terms of value for money", as the lower risk and non essential items of the site investigation (items 2 and 3) can be easily removed if funding is not available for all aspects of detailed inspection.

1 Detailed Scope and Costs of Primary Ground Gas Pollutant Linkages

Table 1 below provides details and costs of the site investigation required to investigate and assess the risks posed by ground gases at the site.

Table 1 (All figures presented are excluding VAT)

Information required	Breakdown Cost Ref	Strategy	Estimated Cost (£, exc. VAT)
Current state of decomposition of the waste and the future potential to generate gas	1	Excavation of 30 No. trial pits to permit detailed inspection and characterisation of the waste body and appropriate sampling for laboratory analysis. Comprehensive descriptions of waste/soil to BS EN 14688-1, including visual quantitative assessment of proportion of main waste components.	£4550.00
	2	Allowance for laboratory testing of selected soil samples (40 No.) for key gas indicator compounds such as Total Organic Carbon and pH. Allowance for selected soil samples (15 No.) with samples submitted for VOC+TIC and SVOC+TIC determination (to inform the assessment of human health vapour risks reflecting 'chemical odour' observed during previous trial pits).	£1740.00
	3	Allowance for laboratory screening of selected soil samples (10 No.) for assessment of waste ratios in bulk samples.	£3500.00
	4	Drill cable percussion boreholes and install wells in the existing landfill material at shallow depth – allow 10 No. wells within the industrial estate and POS.	£7800.00

Information required	Breakdown Cost Ref	Strategy	Estimated Cost (£, exc. VAT)
	5	Sampling of leachate from within the wells for BOD, COD, Chloride, ammoniacal nitrogen, metals (inc iron, manganese, Ortho phosphate, volatile acids, nitrate, TOC, dissolved methane, dissolved carbon dioxide.	£2570.00
Detailed geology of the surrounding area, groundwater levels, the permeability of the strata and the depth / location of the existing vent trench	6	The completion of 6 No. rotary core boreholes with standpipe installations to monitor the deep gas regime / bedrock.	£12150.00
	7	The completion of 10 No. probehole boreholes with standpipe installations to monitor the shallow gas regime / drift deposits and reflect any areas of restricted access.	£4470.00
	8	The implementation of an appropriate ground gas monitoring regime – 12 No. monitoring visits over a 3 month period. Selected use of high frequency monitoring where it is deemed appropriate based on the results of the investigation and the risk assessment.	£7800.00
	9	Further gas monitoring to cover seasonal variations if this is likely to have a significant influence on the conclusion of the risk assessment. Provisional item if required.	5 days at £560/day £2,800
	10	The completion of 10 No. falling head tests within selected boreholes to provide an indication of material permeability.	£1500.00
	11	In highest 5% of gas producing wells, allowance for canister sample collection of gas/vapour for laboratory analysis of bulk gases, top-20 vapour compounds and Total Petroleum Hydrocarbons CWG C4-C12.	£735.00
Condition of floor slabs and the precise dimensions and internal layout of the buildings. There is also uncertainty regarding internal detection of "landfill gas" within some buildings	12	Topographical survey of 10% of commercial premises (15 No.) to provide dimensions of building and internal layout.	£8970.00
	13	Structural survey by structural engineer to identify all cracks in building wall / floor slab at ground floor level in 10% of commercial premises (15 No.).	£5750.00
	14	Ground Penetration Radar survey of floor slab of selected 10% of commercial premises (15 No.) to determine if any voids are present beneath the slab construction and identify if any reinforcement is present.	£10125.00
Occurrence of odour and headaches.	15	A pre-inspection questionnaire to all businesses asking them to identify any complaints which have been made regarding possible issues associated with the landfill.	£1300.00
	16	Complete a thorough inspection of each building to assess current usage, any potential spark ignition activities, determine the floor slab construction and	£1300.00

Information required	Breakdown Cost Ref	Strategy	Estimated Cost (£, exc. VAT)
		any evidence of settlement.	
	17	Complete a robust phase of internal air spac monitoring within each commercial premises on site, to include monitoring of all small spaces at ground floor level (e.g. service cupboards). Ensure this also targets key areas of weakness within the ground bearing slabs – e.g. utility service inlet points. Recommend minimum 6 No. visits bi-monthl for a period of 1-yr, targeting periods of low / falling atmospheric pressure where possible and utilising a calibrated Flame Ionisation Detector combined with GC-MS if available.	£11700.00
	18	Any buildings where vapour concentrations over 50ppm are recorded on 2 No. consecut visits (which can not be attributed to busines related activities) to be subject to internal spa fixed monitoring via diffusion tubes and laboratory analysis.	£1225.00
The efficacy of the gas vent trench is unknown.	19	Complete geophysics resistivity survey perpendicular to the gas vent trench at 50m centres to confirm its depth.	£2990.00
	20	Target trial pit locations at 50m centres along the western boundary of the site to define the extent of the landfill waste in relation to the gas vent trench / site boundary and the underlying natural geology.	£1820.00
	21	Survey the gas vent trench to determine its exact dimensions and assess the ratio of are which has become defunct due to lack of maintenance (i.e. vegetation overgrowth).	£1350.00
Ancillary works	22	Provision of all documentation, inc. H&S Plans, Method Statements, Risk Assessment and Factual Report.	£5000.00
	23	Utility service clearance works, skip for disposal of all excess arising, heras fencing to demark work areas and setting up of Contractor compound.	£5000.00
Site Supervision	24	Allows for 22 days at 1,100/day including accommodation.	£24,200.00
Part 2A risk assessment and options appraisal	25	Allow for robust assessment of all the collated factual data by an appropriately experienced specialist in order to assess the identified risks within the context of the Part 2A process. Must provide a definitive recommendation on whether the site meets the statutory definition of Contaminated Land on the basis of the investigation specified above. Prepare detailed and costed options appraisal if remediation is considered necessary.	£20000.00
TOTAL FEE			**£150,345.00**
CONTINGENCY @ 15%			**£22,551.75**
FINAL FEE			**£172,896.75**

2 Detailed Scope and Costs of Climate Change Mitigation Assessment (Greenhouse Gases)

Table 2 below provides details and costs of the site required to investigate the impact of greenhouse gases.

Table 2 (All figures presented are excluding VAT)

Item	Estimated Cost
Walkover survey and Flame Ionisation Detector (FID) monitoring	**£2,000**
Measurement of methane flux using flux boxes	**£4,500**
Measurement of trace components within landfill gas	**Already allowed for in main site investigation (£735)**
TOTAL FEE	**£6,500.00**
CONTINGENCY FEE at 15%	**£975.00**
FINAL FEE	**£7,475.00**

3 Detailed Scope and Costs of Secondary Non Ground Gas Pollutant Linkages

Table 3 below provides details and costs of the site investigation required to investigate and assess the risks posed by secondary non ground gas pollutant linkages at the site.

Table 3 (All figures presented are excluding VAT)

Item	Detail	Estimated Cost (£, exc. VAT)
Chemical testing of shallow soils (<0.5m) to inform human health assessment	Soil samples submitted for suite of analysis to include; • Metals • Speciated Total Petroleum Hydrocarbons - CWG • Speciated Polycyclic Aromatic Hydrocarbons • Volatile Organic Compounds with TICS • Semi Volatile Organic Compounds with TICS • TOC and pH • Asbestos screen Allow 20 No. samples	£4,316.00
Chemical testing of potable water samples as collected from on-site drinking water taps	Drinking water samples submitted for suite of analysis to include; • Metals • Speciated Total Petroleum Hydrocarbons - CWG • Speciated Polycyclic Aromatic Hydrocarbons • Volatile Organic Compounds with TICS	£1,085.00

	• Semi Volatile Organic Compounds with TICS • Ammonia, Nitrogen, Chloride, Cyanide and Sulphate Allow 5 No. samples	
Detailed Quantitative Risk Assessment for human health assessment	Nominal allowance for DQRA in accordance with CLEA framework.	£4,500.00
Chemical testing of soil samples for leachate assessment to inform risks to Controlled Waters	Supplement to Item 5 in main 'Proposed Site Investigation' table. Leachate suite of analysis to include; • Metals • Speciated Total Petroleum Hydrocarbons - CWG • Speciated Polycyclic Aromatic Hydrocarbons • Volatile Organic Compounds with TICS • Semi Volatile Organic Compounds with TICS Allow 10 No. samples	£1,915.00
Chemical testing of groundwater samples to inform risks to Controlled Waters	Removal of groundwater samples from deep monitoring wells installed as per Item 6 with samples submitted for suite of analysis to include; • Metals • Speciated Total Petroleum Hydrocarbons - CWG • Speciated Polycyclic Aromatic Hydrocarbons • Volatile Organic Compounds with TICS • Semi Volatile Organic Compounds with TICS • Ammonia, nitrogen, chloride, cyanide and sulphate • BOC, COD, Alkalinity and pH Allow for 10 No. groundwater samples	£2,464.00
Allowance for additional deep wells to permit targeted groundwater chemical testing	Supplement to Item 6 in main 'Proposed Site Investigation' table. Assumes all rotary core boreholes completed as one phase of works to limit mobilisation costs. Allowance for 3 No. additional boreholes, extended to 10m depth, including; liners, core boxes, casing, standpipes, covers and part-time Engineer supervision.	£4,766.00
Detailed Quantitative Risk Assessment for Controlled Waters assessment	Nominal allowance for DQRA in accordance with R&D P20/CONSIM frameworks (as appropriate).	£4,500
TOTAL FEE		**£23,546.00**
CONTINGENCY FEE at 15%		**£3,531.90**
FINAL FEE		**£27,077.90**

4 Summary of Costs Including Contingency

Table 4 below provides final costs including contingency of each of the 3 itemised aspects of detailed inspection along with cumulative costs in order that it can be seen how these items 2 and 3 can be easily removed if these aspects do not meet the “value for money” test.

Table 4 (All figures presented are excluding VAT)

No’	Detailed Inspection	Cost	Cumulative Total
1	Primary Ground Gas Pollutant Linkages	£172,896.75	
2	CCMA	£7,475.00	£180,371.75
3	Secondary Non Ground Gas Pollutant Linkages	£27,077.90	£207,449.65

5 Summary of Costs Excluding Contingency

Table 5 below provides final costs excluding contingency of each of the 3 itemised aspects of detailed inspection along with cumulative costs in order that it can be seen how these items 2 and 3 can be easily removed if these aspects do not meet the “value for money” test.

Table 5 (All figures presented are excluding VAT)

No’	Detailed Inspection	Cost	Cumulative Total
1	Primary Ground Gas Pollutant Linkages	£150,345.00	
2	CCMA	£6,500.00	£156,845
3	Secondary Non Ground Gas Pollutant Linkages	£23,546.00	£180,391

6. Justification for Contingency Figure

Unexpected work such as extra boreholes, testing or delays due to weather and the risk of gas monitoring boreholes being damaged/lost are allowed for by using a simple contingency allowance of 15%. This is a standard method of dealing with risk items in simple small value contracts.