- ***Discussion on Alternative Sites***

- **Alternative A:** Comprise mostly agricultural fields with mining activity to the west. Extensive grassland and riparian habitat located to the east and north of this site is a concern, but could potentially be protected by means of strict mitigation measures. The suitability of this site for the proposed development is therefore regarded medium.
- **Alternative B:** Although this site comprises extensive agricultural fields, some parts are characterised by wetland habitat that was not previously captured on the database and only observed during the brief site investigation. As a result of the presence of these scattered wetlands, the suitability of the site for the proposed development is regarded medium, also considering the distance to the power station.
- **Alternative C:** This site comprises exclusively of agricultural fields and no habitat of sensitivity is present within the proposed boundaries. A riparian habitat is located to the east of the site and this habitat will need to be crossed by the required pipeline infrastructure. In addition, extensive natural grassland and riparian wetland is present to the south and east of this site, rendering the suitability of this site for the proposed development is regarded as medium-low.
- **Alternative D:** Similar to Site A, this site comprises extensive agricultural areas, but grassland and riparian habitat is located to the immediate east and west of the site. The perceived ecological status of the wetland areas to the west was estimated to be relative low as a result of mining activities. Ultimately, the suitability of the site for the proposed development is regarded as medium, mainly as a result of the presence of extensive areas of natural grassland habitat located to the east of the site.
- **Alternative E:** The presence of wetland and grassland habitat that was not captured in the existing database, within this site was confirmed during the site investigation. The position of this site in close proximity to the power station implies that no sensitive habitat needs to be crossed by the required infrastructure. Surrounding habitat is similarly low in sensitivity. The suitability of the site for the proposed development is regarded as medium. This site is furthermore entirely isolated by means of road infrastructure and mining development.

Further detail can be obtained from the Biodiversity Specialist Report in **Appendix K**.

7.3.8 Avifauna

Data on the bird species that could occur in the study area and their abundance was obtained from the Southern African Bird Atlas Project (Harrison et al, 1997). These data provided an indication of the bird species that were recorded in the quarter degree squares within which this proposed project falls, i.e. 2629BA and 2529DC.

Table 7.3: Red Listed bird species recorded in the quarter degree squares (2629BA and 2529DC) within which the study area is located (Harrison et al, 1997). Report rates are percentages of the number of times a species was recorded by the number of times the square was counted. Conservation status is classified according to Barnes (2000).

Total Cards		66	64
Total Species		193	221
Total Breeding Species		44	27
Name	**Conservation status**	**2629BA report rate**	**2529DC report rate**
Botha's Lark	EN	2	-
Southern Bald Ibis	VU	5	14
African Marsh-Harrier	VU	2	-
Lesser Kestrel	VU	3	13
African Grass Owl	VU	2	2
Denham's Bustard	VU	-	2
White-bellied Korhaan	VU	-	2
Yellow-billed Stork	NT	3	-
Greater Flamingo	NT	27	36
Lesser Flamingo	NT	8	17
Secretarybird	NT	3	5
Black Harrier	NT	2	-
Pallid Harrier	NT	-	2
Blue Korhaan	NT	3	2
Black-winged Pratincole	NT	5	2
Black Stork	NT	-	5
White Stork	Bonn	11	14

EN=Endangered; VU=Vulnerable; NT=Near-threatened; Bonn=Protected Internationally under the Bonn Convention on Migratory Species.

The SABAP data lists 1 Endangered, 6 Vulnerable and 9 near threatened species as occurring within the study area. In addition, one species, the White Stork is protected internationally under the Bonn Convention on Migratory Species.

SABAP 2 data was also consulted, with the two pentads in the study area, 2600_2935 and 2555_2935, recording totals of 70 and 78 species respectively. Only one card had been submitted for pentad 2600_2935, while three counts have been conducted in pentad 2555_2935 to date. This represents insufficient data to be considered an accurate indication of species present or absent. It was noted, however, that pentad 2555_2935 had report rates of 33% (i.e. 1 of 3 counts) for both Greater and Lesser Flamingoes.

Two CWAC sites occur in the study area. A potential CWAC site is any body of water, other than the oceans, which supports a significant number of birds. This definition includes natural pans, vleis, marshes, lakes, rivers, estuaries and lagoons as well as the whole gamut of manmade impoundments. The two CWAC sites are Oranje Pan and Coetzeespruit Dam. Key IUCN Listed species recorded at the CWAC sites include the Greater Flamingo and African Marsh-Harrier.

CAR route MM03 of the Mpumalanga Precinct runs in close proximity to the Study area. Southern Bald Ibis was the only key species recorded on this route during the study period.

The 2629BA QDGS, in which all 5 alternative sites are found, also incorporates part of an Important Bird Area (IBA) - Amersfoort-bethal-carolina District. Although this IBA falls outside of the 8km study radius, it is known to hold a large proportion (>10%) of the global population of the endangered Botha's Lark (Barnes 1998). This species favors short dense, natural grassland found on plateaus and upper hill slopes. Such habitat was not observed at any of the proposed sites for this project. The majority of the study area comprised of agricultural lands, planted pastures, vleis and dams which are habitats not usually preferred by Botha's Lark. The Globally threatened Wattled Crane was listed as a vagrant to this IBA, while other key listed species recorded include Southern Bald Ibis, Lesser Kestrel, Blue Crane, African Grass Owl, Lanner Falcon and Blackwinged Lapwing. However, of these only the Southern Bald Ibis, African Grass Owl and Lesser Kestrel were recorded in the SABAP1 data from the QDGS, and the fact that the study area does not fall within the IBA, suggests that those species not recorded in SABAP1 data, are unlikely to occur on site.

- **Bird Micro-habitats**

An examination of the micro habitats available to birds was conducted. These are generally evident at a much smaller spatial scale than vegetation types, and are determined by a host of factors such as vegetation type, topography, land use and man-made infrastructure. The following micro-habitats were identified in the study area.

- *Cultivated Lands and Pasture*
  Arable or cultivated land as well as pastures, represents a significant feeding area for many bird species in any landscape for the following reasons: through opening up the soil surface, land preparation makes many insects, seeds, bulbs and other food sources readily accessible to birds and other predators; the crop or pasture plants cultivated are often eaten themselves by birds, or attract insects which are in turn eaten by birds; during the dry season arable lands often represent the only green or attractive food sources in an otherwise dry landscape. Arable lands exist in this study area, mostly planted to pasture or corn at the time of site visit. Relevant bird species that will be attracted to these areas include the Denham's Bustard and White Stork

- *Drainage Lines and Wetlands*
  Drainage lines and wetlands are an important form of habitat to numerous species. Drainage lines are often surrounded by natural grasslands, which may provide habitat for species such as African Grass Owl and Botha's lark. Various waterfowl, such as ducks and geese, may make use of these areas

- *Man-made Dams*
  Artificially constructed dams have become important attractants to various bird species in the South African landscape. Various waterfowl frequent these areas and crane

species often use dams to roost in communally. Birds such as flamingos and African Spoonbills may make use of these areas. Therefore dams are a key element of this study, and as shown in the sensitivity map, should be classed as no-go areas for this project.

- *Open Grassland*
  Grasslands represent a significant feeding area for many bird species, as well as possible breeding areas for others such as the African Grass Owl. Specifically, these open grassland patches typically attract the Blue Crane, Grey Crowned Crane (which have been identified in the nearby IBA discussed above) Sothern Bald Ibis, Secretarybird, White-bellied Korhaan, Denham's Bustard and White Stork. The grassland patches are also a favourite foraging area for game birds such as francolins and Helmeted Guineafowl. This in turn attracts large raptors because of both the presence and accessibility of prey.

- *Stands of Alien Trees*
  These areas will mostly be important to physically smaller bird species and passerines, as well as providing roosting for certain raptors and larger species such as Geese and Ibises.

Table 7.4 below shows the micro habitats that each Red Data bird typically frequents in the study area. It must be stressed that birds can and will, by virtue of their mobility, utilise almost any areas in a landscape from time to time. However, the analysis below represents each species' most preferred or normal habitats. These locations are where most of the birds of that species will spend most of their time – so logically that is where impacts on those species will be most significant.

Table 7.4: Preferred Micro-habitats and likelihood of occurrence on site of Red Data species recorded in the relevant QDGS's.

Species	Preferred Micro-habitat	Likelihood of occurrence on site
Botha's Lark	Long, mature natural grassland	Unlikely
Southern Bald Ibis	Grassland	Likely
African Marsh-Harrier	Dams and Wetlands	Possible
Lesser Kestrel	Arable lands and Grasslands	Possible
African Grass Owl	Grasslands	Unlikely
Denham's Bustard	Cultivated lands and Grasslands	Possible
White-bellied Korhaan	Cultivated lands and Grasslands	Possible
Yellow-billed Stork	Cultivated lands and Grasslands	Possible
Greater Flamingo	Dams and wetlands	Possible
Lesser Flamingo	Dams and Wetlands	Possible
Secretarybird	Cultivated lands and Grasslands	Unlikely
Black Harrier	Cultivated lands and Grasslands	Possible
Pallid Harrier	Grasslands and Wetlands	Unlikely
Blue Korhaan	Cultivated lands and Grasslands	Possible
Black-winged Pratincole	Cultivated lands and Grasslands	Possible
Black Stork	Rivers and Kloofs	Unlikely

White Stork	Cultivated lands and Grasslands	Likely

Further detail can be obtained from the Avifauna Specialist Report in **Appendix L**.

7.3.9 Surface Water

A characterisation of the rivers in the study area reveals that the receiving Klein-Olifants River is an order three river (**Table 7.5**). Six attributes were used to obtain the PES on desktop quaternary catchment level by the NSBA (Nel et al., 2004). These attributes predominantly allude to habitat integrity of instream and riparian habitat. With this in mind, the receiving Klein-Olifants River and the Woestalleen systems according to the NSBA (Nel et al., 2004) fall within a D-category, which relates to a largely transformed ecosystem state (Table 8). Biological communities also reflect fair to unacceptable health in these systems (RHP, 2001). The instream habitat associated with the ecoregion in the study area reflects more degradation than adjacent ecoregions (RHP, 2001).

According to the desktop PES category from DWAF (2000), the rivers in quaternary catchment B12B fall in a C ecological category, indicating a moderately modified ecosystem with clear community modifications and some impairment of health evident. The catchment at present is affected by severe erosion, sedimentation, weirs, infrastructural development in the form of power stations and mines, and translocation of species (Labeo umbratus). The EIS (DWAF, 2000) is considered moderately sensitive due to the expected presence of flow intolerant fish species in parts of the catchment, and the system's sensitivity to changes in flow and water quality.

Most of the surface water systems are perennial systems. Nel et al. (2004) lists a status of critically endangered for all the river signatures associated with the study area. The ascribed river status indicates a limited amount of intact river systems carrying the same heterogeneity signatures nationally. This implies a severe loss in aquatic ecological functioning and aquatic diversity in similar river signatures on a national scale (Nel et al., 2004).

Table 7.5: Desktop river characterisation of rivers and streams located in the study area (Nel et al., 2004) and DWAF (2000).

	Klein-Olifants River	Woestalleen System
River Order	3	1
Quaternary Catchment	B12B	B12B
Class	Perennial	Perennial
PES (NSBA)	D	D
PES (DWAF)	C	C
EIS (DWAF)	Moderate	Moderate
Conservation Status (NSBA)	Critically Endangered	Critically Endangered

- ***Drivers of Ecological Change***

The property falls within the Upper Olifants Sub-Area of the Olifants Water Management Area (WMA4). The Upper Olifants Sub-Area is the most urbanised of the 4 sub-areas in WMA4. The Upper Olifants covers an area of 11 464 km2 with a mean annual runoff of 10 780 million m3 (Midgley et al., 1994). Surface runoff in this area is regulated by a number of large dams, namely Witbank, Bronkhorstspruit and the Middleburg dams (Basson et al., 1997). Majority of the urban population is located in Witbank and Middelburg areas, and it is projected that the population in these urban areas is expected to grow in the near future therefore increasing the water requirement in the Sub-Area (**Table 7.6**). Extensive coal mining activities are taking place in the sub-area, both for export to other provinces and for use in the six active coal fired power stations in the sub-area. Water quality in this sub-area is therefore under threat. Mining activities in the area impact on the natural hydrological system by increasing infiltration and recharge rates of the groundwater. Approximately 62 million m3 is predicted to decant from mining activities (post closure) every year, creating a need for water quality management plans in this Sub-Area (DWAF, 2004).

Table 7.6: Reconciliation of water requirements and availability (million m^3/a) for the year 2000 in the Olifants Water Management Area (DWAF, 2004b).

Sub-area	MAR	Local yield	Transfers in	Transfer out	Local requirement	Deficit
Upper Olifants	465	238	171	96	314	1
Middle Olifants	481	210	91	3	392	94
Steelpoort	396	61	0	0	95	34
Lower Olifants	698	100	1	0	104	63

- ***Expected Fish***

The expected fish species list was limited to fish that have been sampled in, and immediately around or adjacent to the quaternary catchments associated with the study area. A total of 14 indigenous species representing 5 families are expected to utilise surface water systems associated with the study area. Table 10, shows the expected species as well as their conservation status. No species with conservation status occur in the study area, however, Barbus neefi is Data Deficient (DD). Barbus trimaculatus has a status of Least Concern (LC), but some literature suggests that it is Vulnerable (V) in the Orange-system (Benade et al., 1995). Amphilius uranoscopus as well as Chiloglanis pretoriae both have been sampled in quaternary catchment B12C and are expected to occur in the study area (Kleynhans et al., 2007). Both of these fish are rheophillic; having a low tolerance for degraded water quality and a high preference for sensitive habitat, thus making them excellent indicators of ecosystem health.

The expected fish list also includes alien and introduced species. Labeo umbratus naturally occurs in the Vaal-system, but has been introduced into the Limpopo and Olifants systems. Alien species that are expected in and around the study area include Gambusia affinis and Micropterus salmoides (**Table 7.7**).

Table 7.7: Fish species expected to utilise the river systems associated with the study area, in and around the quaternary catchment (B12A, B12B and B12C). Alien species are shown in red while sensitive species are indicated in green. LC = Least Concern; DD = Data Deficient; EX = Exotic (IUCN, 2009).

Status	Family	Species	Status
LC	Amphiliidae	Amphilius uranoscopus	Stargazer Catfish
LC	Cyprinidae	Barbus anoplus	Chubbyhead barb
DD	Cyprinidae	Barbus neefi	Sidespot barb
LC	Cyprinidae	Barbus paludinosus	Straightfin barb
LC -Vulnerable in Orange*	Cyprinidae	Barbus trimaculatus	Threespot barb
LC	Cyprinidae	Barbus unitaeniatus	Longbeard barb
LC	Mochokidae	Chiloglanis pretoriae	Shortspine rock catlet
LC	Clariidae	Clarias gariepinus	Sharptooth catfish
LC	Cyprinidae	Labeo cylindricus	Redeye labeo
LC	Cyprinidae	Labeo molybdinus	Leaden labeo
Introduced	Cyprinidae	Labeo umbratus	Moggel
LC	Cyprinidae	Labeobarbus marequensis	Largescale yellowfish
LC	Cyprinidae	Labeobarbus polylepis	Smallscale yellowfish
LC	Cichlidae	Pseudocrenilabrus philander	Southern mouthbrooder
LC	Cichlidae	Tilapia sparrmanii	Banded tilapia
EX	Poeciliidae	Gambusia affinis	Mosquito fish
EX	Centrarchidae	Micropterus salmoides	Largemouth bass
DD: Data deficient; LC: Least Concern; EX: Exotic (alien) *: Benade et al., 1995			
	Alien/Exotic/Introduced		Sensitive

- ***Expected Aquatic Macroinvertebrates***

A number of macroinvertebrate families are expected to utilise the habitat provided by the surface water systems associated with the proposed development and are shown in **Table 7.8** (Gerber, 2002; Thirion, 2007). Also reflected by **Table 7.8** is the respective sensitivity scores associated with each invertebrate family. The majority of expected macroinvertebrates are of low to moderate sensitivity, scoring between 3 and 8 out of a possible 15. Conversely a few relatively sensitive families are expected, these include: Heptageniidae, Leptophlebiidae, Tricorythidae and Chlorocyphidae.

Table 7.8: Macroinvertebrate species expected to use the non perennial systems for a part of their life cycle.

Order	Family	Common Name	SASS Score
Turbellaria	Planaria	Flatworms	3
Annelida	Oligochaeta	Aquatic earthworms	1
	Hirudinea	Leeches	3
Crustacea	Potamonautidae	Crabs	3
	Atyidae	Freshwater prawns	8
Hydracarina	Hydrachnellae	Water mites	8
Ephemeroptera	Baetidae	Small Minnow Flies	4
	Caenidae	Cain Flies	6
	Heptageniidae	Flat-headed Mayflies	13
	Leptophlebiidae	Prongill Mayflies	9
	Tricorythidae	Stout Crawlers	9
Odonata	Chlorocyphidae	Damsel flies	10
	Chlorolestidae	Sylphs	8
	Coenagrionidae	Sprites and Blues	4
	Lestidae	Emerald Damsel flies	8
	Aeshnidae	Hawkers	8
	Corduliidae	Cruisers	8
	Gomphidae	Clubtails	6
	Libellulidae	Darters	4
Hemiptera	Belostomatidae	Giant water bugs	3
	Corixidae	Water boatmen	3
	Gerridae	Pond skaters	5
	Hydrometridae	Water measurers	6
	Naucoridae	Creeping water bugs	7
	Notonectidae	Back swimmers	3
	Pleidae	Pygmy back swimmers	4
	Veliidae	Ripple bugs	5
Trichoptera	Hydropsychidae	Caseless caddis flies	4
	Hydroptilidae	Cased caddis flies	6
	Leptoceridae	Cased caddis flies	6
Coleoptera	Dytiscidae	Diving beetles	5
	Elmidae	Riffle beetles	8
	Gyrinidae	Whirligig beetles	5
	Hydrophilidae	Water scavenger beetles	5
Diptera	Ceratopogonidae	Biting midges	5
	Chironomidae	Midges	2
	Culicidae	Midges	1
	Ephydridae	Shore flies	3
	Muscidae	House flies	1
	Psychodidae	Moth flies	1
	Simuliidae	Black flies	5
	Syrphidae	Rat tailed maggots	1
	Tabanidae	Horse flies	5
	Tipulidae	Crane flies	5
Gastropoda	Ancylidae	Freshwater limpets	6

Order	Family	Common Name	SASS Score
	Lymnaeidae	Pond snails	3
	Physidae	Pouch snails	3
	Planorbinae	Orb snails	3
	Thiaridae		3
	Corbiculidae		5
Pelecypoda	Sphaeriidae		3

Further detail can be obtained from the Surface Water Specialist Report in **Appendix M**.

7.3.10 Groundwater

Groundwater storage and transport in the unweathered Vryheid Formation is likely to be mainly via fractures, bedding planes, joints and other secondary discontinuities. The success of a water supply borehole in these rocks depends on whether one or more of these structures are intersected. In general the Vryheid Formation is considered to be a minor aquifer, with some abstractions of local importance. Relatively minor outcrops of the Rooiberg and Quaggasnek Formations that underlie the Vryheid Formation are also found in the study area.

The Department of Water Affairs (DWA) have produced a series of 1:500 000 scale hydrogeology maps (General Hydrogeology Map Series), together covering the whole of South Africa. Analysis of median borehole yields and aquifer types has allowed DWA to classify the hydrogeology of the country according to an alphanumeric code incorporating aquifer type and borehole yield, as follows:

Table 7.9: General Hydrogeology Map Classification Of South Africa

Aquifer Type	Borehole Yield Class (L/s)				
	Class "1" 0 - 0.1	Class "2" 0.1 - 0.5	Class "3" 0.5 - 2.0	Class "4" 2.0 - 5.0	Class "5" >5.0
Type "a": Intergranular	A1	A2	A3	A4	A5
Type "b": Fractured	B1	B2	B3	B4	B5
Type "c": Karst	C1	C2	C3	C4	C5
Type "d": Intergranular and fractured	D1	D2	D3	D4	D5

The area within an 8 km radius of the Hendrina site is almost all classified as "D2". The small outcrop of the Quaggasnek Formation in the NW of the study area appears to be the reason for the small area classified as "D3" on the general hydrogeology map series. **Figure 7.7** provides an overview of the hydrogeology of the study area.

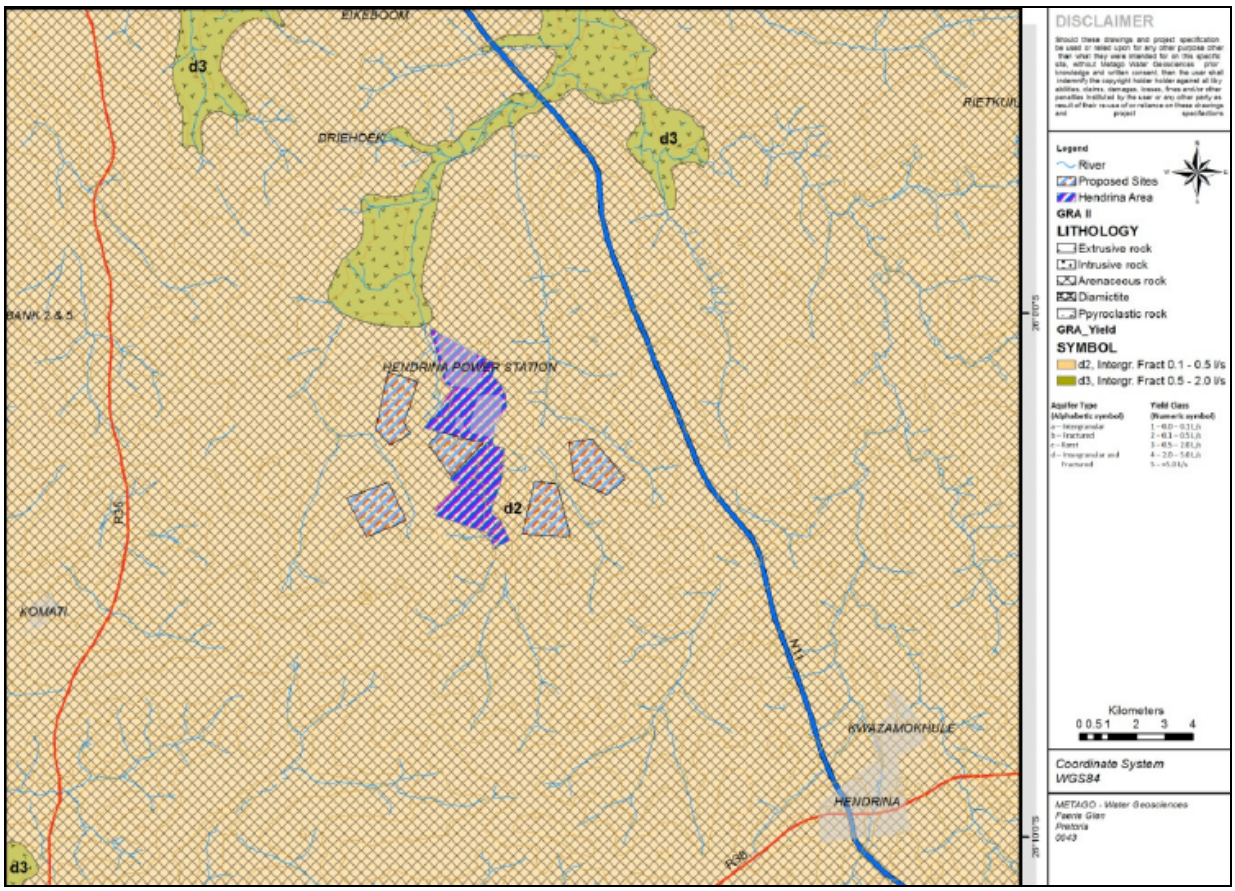

Figure 7.7: An overview of the hydrogeology of the study area.

A number of databases including the National Groundwater Database (NGDB), data from the Water Management System (WMS), maps published for the Groundwater Resource Assessment Phase I (GRA I) project, data from the Groundwater Resource Assessment Phase II (GRA II) project and information on water-use registrations obtained from the WARMS (Water Authorisation and Resource Management System) dataset managed by the Department of Water Affairs (DWA) were consulted for this study. The type of data collated included borehole yield estimates, groundwater level and groundwater chemistry data, as well as information on aquifer characteristics and exploitation potential.

From the NGBD, there are only 3 boreholes available within close proximity of the site (with one of the borehole within the 8km radius).

A field visit was undertaken on 21 April 2011 in order to inspect the Hendrina power station site, identify potential receiving environments (e.g. wetlands, water sources) (where possible) and take groundwater level measurements and electrical conductivity readings where accessible boreholes allowed. Information from the field visit was combined with the desktop study using existing datasets to develop a conceptual model of groundwater occurrence in the vicinity of the site. Based on the conceptual model, possible groundwater issues of concern were identified, and management actions proposed. Possible sources, pathways and receptors of groundwater contamination were considered.