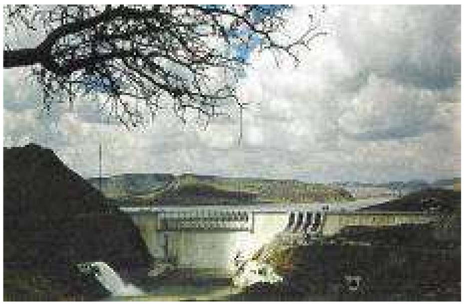
ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED NUCLEAR POWER STATION ("NUCLEAR-1") AND ASSOCIATED INFRASTRUCTURE

Fresh Water Supply Environmental Impact Report

March 2011



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March 2011

DECLARATION OF INDEPENDENCE

I, Peter Nigel Rosewarne as duly authorised representative of SRK Consulting, hereby confirm my independence (as well as that of SRK Consulting) as a specialist and declare that neither I nor SRK Consulting have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Arcus GIBB was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Environmental Impact Assessment for the proposed conventional nuclear power station (‘Nuclear-1’). I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in my attached report.

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Qualification(s): BSc (Hons) MSc

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Registration(s): Pr Sci Nat

EXECUTIVE SUMMARY

This Environmental Impact Report (EIR) covers the impacts and mitigation measures associated with the construction and operation of a conventional Nuclear Power Station (NPS) and associated infrastructure at three sites in the Eastern (1) and Western (2) Cape. The sites were originally identified as a result of site investigations undertaken since the 1980s and from the EIA Scoping Study. This specialist study covers Fresh Water Supply and was carried out by SRK Consulting.

Water requirements for a 4 000 MWe NPS are the following:

- Normal requirement : 70 L/s
- Construction peak : 104 L/s
- Site establishment : 23 L/s

Water supply is required for potable and construction purposes during NPS construction and for potable, demineralised and fire protection purposes during NPS operation.

This EIR is based on a desk study and site investigation involving the following:

- Department of Water Affairs and Forestry (DWAF) reports;
- Review of Atomic Energy Corporation/Eskom reports on the three sites from the 1980s and 1990s;
- Review of relevant legislation;
- Detailed site investigations for this EIR, including a census of existing water users/sources, drilling and testing of boreholes, water sample chemical analyses;
- Information supplied by various local authorities.

Water supply options for all three sites are as follows:

- Municipal or DWAF supply from existing local or regional schemes, mainly sourced from surface water/dams but also possibly from groundwater;
- Development of new dams by Eskom or local authorities;
- Development of groundwater resources; and
- Desalination of sea water (Eskom preferred option).

The following conclusions are drawn from this specialist study:

(a) Thyspunt

- There is extensive use of groundwater in the surrounding area;
- There are coastal springs at the site;
- The surrounding towns are supplied with water from the Churchill and Impofu dams and from groundwater;
- There is scope for further development of local groundwater resources for construction supply both on-site and in the surrounding area;
- Local and regional surface water resources are under stress and additional draw-off to supply a NPS would exacerbate this situation;

- The main option for surface water supply with least local and regional impact is import of water from the Orange River Scheme;
- Surface water and to a lesser extent groundwater is likely to be adversely affected by climate change; and
- Desalination of sea water is the most viable option for an assured water supply with least environmental impact and would not be affected by climate change. This option would have the least environmental impact and is Eskom's preferred option for fresh water supply.

(b) Bantamsklip

- There are no viable aquifers in the area;
- Local and regional surface water sources are fully utilized;
- The surrounding towns are supplied with surface water from Kraaibosch Dam and groundwater from springs and boreholes;
- Local and regional surface water resources are under stress and additional draw-off to supply a NPS would exacerbate this situation;
- The only option for surface water supply is import of water from the Riviersonderend-Bree scheme;
- Surface water and to a lesser extent groundwater is likely to be adversely affected by climate change; and
- Desalination of sea water is the most viable option for an assured water supply with least environmental impact and would not be affected by climate change. This option would have the least environmental impact and is Eskom's preferred option for fresh water supply.

(c) Duynefontein

- There is extensive use of groundwater in the surrounding area;
- The Aquarius Wellfield was previously developed to supply groundwater to the Koeberg Nuclear Power Station (KNPS) but has not been used recently because of quality constraints. This wellfield requires extensive rehabilitation but could supply the required construction and partial operational demand;
- KNPS is connected to the municipal water supply scheme;
- Additional surface water supply from existing municipal supply sources cannot be guaranteed;
- Surface water and to a lesser extent groundwater is likely to be adversely affected by climate change; and
- Desalination of sea water is the most viable option for an assured water supply with least environmental impact and would not be affected by climate change. This option would have the least environmental impact and is Eskom's preferred option for fresh water supply.

d) No go option

- In the event that the sites are not developed for NPSs, Eskom will sell the Bantamsklip and Thyspunt properties and non-essential parts of Duynefontein could also be sold. In this scenario the impact is seen to be *low* intensity, *neutral* consequence and *low* significance for the Bantamsklip site (no aquifers) but of *medium* intensity, *negative* consequence and *high* significance for the Thyspunt and Duynefontein sites as local groundwater resources could be exploited by private land owners/developers. The main mitigation measure for this scenario would be strict enforcement of conditions applicable to any approved future development of the sites.

It is recommended that desalination of sea water is implemented at the chosen site for fresh water supply. The main mitigation measures required for this supply option are:

- Brine produced as a by-product of the desalination process must be discharged in the surf zone during the construction phase (up to 156 L/s) to facilitate mixing;
- Brine produced as a by-product of the desalination process must be mixed with the cooling water discharge from the NPS during operation;
- A marine ecologist must monitor the discharge areas to assess impacts on marine ecology.

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED NUCLEAR POWER STATION (“NUCLEAR-1”) AND ASSOCIATED INFRASTRUCTURE
FRESH WATER SUPPLY

CONTENTS

TABLES

FIGURES

ABBREVIATIONS

a	Annum/per year
APAS	Atlantis Primary Aquifer System
DWAF	Department of Water Affairs and Forestry
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
h	Hour
IWRM	Integrated Water Resources Management
KNPS	Koeberg Nuclear Power Station
L	Litres
mg/ℓ	milligrammes per litre
M	Million
m^3	cubic metres
mm	Millimetres
mS/m	milli-siemens per metre
MWe	million watts electricity
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NPS	nuclear power station
pH	measure of acidity/alkalinity of water on a scale of 0-14
PWR	Pressurised Water Reactor
s	Second
SSR	Site Safety Report
TMG	Table Mountain Group
ToR	Terms of Reference
WMA	Water Management Area
WTW	Water Treatment Works

1 INTRODUCTION

1.1 Background

This specialist study covers Fresh Water Supply (hereinafter referred to as water supply), and has been undertaken by SRK Consulting to inform the Environmental Impact Assessment (EIA) conducted by Arcus Gibb for Eskom's Nuclear-1 project.

This report investigates the existing water resources as well as the impacts and mitigation measures associated with the supply of fresh water for the construction and operation of a conventional Nuclear Power Station (NPS) and associated infrastructure at three sites in the Eastern (1) and Western (2) Cape (**Figure 1.1**). The sites have been identified based on site investigations undertaken since the 1980s (Eskom 1994 a, b, c), as well as the Scoping phase of this EIA.

Eskom proposes to construct a NPS of the Pressurised Water Reactor type technology, with a capacity of ~4 000 MWe. The proposed NPS will include nuclear reactor, turbine complex, spent fuel and nuclear fuel storage facilities, waste handling facilities, intake and outfall structure and various auxiliary service infrastructure. The main infrastructure buildings as listed above will be situated in a so-called corridor area, which is shown schematically on the various site plans in **Section 20.** Other associated buildings such as security, reservoirs, bulk stores, weather station and nature conservation may be located elsewhere within the property boundaries.

Water requirements for a ~4 000 MWe NPS are as follows (Eskom 2008 a):

- Normal requirement : 70 L/s
- Construction peak : 104 L/s
- Site establishment : 23 L/s

Water supply is required for potable and construction purposes during construction and for potable, demineralised and fire protection purposes during operation. To provide for 48 h storage a 20 ML reservoir or 2 x 10 ML reservoirs will be required.

This study provides a description of the existing and potential water supply sources to the sites in terms of their location, capacity and water quality, and an assessment of the impact of supplying the fresh water requirements of an NPS.

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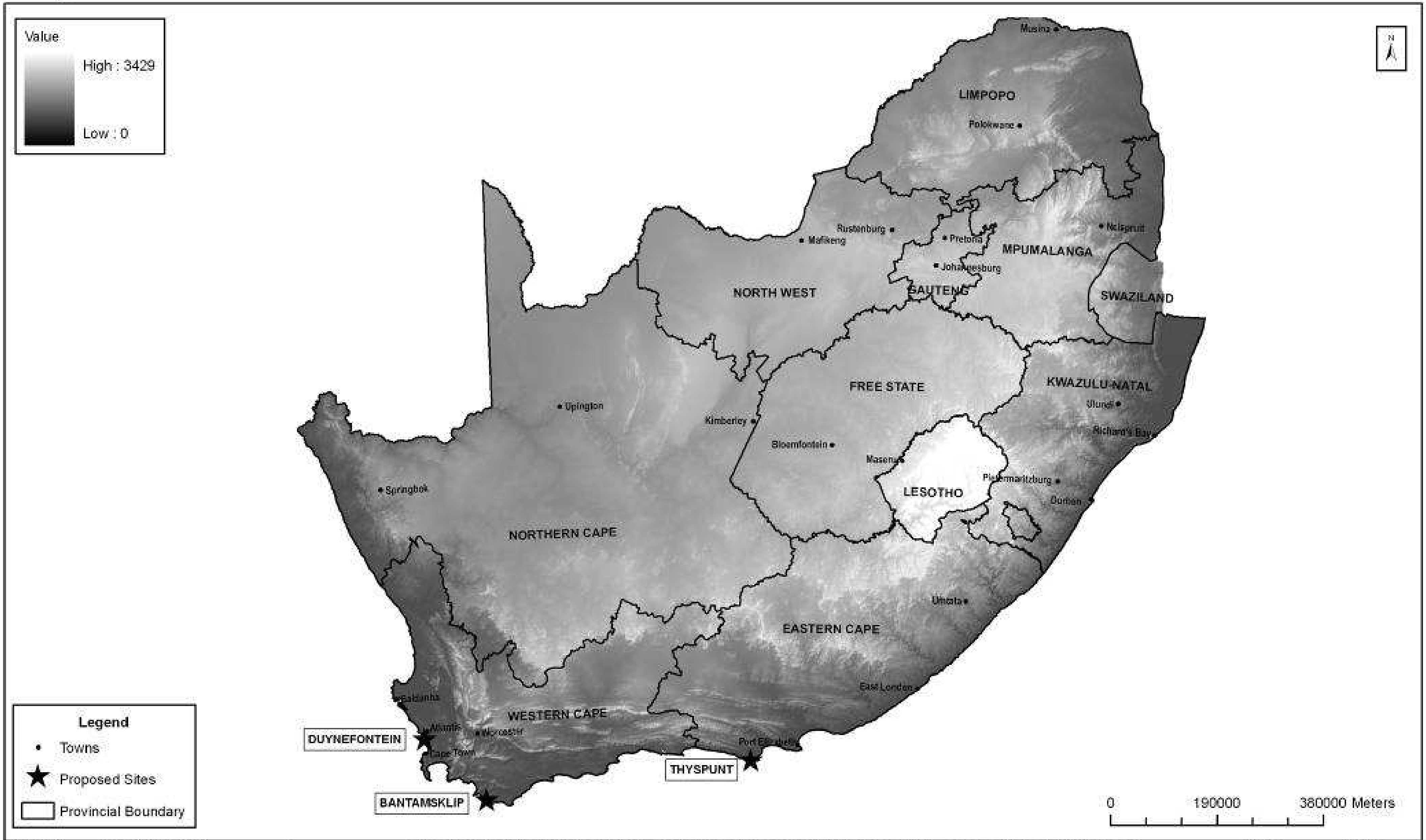

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378677	GAUSS CONFORMAL		NUCLEAR-1 ENVIRONMENTAL IMPACT ASSESSMENT FOR A PROPOSED NUCLEAR POWER STATION AND ASSOCIATED INFRASTRUCTURE LOCATION OF THE PROPOSED NUCLEAR POWER STATION SITES	08/07/2009	1:9,000,000
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	WGS84	25		SCHN	1.1

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1.2 Study Approach

1.2.1 Terms of Reference

The assessment of impacts has been broadly undertaken in accordance with the guidelines provided in the Guideline Document: EIA Regulations, Department of Environment Affairs and Tourism, (1998), the NEMA principles and Section 24(4) of NEMA (as amended), as appropriate to the specific field of study. In addition, the following General Terms of Reference apply to each of the specialist studies:

- Discussion of relevant policies and frameworks, where applicable;
- The affected environments (baseline information) as well as inferred changes to the baseline environment considering the effects of climate change;
- Identification of information gaps, limitations and additional information required;
- Description of the anticipated impacts using the impact assessment criteria as defined in **Section 1.2.4** for the various phases of the project, i.e. design, construction and operation;
- Development of relevant mitigation measures;
- Specialist will determine the effects of climate change on the proposed development and *vice versa* in terms of their fields of expertise;
- Utilisation of information from the existing Koeberg NPS in order to determine the cumulative impacts at the Duynefontein site;
- Assessment of the impacts associated with the desalination plant;
- Derivation of monitoring and auditing programmes, where necessary.

The specific ToR for the specialist Fresh Water Supply Assessment are to assess:

- Local authority supply of fresh water;
- Hydrocensus and potential water yield;
- Community water supply; and
- Water analysis.

1.2.2 Methodology

This Specialist Assessment is based on detailed site investigations and a desk study involving the following:

- Department of Water Affairs and Forestry[1] (DWAF) reports;
- Review of Atomic Energy Corporation/Eskom reports on the three sites from the 1980s and 1990s;
- Review of relevant legislation;
- Koeberg Site Safety Report (SSR), Chapter 11;
- Information supplied by various local authorities; and
- Detailed site investigations into groundwater and surface water occurrence at and around the sites. This has included, *inter alia*, a hydrocensus, evaluation of existing and potential surface water resources, the drilling of boreholes, yield testing, chemical analysis of water samples and numerical flow modelling.

[1] ***Correct at time of original issue of these reports***

1.2.3 Legislative Framework

Key legislation relating to water supply in South Africa comprises the following:

- National Water Act, 1998 (Act No. 36 of 1998).
- National Water Policy for South Africa, 1997
- Strategic Framework for Water Services, 2003.
- The Water Services Act, 1997 (Act No. 108 of 1997).
- National Environmental Management Act, 1998 (Act No. 107 of 1998).
- SABS Guidelines for Drinking Water (241-2006).
- The DWAF's Water Quality Guidelines, 1996.

The National Water Act, 1998 is the principal legal instrument relating to water resource management in South Africa and contains comprehensive provisions for the protection, use, development, conservation, management and control of the country's water resources. In addition, the management of water as a renewable resource must be carried out within the framework of environmental legislation, i.e. the National Environmental Management Act.

A key aspect of the National Water Policy is Integrated Water Resources Management (IWRM). This recognises that water resources can only be successfully managed if the natural, social, economic and political environments in which water occurs and is used are taken into consideration. IWRM aims to strike a balance between the use of water resources for livelihoods and conservation of the resource whilst promoting social equity, environmental sustainability and economic growth and efficiency.

The above principles will need to be applied in the investigation and supply of fresh water to any new NPS.

1.2.4 Impact Assessment standards

Impact Assessment is based on a standard approach defined in **Table 1.1** below, as supplied by Arcus Gibb.

Table 1.1: Impact assessment criteria and ratings scales

Criteria	***Rating Scales***	***Notes***
Nature	***Positive***	***This is an evaluation of the type of effect the construction, operation and management of the proposed NPS development would have on the affected environment.***
	Negative	
	Neutral	
Extent	***Low***	***Site-specific, affects only the development footprint***
	Medium	***Local (limited to the site and its immediate surroundings, including the surrounding towns and settlements within a 10 km radius);***
	High	***Regional (beyond a 10 km radius) to national***
Duration	***Low***	***0-5 years (i.e. duration of construction phase)***
	Medium	***6-10 years***
	High	***More than 10 years to permanent***

Criteria	Rating Scales	Notes
Intensity	*Low*	*Where the impact affects the environment in such a way that natural, cultural and social functions and processes are minimally affected*
	Medium	*Where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way; and valued, important, sensitive or vulnerable systems or communities are negatively affected*
	High	*Where natural, cultural or social functions and processes are altered to the extent that the impact will temporarily or permanently cease; and valued, important, sensitive or vulnerable systems or communities are substantially affected.*
Potential for impact on irreplaceable resources	*Low*	*No irreplaceable resources will be impacted.*
	Medium	*Resources that will be impacted can be replaced, with effort.*
	High	*There is no potential for replacing a particular vulnerable resource that will be impacted.*
Consequence (a combination of extent, duration, intensity and the potential for impact on irreplaceable resources).	*Low*	*A combination of any of the following* • *Intensity, duration, extent and impact on irreplaceable resources are all rated low* • *Intensity is low and up to two of the other criteria are rated medium* • *Intensity is medium and all three other criteria are rated low*
	Medium	• *Intensity is medium and at least two of the other criteria are rated medium*
	High	• *Intensity and impact on irreplaceable resources are rated high, with any combination of extent and duration* • *Intensity is rated high, with all of the other criteria being rated medium or higher.*
Probability (the likelihood of the impact occurring)	*Low*	*It is highly unlikely or less than 50 % likely that an impact will occur.*
	Medium	*It is between 50 and 70 % certain that the impact will occur.*
	High	*It is more than 75 % certain that the impact will occur or it is definite that the impact will occur.*
Significance (all impacts including potential cumulative impacts)	*Low*	• *Low consequence and low probability* • *Low consequence and medium probability* • *Low consequence and high probability*
	Low - Medium	• *Low consequence and high probability* • *Medium consequence and low probability*
	Medium	• *Medium consequence and low probability* • *Medium consequence and medium probability* • *Medium consequence and high probability* • *High consequence and low probability*
	Medium - High	• *High consequence and medium probability*
	High	• *High consequence and high probability*

1.2.5 Assumptions & Limitations

This Specialist Assessment has been based on detailed site investigations and a desk study. Other detailed work has also previously been carried out at the Duynefontein (Koeberg Nuclear Power Station) site. A list of references sourced for the study is given in **Section 7**.

Cognisance has been taken of the parallel specialist EIA studies on geohydrology, hydrology and freshwater ecology in the compilation of this report.

It is considered that the information available is sufficient to successfully carry out this impact assessment to a high level of confidence.

2 DESCRIPTION OF AFFECTED ENVIRONMENT

The locations of the three sites are shown on **Figure 1.1**.

2.1 Thyspunt

2.1.1 Local Authority Supply

The site falls within the Fish-Tsitsikamma Water Management Area (WMA) but large quantities of water are imported from the Upper Orange River WMA, (DWAF 1986).

According to water requirement projections in Appendix D of the DWAF's National Water Resource Strategy, (DWAF 2004), there is no allowance for water requirements for power generation for this WMA.

The local authority (Nelson Mandela Metropolitan Municipality) supplies water to Humansdorp and St. Francis Bay via the Churchill Pipeline from the Churchill Dam (26.3 Mm^3 capacity) on the Krom River. This pipeline runs in an E-W direction from Churchill Dam to Port Elizabeth, and is located to the south of the N2 (**Figure 2.1**). The Impofu Dam (formerly Elandsjacht Dam) on the Krom River has a full supply capacity of 32.1 Mm^3 and supplies water to the Nelson Mandela Metropole.

The local authority supplies water to the residential areas of Humansdorp, St. Francis Bay and Oyster Bay. These towns all derive some water supply from groundwater sources, with Oyster Bay being totally reliant on groundwater. Currently the Oyster Bay water supply comprises a spring (located at S 34.17374° and E 24 .66241°) equipped with a pump capable of delivering ~ 4 L/s and a borehole (located at S 34.17146 and E 24.66132°) with an approximate delivery capacity of ~ 2 L/s.

Groundwater is used extensively in the Thyspunt buffer zone. Numerous farms, homesteads and villages use groundwater for domestic consumption, crop and stock watering. Springs to the north of Humansdorp are utilised for municipal water consumption. Groundwater in the Table Mountain Group (TMG) fractured-rock aquifer and from the intergranular aquifer surrounding the non-perennial Sand River between Ashton Bay and Cape St. Francis is utilised for domestic consumption and golf course irrigation purposes (Eskom 2008 c).

2.1.2 Capacity

The Churchill Pipeline to St. Francis Bay has been upgraded and has a design capacity of 93 L/s which is fully utilized by St. Francis Bay (*pers comm* Roberts 2008).

There is apparently no spare capacity from Impofu Dam (*pers comm*. Groenewald 2008).

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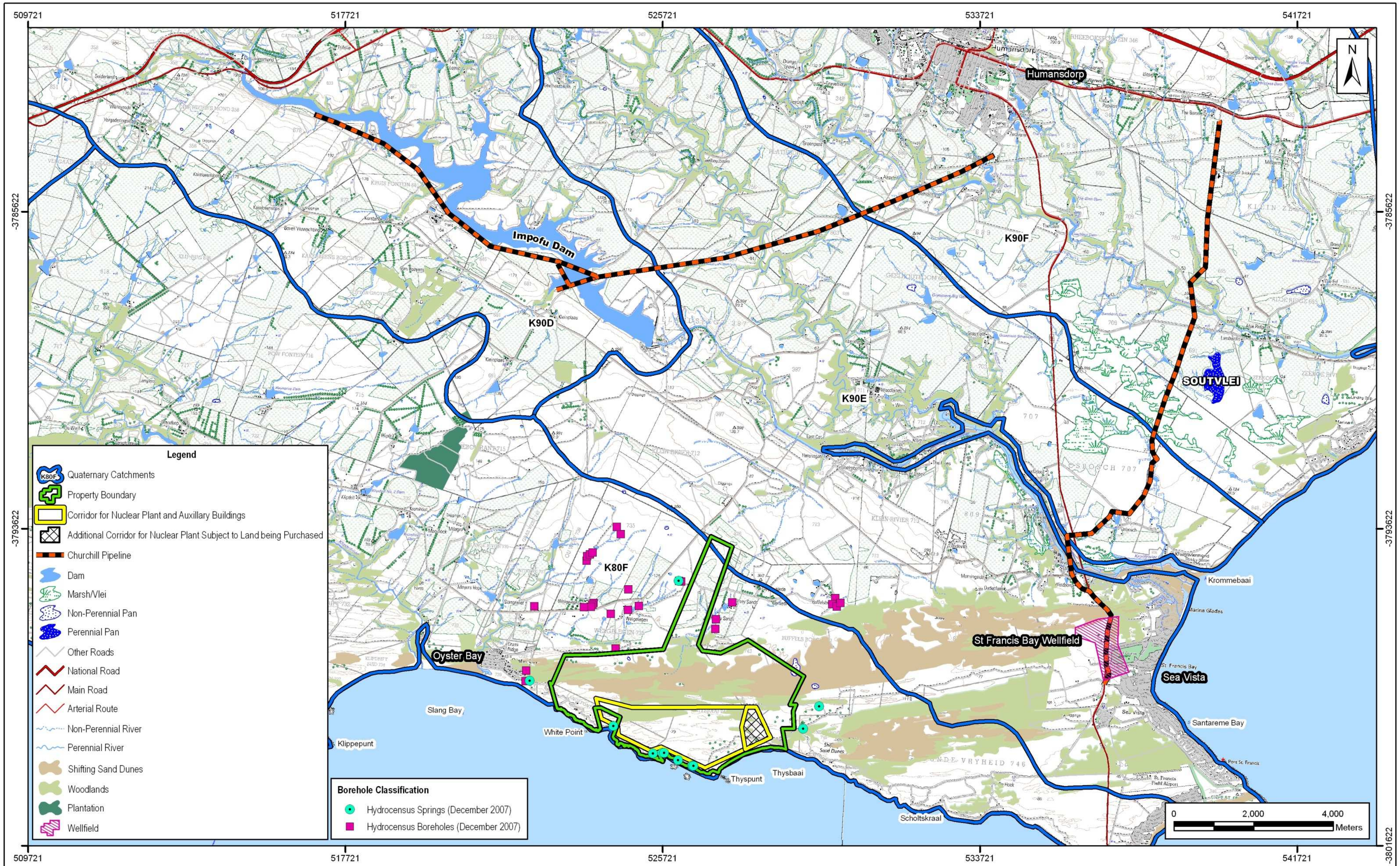

PROJECT NO.	COORDINATE SYSTEM			DATE	SCALE
378677	GAUSS CONFORMAL		NUCLEAR-1 ENVIRONMENTAL IMPACT ASSESSMENT FOR A PROPOSED NUCLEAR POWER STATION AND ASSOCIATED INFRASTRUCTURE SPECIALIST STUDY: FRESHWATER SUPPLY LOCATION OF WATER INFRASTRUCTURE: THYSPUNT	06/10/2009	1:90,000
	SPHEROID	CENTRAL MERIDIAN		COMPILED BY	FIG NO.
	WGS84	25		BURK/BOOK	2.1

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2.1.3 Community Supply

A strong coastal spring of 8 L/s occurs west of Cape St. Francis at Mostert's Hoek and is currently used on a limited basis. Boreholes tapping the TMG fractured rock aquifer supplies Oyster Bay with groundwater for domestic consumption. Small seeps and springs commonly occur along the coast from the base of the Algoa Formation but no high yielding springs are reported from the immediate area surrounding Thyspunt. The majority of these seeps and springs flow directly onto rocky outcrop or sandy beaches and from there directly into the ocean.

The potential to use groundwater in the Thyspunt area is good. The regional TMG Aquifer is of medium potential, while the major intergranular aquifer of the Algoa Group is of high potential. A prominent cobble horizon has been identified during the geohydrological investigation between the base of the Algoa Group and top of the TMG. Sustainable borehole yields of 1 to 5 L/s are obtainable from this horizon. Boreholes drilled during this specialist study are shown on **Figure 2.1**.

2.1.4 Water Quality

The quality of groundwater (electrical conductivity, EC) in the TMG is generally between 10 – 100 mS/m and is of a sodium-chloride-magnesium type. It is typically fresh and suitable for domestic consumption, although sometimes the low pH makes the water soft and corrosive to steel fixtures. The water quality of the springs and seeps originating from the Algoa Group is also of good quality with EC in the 100 mS/m range and pH in the upper 7 and lower 8 ranges. Examples from the hydrocensus undertaken in February 2007 are shown in **Table 2.2**.

The surface water originating on the inland TMG catchments is of similar quality, at the lower end of the EC range given for the TMG. Chemical analyses for water from the treatment works at the Churchill and Impofu dams are shown in **Table 2.1**. These are for 10 August 2008.

Table 2.1: Summary chemical analysis for Churchill and Impofu Dam Water (supplied by Nelson Mandela Metropolitan Municipality)

Determinand	Units	Churchill Dam	Impofu Dam
pH	pH units	7.4	7.5
Conductivity	mS/m	20.5	36.4
Calcium	mg/ℓ	6	11
Magnesium	mg/ℓ	16	28
Sodium	mg/ℓ	26	48
Potassium	mg/ℓ	1.4	2.9
Sulphate	mg/ℓ	6.7	14
Chloride	mg/ℓ	48	88
Total Alkalinity (as $CaCO_3$)	mg/ℓ	8	14
Fluoride	mg/ℓ	<0.1	<0.1
Iron (total)	mg/ℓ	1.44	0.55
Manganese (total)	mg/ℓ	<0.005	<0.005

These ground and surface waters all fall within the South African National Standard (SANS 241-2006) Class 1 (recommended limit) for drinking water (EC <150 mS/m).

Table 2.2: Chemical Analysis of Local Groundwater at and around Thyspunt

Lab No	Sample Id	Sample Date	pH	EC in mS/m	Fe in mg/ℓ	Mn in mg/ℓ	Ca in mg/ℓ	K in mg/ℓ	Mg in mg/ℓ	Na in mg/ℓ	SO_4 in mg/ℓ	NH_4-N in µg/ℓ	NO_3-N in µg/ℓ	Ortho-P in µg/ℓ	F in mg/ℓ	Cl in mg/ℓ	Alkalinity (as $CaCO_3$) in mg/ℓ
31831	Cilliers 2	06/02/2008	6.2	147	<0.05	<0.05	16.6	1.4	31.9	278.7	38.3	55	1442	28	<0.1	381	217
31832	Cilliers 3	05/02/2008	8.6	35	<0.05	<0.05	14.0	<1.0	5.5	43.9	2.3	635	29	<25	<0.1	73	40
31833	Gerber	06/02/2008	6.7	71	<0.05	<0.05	31.2	4.4	16.5	78.2	34.0	41	5	<25	<0.1	167	54
31834	Langfont 1	05/02/2008	8.3	78	<0.05	<0.05	107.2	1.5	11.1	49.9	6.1	66	<25	<25	0.16	82	294
31835	Langfont 2	05/02/2008	7.5	138	<0.05	<0.05	137.1	2.7	20.9	138.3	89.2	97	<25	<25	0.22	224	321
31836	Muni sp 1	05/02/2008	8.2	82	<0.05	<0.05	103.5	1.1	11.8	54.9	13.3	38	<25	25	0.19	105	267
31837	Oyst Bay Sp1	05/02/2008	8	161	<0.05	<0.05	119.2	3.9	20.1	214.9	57.9	41	73	33	0.14	330	255
31838	Oyst Bay Sp 3	06/02/2008	8.4	114	<0.05	<0.05	95.0	2.4	14.9	121.9	40.0	53	767	54	0.15	203	230
31839	Oyst Bay Sp 6	06/02/2008	8.2	109	<0.05	<0.05	93.1	2.3	14.3	114.3	39.6	40	917	67	0.16	206	208
31840	Oyst Bay Sp 7	06/02/2008	8.3	92	<0.05	<0.05	84.1	2.2	12.7	90.5	31.8	68	908	60	0.15	163	203
31841	Pennisands 2A	06/02/2008	6	63	<0.05	<0.05	10.7	1.0	15.6	104.5	25.4	43	4643	62	<0.1	181	12
31842	Strydom	06/02/2008	5.9	37	<0.05	<0.05	3.3	<1.0	7.6	53.5	19.3	41	43	<25	<0.1	93	9
31843	Vulindlela 1	06/02/2008	6.8	51	<0.05	<0.05	7.0	5.4	10.4	68.2	29.9	48	217	<25	<0.1	119	18
31844	Vulindlela 3	06/02/2008	6.6	66	<0.05	<0.05	7.7	<1.0	12.5	96.7	24.5	117	592	<25	<0.1	167	15
31845	Welgelegen	06/02/2008	6	56	<0.05	<0.05	4.1	<1.0	10.9	83.0	26.4	50	650	<25	<0.1	147	10

2.2 Bantamsklip

2.2.1 Local Authority Supply

The site falls within the Breede WMA. All relevant infrastructure and sources are shown in **Figure 2.2**.

According to water requirement projections in Appendix D of the DWAF's National Water Resource Strategy (DWAF 2004), there is no allowance for water requirements for power generation in this WMA.

2.2.2 Capacity

The local authority (Overstrand Municipality) supplies water to the nearby towns of Pearly Beach and Buffelsjag. The former is supplied by springs about 6 km to the north-east of the town. The latter is supplied by boreholes in the town area. Baardkeerdersbos is supplied by a nearby dam of the same name.

Regional scale supply is via a pipeline from Kraaibosch Dam to a treatment works at Franskraal to the north-east of Gansbaai.

Kraaibosch Dam can supply 2 Mm^3 per annum to the Franskraal Water Treatment Works (WTW). A new works is under construction that will give 70 L/s but will only deliver to the villages around Gansbaai. No pipeline exists between the WTW and Pearly Beach. The existing system will be fully utilised to supply existing and future extensions in the Greater Gansbaai Area. Pearly Beach is supplied by a small local scheme from springs that feed into a dam which is then piped to the village. This source is very limited and will have to be supplemented in the near future (*pers comm*. D Crafford 2008).

Eskom (1994) was concluded that any major industrial undertaking in this WMA would require the supply of fresh water by pipeline from a major source outside of the immediate region. The nearest such system is the Riviersonderend/Breë.

2.2.3 Community Supply

There are few boreholes in the buffer zone around the site and groundwater potential is generally low. Exploration boreholes were drilled at Pearly Beach and Buffelsjag in the early 1990s for town supply but were unsuccessful. In Eskom (1994) it is stated that there were 700 boreholes tapping the aquifer of the coastal plain of which fewer than half yielded >1.4 L/s.

Drilling on the site and surrounds for this specialist study has indicated that there are no viable aquifers within this area. Boreholes drilled during the investigation are shown on **Figure 2.2**.

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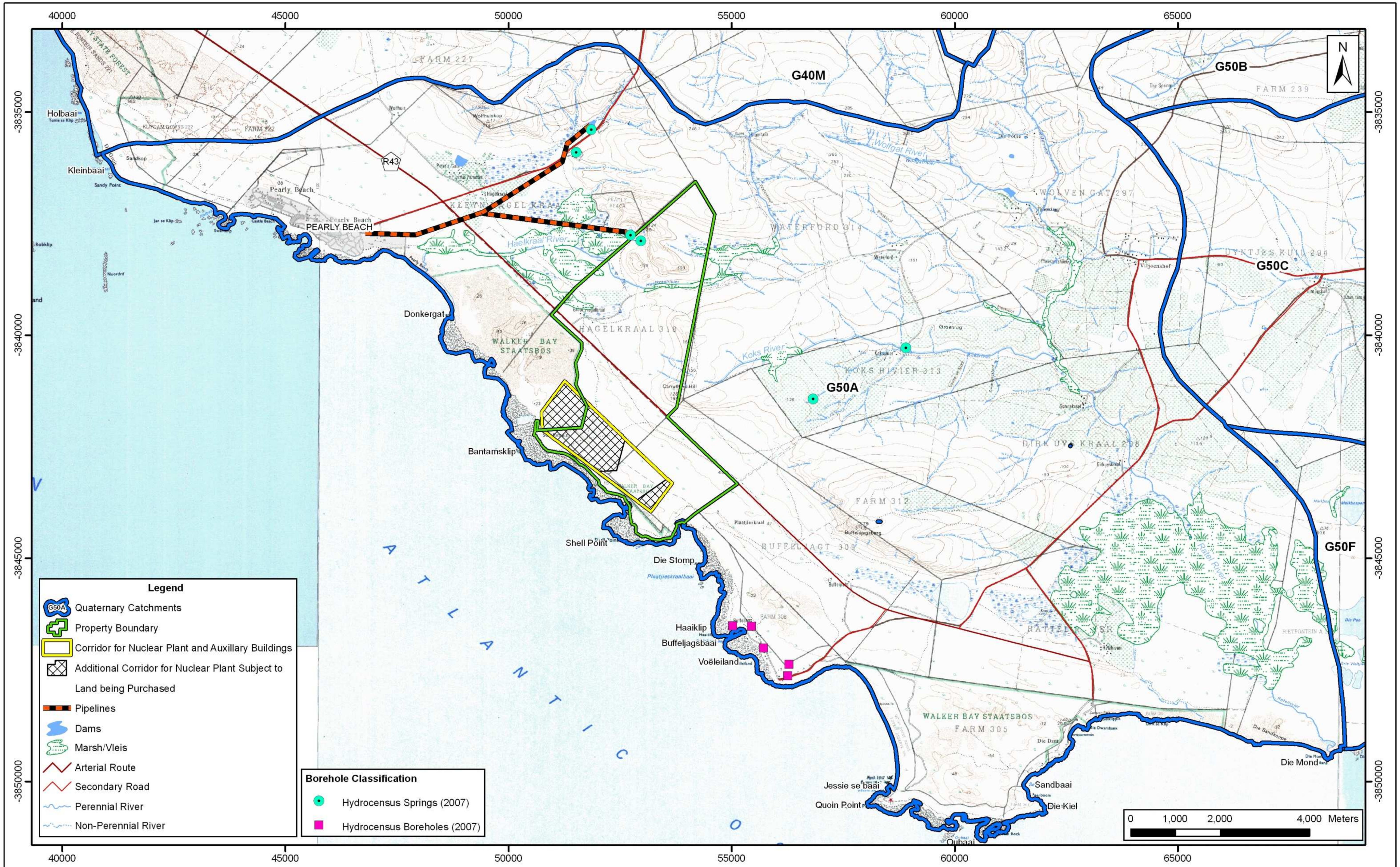

PROJECT NO.	COORDINATE SYSTEM			DATE	SCALE
385908	GAUSS CONFORMAL		NUCLEAR-1 ENVIRONMENTAL IMPACT ASSESSMENT FOR A PROPOSED NUCLEAR POWER STATION AND ASSOCIATED INFRASTRUCTURE SPECIALIST STUDY: FRESHWATER SUPPLY LOCATION OF INFRASTRUCTURE : BANTAMSKLIP	07/10/2009	1:80,000
	SPHEROID	CENTRAL MERIDIAN		COMPILED BY	FIG NO.
	WGS84	19		BOOK	2.2

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2.2.4 Water Quality

Water quality is generally fairly good. For example the water supply to Pearly Beach has an EC of 38 mS/m. This puts it in the South African National Standard class 1 (recommended limit) for drinking water (EC <150 mS/m). Chemical analyses from Kraaibosch Dam are shown in **Table 2.3** below. These results indicate good water quality mostly within SANS Class I.

Table 2.3: Chemical Analyses from Kraaibosch Dam

Determinand	Units	Nov 2004	May 2005	Nov 2005	May 2006	Nov 2006	May 2007	Nov 2007	May 2008
pH		7.31	7.11	7.08	7.30	7.35	7.74	7.49	7.75
Conductivity	mS/m	79.00	60.70	66.90	73.10	60.50	70.10	66.90	70.90
Amonia as N	mg/ℓ	0.02	0.07	0.06	0.02	0.11	0.06	0.02	0.02
Nitrate and Nitrite as N	mg/ℓ	0.06	0.30	0.04	0.04	0.17	0.04	0.04	0.04
Calcium	mg/ℓ	15.70	11.95	12.44	12.78	11.89	13.09	11.92	13.99
Magnesium	mg/ℓ	14.34	10.40	12.43	14.58	10.22	11.97	12.84	14.20
Potassium	mg/ℓ	3.61	4.15	2.63	2.88	2.42	3.26	3.23	2.86
Sodium	mg/ℓ	112.83	84.20	95.75	112.44	85.11	95.83	93.84	98.44
Chloride	mg/ℓ	212.88	162.42	180.55	203.22	139.17	176.80	179.86	180.68
Sulphate	mg/ℓ	30.63	49.72	32.93	33.59	46.50	30.83	50.78	75.39
Total Alkalinity	mg/ℓ	36.26	25.05	28.00	30.01	25.01	38.87	22.27	37.22
Ortho Phosphate as P	mg/ℓ	0.01	0.03	0.04	0.03	0.08	0.09	0.02	0.05
Silica	mg/ℓ	1.28	3.18	3.57	2.29	2.52	0.40	1.88	1.19
Fluoride	mg/ℓ	0.10	0.05	0.05	0.13	0.13	0.05	0.05	0.11

Groundwater quality in boreholes identified in the hydrocensus carried out in 2007 ranges from good (~34 mS/m) to poor (~560 mS/m). Chemical analyses from the hydrocensus are shown in **Table 2.4**.

Table 2.4: Chemical Analyses of Local Groundwater at and around Bantamsklip

Bantamsklip Hydrocencus (2007): Results of Macro Chemical Analyses																
Lab No.	Sample Id	Sample Date	pH	EC in mS/m	Ca in mg/ℓ	K in mg/ℓ	Mg in mg/ℓ	Na in mg/ℓ	SO_4 in mg/ℓ	Dissolved Fe in mg/ℓ	Total Fe in mg/ℓ	Dissolved Mn in mg/ℓ	Total Mn in mg/ℓ	F in mg/ℓ	Cl in mg/ℓ	Alkalinity (as $CaCO_3$) in mg/ℓ
31046	BP004/07	12/05/2007	*7.7*	*156*	*88*	*8.2*	*24.4*	*235*	*52*	*<0.05*	*9.92*	*<0.05*	*0.07*	*0.15*	*353*	*230*
31047	BS002/07	12/05/2007	*7.6*	*208*	*106*	*15.3*	*35.6*	*335*	*73*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*0.3*	*263*	*267*
31048	BS004/07	12/05/2007	*7.5*	*531*	*201*	*37.5*	*128.7*	*1009*	*196*	*<0.05*	*0.66*	*<0.05*	*0.02*	*0.33*	*340*	*456*
31049	GHL001/07	12/05/2007	*7.3*	*49*	*36*	*1.5*	*6.8*	*58*	*12*	*<0.05*	*0.05*	*<0.05*	*<0.05*	*<0.1*	*108*	*88*
31050	HF001/07	12/05/2007	*7.7*	*77*	*89*	*2.7*	*17.8*	*53*	*20*	*<0.05*	*5.44*	*<0.05*	*0.05*	*0.15*	*75*	*273*
31051	KHL001/07	12/05/2007	*8.2*	*39*	*19*	*0.8*	*5.9*	*52*	*10*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.1*	*93*	*47*
31052	KHL002/07	12/05/2007	*6.9*	*33*	*3*	*1.5*	*5.4*	*49*	*11*	*0.08*	*0.28*	*<0.05*	*<0.05*	*<0.1*	*89*	*7*
31053	KR001/07	12/05/2007	*6.2*	*46*	*9*	*3.8*	*10*	*70*	*19*	*0.3*	*0.9*	*<0.05*	*<0.05*	*<0.1*	*123*	*12*
31054	KR002/07	12/05/2007	*5.1*	*56*	*8*	*2.4*	*11.5*	*83*	*19*	*<0.05*	*<0.05*	*0.58*	*0.58*	*<0.1*	*159*	*0*
31055	VD001/07	12/05/2007	*7.7*	*64*	*85*	*2.2*	*16.8*	*46*	*18*	*0.1*	*23.34*	*<0.05*	*0.11*	*<0.1*	*63*	*281*

2.3 Duynefontein

2.3.1 Local Authority Supply

The site falls within the Berg WMA. The relevant infrastructure and water sources are shown in **Figure 2.3**.

According to water requirement projections in Appendix D of the DWAF's National Water Resource Strategy (DWAF 2004), there is no allowance for water requirements for power generation in this WMA.

The site receives the bulk of its water from one source via the local authority.

The local authority (City of Cape Town: Bulk Water Branch) augments the water supply to the greater metropolitan area from Voëlvlei Dam approximately 12,5 km south west of Tulbagh. At the dam water is treated and pumped to the Plattekloof Reservoir, along a 75 km, 1 500 mm diameter pre-stressed concrete pipeline. A head meter is located approximately 8 km north of the Reservoir, on the Voëlvlei Dam/Plattekloof Reservoir pipeline. At this head meter a 700 mm diameter fibre cement pipe supplies the 40 000 m^3 Melkbos Reservoir, located on the farm Blaauwberg. The Melkbos Reservoir supplies the Melkbos/Blaauwberg area with water. The water gravitates along a 700 mm diameter fibre cement pipe to a valve chamber north−east of the Melkbosstrand/M14 intersection (Eskom, 2006). This reservoir supplies KNPS with water.

The local authority supplies the required water to the residential areas of Bloubergstrand, Melkbosstrand, Van Riebeeckstrand and Duynefontein.

2.3.2 Capacity

A 500 mm pipeline supplying Atlantis runs along the R27. A connection to this pipeline is proposed at the main entrance to KNPS from the R27. At the moment, supply to KNPS is dependent on draw-down on the Melkbos Reservoir and on-site reservoir storage is needed to regulate this supply. The Duynefontein site is near the end of the supply network and the City of Cape Town's priority is to supply Atlantis. The City is therefore unable to give a definite undertaking to guarantee supply to Nuclear-1 (*pers comm*. R Bishop 2008).

The required supply could be met from the Aquarius Wellfield but this is in need of rehabilitation because of borehole construction problems and clogging with iron bacteria (*pers comm.* R Bishop 2008).

The Atlantis Primary Aquifer System (APAS) is the most important groundwater resource in the study area. The APAS is capable of yielding a minimum of ~4 Mm^3/a of groundwater on a sustainable basis. This figure may be as high as ~9 Mm^3/a if the less conservative 'Harvest Potential' estimate is accepted.

It is relatively straightforward to develop moderate- to high-yielding (5 to 15 L/s) boreholes within specific zones of the APAS, if the correct drilling and construction techniques are applied.

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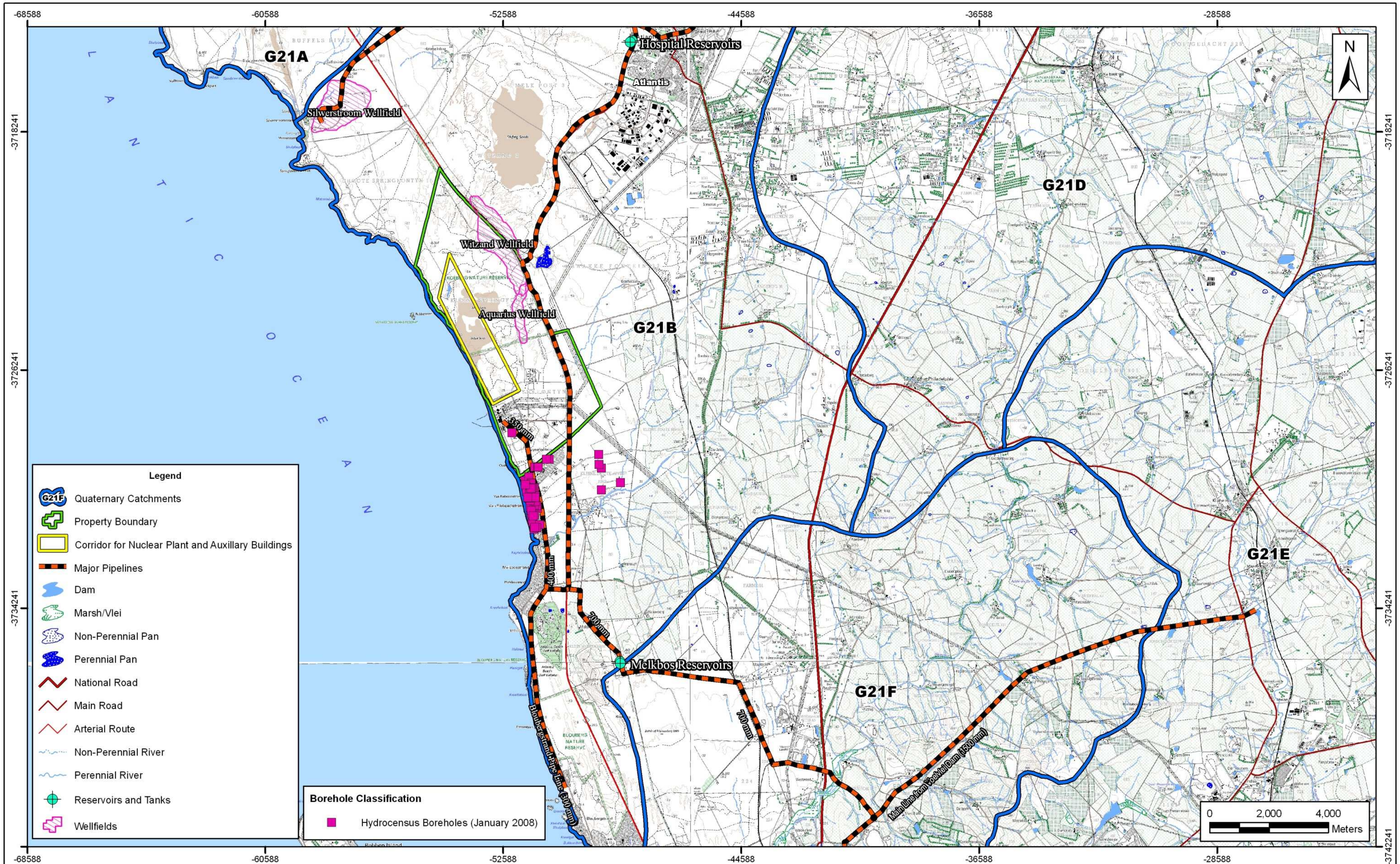

PROJECT NO.	COORDINATE SYSTEM			DATE	SCALE
378677	GAUSS CONFORMAL		NUCLEAR-1 ENVIRONMENTAL IMPACT ASSESSMENT FOR A PROPOSED NUCLEAR POWER STATION AND ASSOCIATED INFRASTRUCTURE SPECIALIST STUDY: FRESHWATER SUPPLY LOCATION OF INFRASTRUCTURE: DUYNEFONTEIN	06/10/2009	1:120,000
	SPHEROID	CENTRAL MERIDIAN		COMPILED BY	FIG NO.
	WGS84	19		BOOK	2.3

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Production boreholes in the APAS are prone to clogging by slime-forming aerobic and anaerobic bacteria in the groundwater, especially if they are over-exploited. Bio-fouling gradually reduces the yield of production boreholes if they are not regularly treated and rehabilitated.

The Witzand and possibly the Silwerstroom groundwater units within the Atlantis Aquifer are currently being fully exploited. The bulk of the groundwater is being abstracted by the City of Cape Town's two wellfields. There may be capacity for the development of additional production holes in those parts of the APAS that straddle the Brakkefontein and Duynefontein units.

Drilling and yield testing of the Malmesbury Aquifer at the Duynefontein site during this investigation has shown that this aquifer has potential for supply to the Site.

2.3.3 Community Supply

The local authorities supply the required water to the residential areas of Bloubergstrand, Melkbosstrand, Van Riebeeckstrand and Duynefontein.

Atlantis is supplied with groundwater extracted from two wellfields managed by the City of Cape Town: Bulk Water Supply and supported by the CSIR. Silwerstroom Wellfield is located approximately 12 km north of the NPS and the Witzand Wellfield approximately 6 km to the north. In 2005, an estimated 2.0 and 3.17 Mm^3 were extracted from the two wellfields, respectively. Supply from the wellfields is augmented from the Voëlvlei pipeline via a 500 mm pipeline.

The Aquarius Wellfield, owned by Eskom, is the closest groundwater abstraction area to the Duynefontein 900 MWe PWR units 1 and 2 and there used to be around 40 000 m^3 water abstracted per month by Eskom to supply KNPS. The wellfield is located approximately 6 km to the north−east of Duynefontein 900 MWe PWR units 1 and 2. The wellfield is presently not utilised for the NPS because of poor water quality. However, groundwater is pumped to feed a dam near the Nature Conservation offices.

Farms in the area derive their water requirements from rainwater harvesting and groundwater.

2.3.4 Water Quality

An analysis of the Voëlvlei water is presented in **Table 2.5** for both raw and treated water.

Table 2.5: Voëlvlei Filtration Plant – Analysis of Composition: 2003 to 2004

Chemical analysis		Raw (average)	Treated (average)
Samples examined		49	49
Physical			
Conductivity @ 20 ºC mS/m		77	140
pH value		7.5	9
Turbidity	NTU	14	0,66
Colour	Plat.Std	26	3
UV Absorbence	300 nm/40mm	0.322	0.041
Oxygen absorbed		2.7	0.4
Hardness			
Total	$CaCO_3$ mg/ℓ	15.3	43.7
Mineral			
Alkalinity	$CaCO_3$ mg/ ℓ	10.0	13.2
Chloride	Cl mg/ ℓ	17.2	19.5
Sulphate	SO_4 mg/ℓ	3.7	27.0
Calcium	Ca mg/ ℓ	2.7	13.8
Magnesium	Mg mg/ ℓ	2.06	2.23
Sodium	Na mg/ ℓ	8.9	8.9
Potassium	K mg/ ℓ	0.79	0.72
Trace metals			
Aluminium	Al mg/ ℓ	0.65	0.08
Iron	Fe mg/ ℓ	0.534	0.035
Manganese	Mn mg/ ℓ	0.008	0.002

This analysis is for 2003 to 2004. The results for the subsequent 12 months (2004 to 2005) are available but have not been averaged as they are considered abnormal due to the drought, and low flow conditions. However, the treated water profile is considered to be a reasonable representation of average conditions sufficient for this EIR. The water meets SANS 241-2006 Class 1 standards (recommended operational limit) for drinking water for all listed determinands.

The quality of groundwater at the site and in the surrounding catchment is good to poor, as shown in **Table 2.6**. ***The Koeberg Nuclear Power Station has been in operation for some 30 years and there are three operational wellfields and a major unconfined aquifer in relatively close proximity. Two of these wellfields form part of the City of Cape Town's domestic water supply network to the Greater Cape Town Area. However, there is no evidence that emissions from the KNPS have had any measurable effect on these features. Local groundwater close to the reactors shows somewhat elevated tritium levels compared to background but well below being anywhere near levels of concern for health impacts.***

Table 2.6: Groundwater Quality at and around Duynefontein

Site Name		SRK-KG01	SRK-KG02	SRK-KG04	SRK-KG06	SRK-KG08	SRK-KG09
Determinand	**Units**	**2008, May 20**	**2008, May 20**	**2008, May 20**	**2008, May 20**	**2008, May 20**	**2008, May 20**
EC (mS/m)	mS/m	357	116	248	234	226	232
pH	-	7.4	7.6	7.8	7.6	7.6	7.7
Temp	ºC	18.2	18.4	17.6	17	18	18.5
Eh	mV	-98	53	-74	-104	-140	-2
K	mg/ℓ	6.2	4	4.6	4.1	7.1	3.5
Na	mg/ℓ	421	107	284	273	245	312
Ca	mg/ℓ	183	98	114	111	115	85
Mg	mg/ℓ	48	21	33	30	46	33
SO_4	mg/ℓ	21	58	73	56	58	87
Cl	mg/ℓ	1007	205	603	586	515	560
T ALK ***(as $CaCO_3$)***	mg/ℓ	216	236	233	204	289	234
N_as NO_3	mg/ℓ	5.4	>0.1	2.5	2.3	0.8	1.4
N_Ammonia	mg/ℓ	>0.1	>0.1	>0.1	>0.1	>0.1	>0.1
HCO_3	mg/ℓ	263	288	284	249	352	285
F	mg/ℓ	0.1	0.3	0.2	0.2	0.3	0.3
Tritium	***Tritium Units***	***0.4 (+/-0.2)***	***2.0 (+/-0.3)***	***0.6 (+/-0.2)***	***0.3 (+/-0.2)***	***0.2 (+/-0.2)***	***0.3 (+/-0.3)_***

2.4 Site Sensitivity

Site sensitivity has been assessed according to the categories listed below.

Category	Description
High sensitivity	These are no go areas or severely prohibited areas for development; they may be protected by legislation
Medium sensitivity	These are areas that may have the potential for development, if adequate mitigation measures are prescribed
Low sensitivity	These areas have no sensitivity to development

The sensitivity of each of the sites is shown in **Figure 2.4** (Thyspunt), **Figure 2.5** (Bantamsklip) and **Figure 2.6** (Duynefontein) for the defined site areas.

Criteria used for defining site sensitivity were the presence of any of the following:

- Major aquifers;
- Existing supply boreholes/springs;
- Wetlands/seeps;
- Surface water features such as rivers and dams; and
- 500 m buffer zones around the above.

2.4.1 Thyspunt

Site sensitivity analysis indicates areas of high sensitivity associated with wetlands and medium sensitivity associated with the major aquifer in the superficial deposits. The corridor for nuclear plant and auxiliary buildings has a mostly low to medium sensitivity rating.

2.4.2 Bantamsklip

Site sensitivity analysis indicates that the majority of the site has a low sensitivity.

2.4.3 Duynefontein

Site sensitivity analysis indicates a mostly low sensitivity with some small areas of medium to high sensitivity associated with wetlands and a wellfield.

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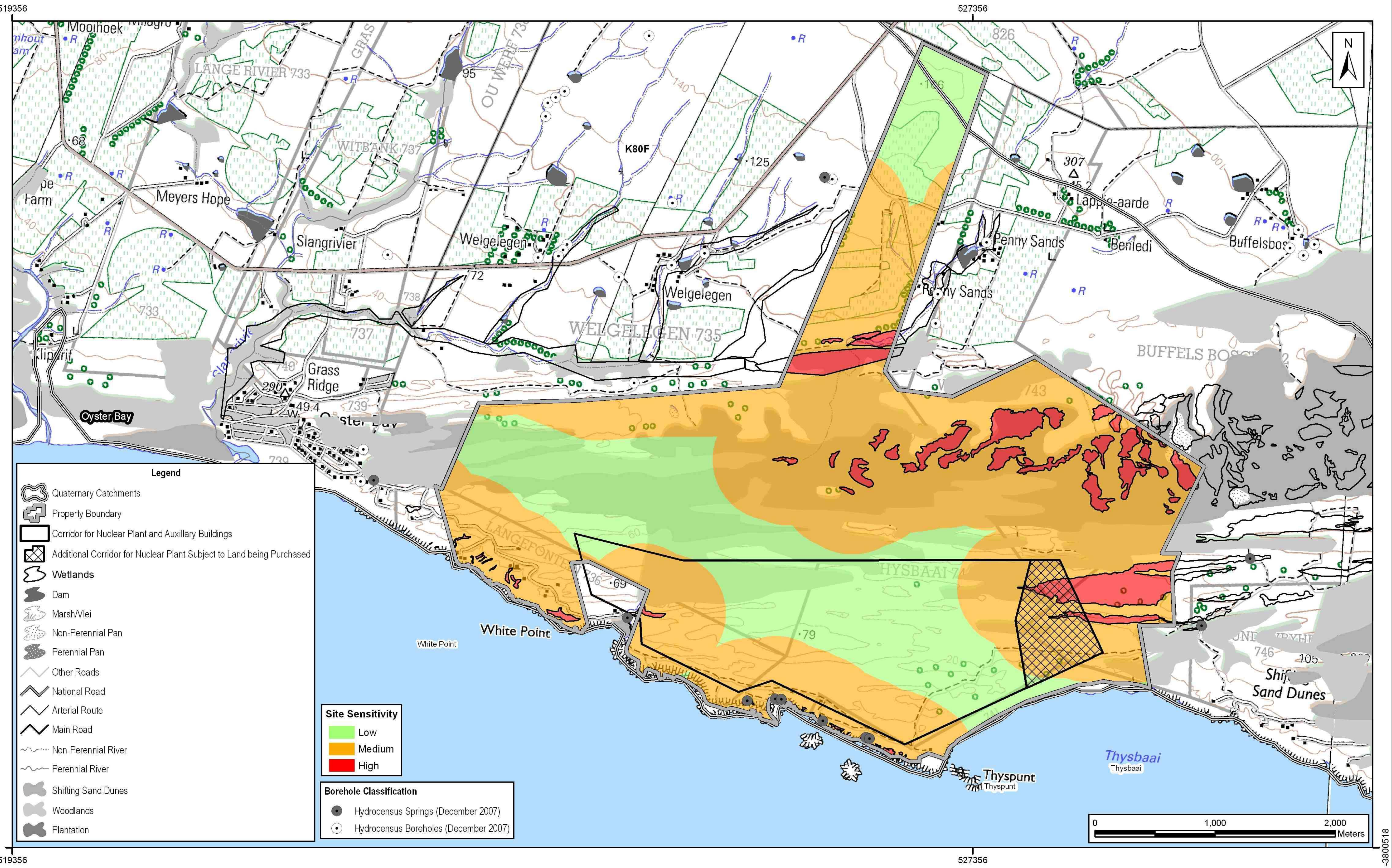

PROJECT NO.	COORDINATE SYSTEM		DATE	SCALE
378677	GAUSS CONFORMAL		20/11/2009	1:30,000
	SPHEROID	CENTRAL MERIDIAN	COMPILED BY	FIG NO.
	WGS84	25	GOES	2.4

NUCLEAR-1 ENVIRONMENTAL IMPACT ASSESSMENT FOR A PROPOSED NUCLEAR POWER STATION AND ASSOCIATED INFRASTRUCTURE
SPECIALIST STUDY: FRESHWATER SUPPLY
SENSITIVTY ANALYSIS : THYSPUNT

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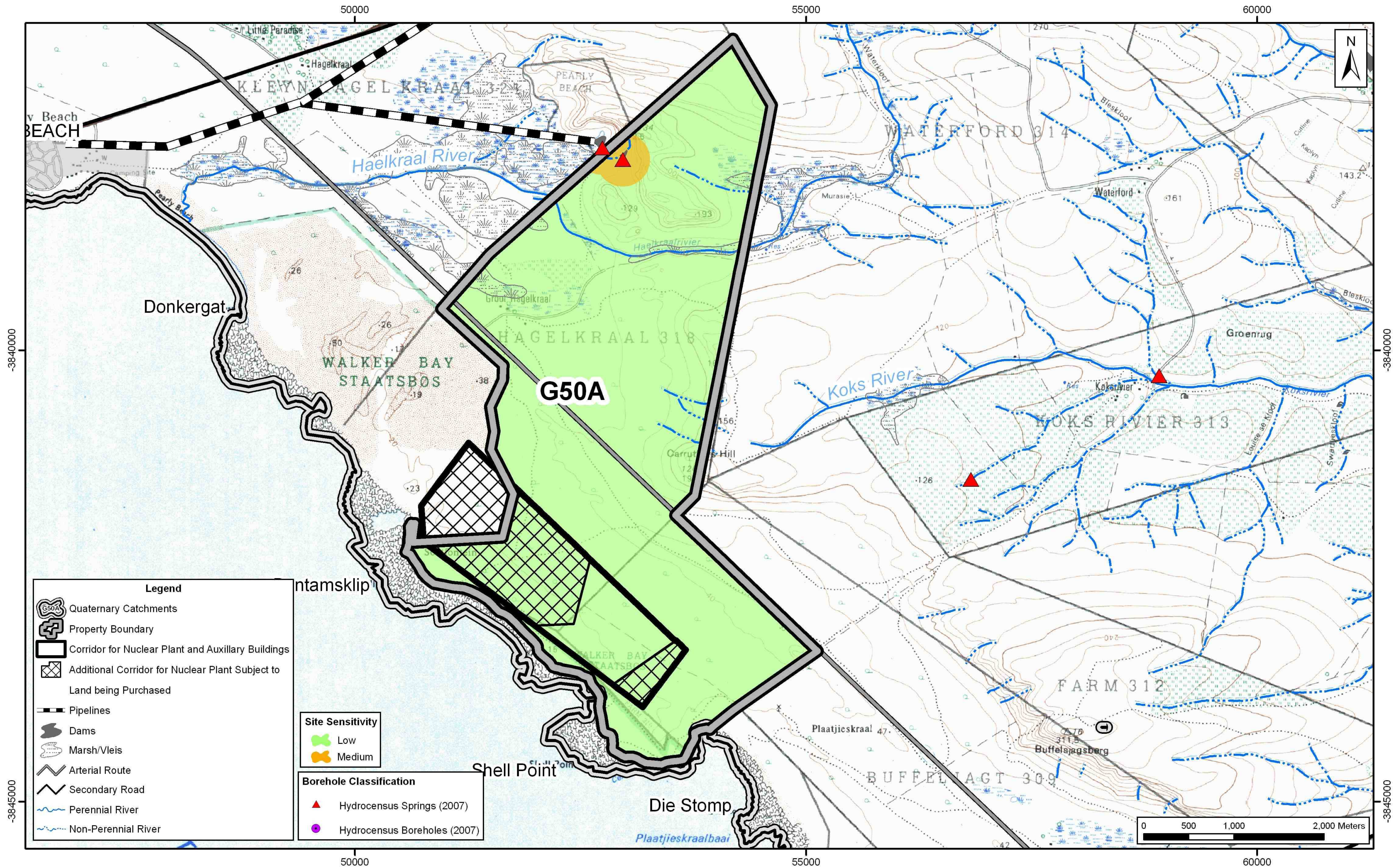

PROJECT NO.	COORDINATE SYSTEM		TITLE	DATE	SCALE
378677	GAUSS CONFORMAL		NUCLEAR-1 ENVIRONMENTAL IMPACT ASSESSMENT FOR A PROPOSED NUCLEAR POWER STATION AND ASSOCIATED INFRASTRUCTURE SPECIALIST STUDY: FRESHWATER SUPPLY SENSITIVITY ANALYSIS : BANTAMSKLIP	20/11/2009	1:40,000
	SPHEROID	CENTRAL MERIDIAN		COMPILED BY	FIG NO.
	WGS84	19		GOES	2.5

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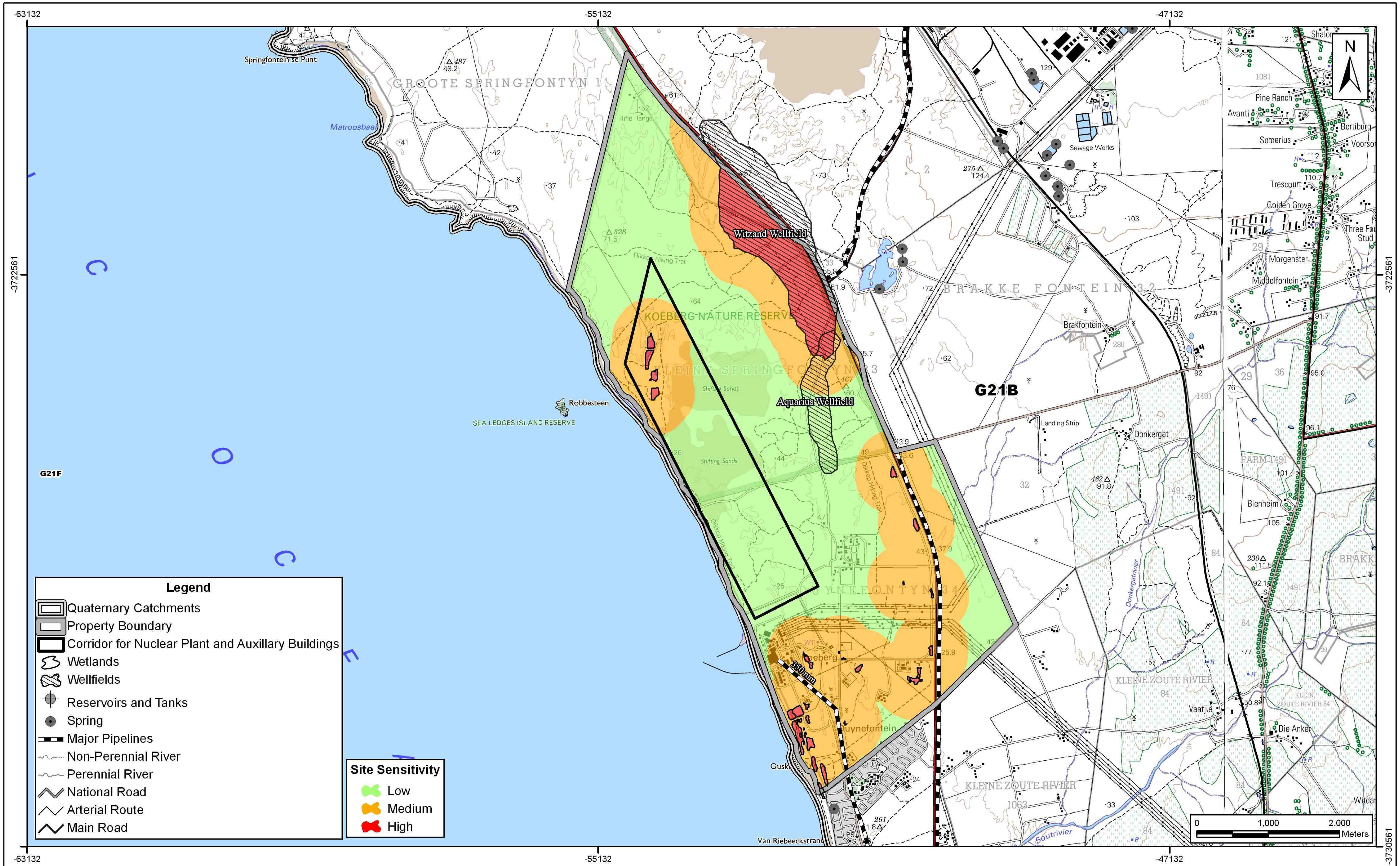

PROJECT NO.	COORDINATE SYSTEM			DATE	SCALE
378677	GAUSS CONFORMAL		NUCLEAR-1 ENVIRONMENTAL IMPACT ASSESSMENT FOR A PROPOSED NUCLEAR POWER STATION AND ASSOCIATED INFRASTRUCTURE SPECIALIST STUDY: FRESHWATER SUPPLY SENSITIVITY ANALYSIS: DUYNEFONTEIN	20/11/2009	1:50,000
	SPHEROID	CENTRAL MERIDIAN		COMPILED BY	FIG NO.
	WGS84	19		GOES	2.6

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3 IMPACT IDENTIFICATION AND ASSESSMENT

Water supply options for all three sites are as follows:

- Municipal supply from existing schemes, mainly sourced from surface water/dams but also possibly from groundwater;
- Development of new dams by Eskom or local authorities;
- Development of groundwater resources; and
- Desalination of sea water.

South Africa is a water scarce country with an average rainfall of some 460 mm/a compared to a world average of 880 mm/a. Droughts are common and often severe. An additional demand of up to ~100 L/s could therefore have a significant impact on local water resources, but less of an impact on major regional schemes, e.g. Orange River, Riviersonderend/Breë.

There are no rivers or perennial streams at the three sites. Construction and operation of the NPS will thus not have any direct effects on surface water supply schemes or catchments.

The NPS will be developed at a coastal site where groundwater is near the end of the flow path. The only existing groundwater use that could be directly affected is that from coastal springs. Any impacts on these springs will be of a very localized extent.

In terms of safety and assurance of supply and given the periodic droughts that affect the areas, the already scarce water supply situation and global warming impacts, establishment of a desalination plant is a very favourable option and is in fact Eskom's preferred option.

There is a ready supply of sea water at the sites and there would be a ready supply of power from an operational NPS. Desalination could therefore be a cost-effective method to provide an assured water supply to the sites during operation and also during construction initially as a package plant installation. If a maximum of 104 L/s are required and assuming a 40% recovery of fresh water, 260 L/s of seawater will be required and ~156 L/s of brine will require discharge. Disposal of such quantities of brine in the surf zone (to promote mixing) during construction of the NPS should not cause adverse environmental impacts. During the NPS operational stage, the brine should be mixed with the very large volumes of cooling water discharged by an NPS which would minimise any potential impacts.

During the early start-up construction phase, beach wells may be used to obtain sea water, while during the main construction phase a pipeline into the sea would be used. During the operational phase, sea water would be siphoned off from the cooling water intake (Eskom 2009).

Global warming is likely to increasingly impact on water availability in South Africa. For example, one scenario is that the Western Cape will lose some of its winter rainfall. Rainfall may also become more erratic and extreme events more common and severe. These impacts are likely to be negative in terms of availability and assurance of water supply.

Possible impacts are listed in **Table 3.1** and **Table 3.2** for construction and operation, respectively. Site construction is scheduled to take five years and the NPS will be in operation for about 60 years. Decommissioning will therefore only occur in more than 65 year's time. This is too far in the future for any meaningful predictions of likely impacts and mitigating measures.

Impacts on wetlands and ecology (terrestrial and marine) ***and geohydrological issues*** are dealt with in separate specialist studies.

Table 3.1: Impact Identification: Construction

Action	Impacts	Comments
Use of groundwater	Drying up of springs. ***Degradation of wetlands*** Sea water intrusion. Decreased supply from existing sources.	These impacts are all very localised.
Use of surface water	Stress on existing local and regional supplies from already committed sources	Local and regional impacts
Installation and pumping of beach wells for sea water	Disturbance in the shore zone during access and installation	Very localised impact
Disposal of brine into the surf zone.	None on fresh water supplies	Impact on marine environment therefore not considered further

Table 3.2: Impact Identification: Operation

Action	Impacts	Comments
Use of groundwater	Drying up of springs. ***Degradation of wetlands*** Sea water intrusion. Decreased supply from existing sources.	These impacts are all very localised.
Use of surface water	Stress on existing local and regional supplies from committed sources	Local and regional impacts
Disposal of brine into coastal marine environment	See Table 3.1	See Table 3.1

4 ENVIRONMENTAL ASSESSMENT

4.1 Thyspunt

Direct potential impacts are assessed using the Impact Rating Methodology supplied with the ToR in **Table 4.1** and **Table 4.2**.

Potential impacts:

Drying up of coastal springs/degradation of wetlands: These are mainly fed by groundwater from the superficial deposits and are of local importance only, for domestic water supply and ecology. Domestic use will stop as the on-site houses will be vacated prior to the commencement of construction. Use of deep (>100 m) boreholes in the TMG Aquifer away from these features will minimise impacts. Any such potential impacts will be *local*, of *low significance* and have a *high* reversibility.

Sea water intrusion: This could be caused by pumping of supply boreholes (or dewatering/groundwater control measures). This would be a *localised* impact of *low significance* but could have a *medium* reversibility.

Installation of beach wells: *Local* impact in the shore zone of *low* significance and *short* duration.

Disposal of brine: This would have a *local* impact of *low* significance and *high* reversibility.

Based on the above assessment there are not considered to be any Fatal Flaws associated with the Thyspunt site.

4.2 Bantamsklip

Direct potential impacts are assessed using the Impact Rating Methodology supplied with the ToR in **Table 4.3** and **Table 4.4**.

Potential Impacts

Sea water intrusion: This could be caused by pumping of supply boreholes (or dewatering/groundwater control measures). This would be a *localised* impact of *low* significance but could have a *medium* reversibility. However, there is no on-site use of groundwater and no viable aquifers and so this impact is seen as of *low* consequence and significance.

Installation of beach wells: *Local* impact in the shore zone of *low* significance and *short* duration.

Disposal of brine: This would have a *local* impact of *low* significance and *high* reversibility.

Based on the above assessment there are not considered to be any Fatal Flaws associated with the Bantamsklip site.

4.3 Duynefontein

Direct potential impacts are assessed using the Impact Rating Methodology supplied with the ToR in **Table 4.5** and **Table 4.6**.

Potential impacts

Sea water intrusion: This could be caused by pumping of supply boreholes (or dewatering/groundwater control measures). This would be a *localised* impact of *low* significance. However, there is no on-site use of groundwater. Sea water intrusion occurred during dewatering operations for the foundations for KNPS but there are no reports of adverse impacts and this was of a very localised extent. .

Cumulative impacts: The existing KNPS is supplied with fresh water from municipal sources and potentially from the Aquarius Wellfield (poor water quality so is only being used for game watering). Use of municipal water would put additional strain on local supplies, and supply could not be guaranteed.

Installation of beach wells: *Local* impact in the shore zone of *low* significance and *short* duration.

Disposal of brine: This would have a *local* impact of *low* significance.

Based on the above assessment there are not considered to be any Fatal Flaws associated with the Duynefontein Site.

Table 4.1: Direct Impacts during the Construction Phase: Thyspunt

Impact	Nature	Intensity	Extent	Duration	Impact on irreplaceable resources	Consequence	Probability	SIGNIFICANCE
Impact 1: Drying up of coastal springs/ degradation of wetlands	Negative	Low	Low	Low	Low	Low	Low	Low
With mitigation	Negative	Low	Low	Low	Low	Low	Low	Low
Impact 2: Sea water intrusion	Negative	Low	Low	Low	Low	Low	Low	Low
With mitigation	Negative	Low	Low	Low	Low	Low	Low	Low
Impact 3: Installation of beach wells	Negative	Low	Low	Low	Low	Low	High	Low - Medium
With mitigation	Negative	Low	Low	Low	Low	Low	Low	Low
Impact 4: Disposal of brine	Negative	Low	Low	Low	Low	Low	High	Low - Medium
With mitigation	Negative	Low	Low	Low	Low	Low	Low	Low

Table 4.2: Direct Impacts during the Operational Phase: Thyspunt

Impact	Nature	Intensity	Extent	Duration	Impact on irreplaceable resources	Consequence	Probability	SIGNIFICANCE
Impact 1: Drying up of coastal springs/ degradation of wetlands	Negative	Low	Low	Low	Low	Low	Low	Low
With mitigation	Negative	Low	Low	Low	Low	Low	Low	Low
Impact 2: Sea water intrusion	Negative	Low	Low	Low	Low	Low	Low	Low
With mitigation	Negative	Low	Low	Low	Low	Low	Low	Low
Impact 3: Disposal of brine	Negative	Low	Low	High	Low	Low	High	Low - Medium
With mitigation	Negative	Low	Low	Low	Low	Low	Low	Low

Table 4.3: Direct Impacts during the Construction Phase: Bantamsklip

Impact	*Nature*	*Intensity*	*Extent*	*Duration*	*Impact on irreplaceable resources*	*Consequence*	*Probability*	*SIGNIFICANCE*
Impact 1: Sea water intrusion	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*
With mitigation	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*
Impact 2: Installation of beach wells	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*
With mitigation	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*
Impact 3: Disposal of brine	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*High*	*Low - Medium*
With mitigation	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*

Table 4.4: Direct Impacts during the Operational Phase: Bantamsklip

Impact	*Nature*	*Intensity*	*Extent*	*Duration*	*Impact on irreplaceable resources*	*Consequence*	*Probability*	*SIGNIFICANCE*
Impact 1: Sea water intrusion	*Negative*	*Low*	*Low*	*High*	*Low*	*Low*	*Low*	*Low*
With mitigation	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*
Impact 2: Disposal of brine	*Negative*	*Low*	*Low*	*High*	*Low*	*Low*	*High*	*Low - Medium*
With mitigation	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*

Table 4.5: Direct Impacts during the Construction Phase: Duynefontein

Impact	*Nature*	*Intensity*	*Extent*	*Duration*	*Impact on irreplaceable resources*	*Consequence*	*Probability*	*SIGNIFICANCE*
Impact 1: Sea water intrusion	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*Medium*	*Low*
With mitigation	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*
Impact 2: Installation of beach wells	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*High*	*Low - Medium*
With mitigation	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*
Impact 3: Disposal of brine	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*High*	*Low - Medium*
With mitigation	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*

Table 4.6: Direct Impacts during the Operational Phase: Duynefontein

Impact	*Nature*	*Intensity*	*Extent*	*Duration*	*Impact on irreplaceable resources*	*Consequence*	*Probability*	*SIGNIFICANCE*
Impact 1: Sea water intrusion	*Negative*	*Low*	*Low*	*High*	*Low*	*Low*	*Medium*	*Low*
With mitigation	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*
Impact 2: Disposal of brine	*Negative*	*Low*	*Low*	*High*	*Low*	*Low*	*High*	*Low - Medium*
With mitigation	*Negative*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*	*Low*

4.4 No Go Option

In the event that the sites are not developed for NPSs, Eskom will sell the Bantamsklip and Thyspunt properties and non-essential parts of Duynefontein could also be sold. In this scenario the impact is seen to be *low* intensity, *neutral* consequence and *low* significance for the Bantamsklip site (no aquifers) but of *medium* intensity, *negative* consequence and *high* significance for the Thyspunt and Duynefontein sites as local groundwater resources could be exploited by private land owners/developers. The main mitigation measure for this scenario would be strict enforcement of conditions applicable to any approved future development of the sites.

5 MITIGATION MEASURES

For each identified impact, mitigation measures have been identified with time frames, evaluation programme and hierarchy. These are shown in **Table 5.1** and **Table 5.2**.

Table 5.1: Mitigation Measures: Construction

Action	Mitigation measures	Time frame	Evaluation	Hierarchy
Use of Groundwater	Only use deep (>100 m depth) boreholes on site. Apply sustainable pumping rates derived from credible geohydrological testing and analysis. Set target groundwater levels for maximum allowable drawdown. Implement a monitoring programme to provide early warning of any detrimental effects of pumping.	From start of construction From start of construction From start of construction From start of construction	Geohydrologist to review monitoring data on a quarterly basis. Revise pumping regime as required.	Reduction
Long-term groundwater control measures around the NPS	Detailed site investigation and numerical simulation to predict effects. Injection of pumped groundwater back into the aquifer to maintain groundwater levels. Coastal location of the NPS.	Prior to construction During construction period	Geohydrologist to review monitoring data on a quarterly basis.	Reduction
Use of surface water	Tap into a regional scheme rather than a local scheme Relatively small volumes of water required Use desalinated water	Establish package plant in time for start of construction		Avoidance
Installation of beach wells	Draw-up an environmental management plan prior to installation. Monitor water levels and quality.	During early construction period only	Geohydrologist to review monitoring data	Reduction
Disposal of brine	Disposal in the surf zone	During construction	Marine ecologist to monitor	Reduction

Table 5.2: Mitigation Measures: Operation

Action	Mitigation measures	Time frame	Evaluation	Hierarchy
Use of groundwater	Only use deep (>100 m depth) boreholes. Apply sustainable pumping rates derived from credible geohydrological testing and analysis. Continue and expand the monitoring programme to provide early warning of any detrimental effects of pumping.	From start of operation Determined from construction period From start of construction	Geohydrologist to review monitoring data on a quarterly basis. Revise pumping regime as required.	Reduction
Long-term groundwater control measures around the NPS	Detailed site investigation and numerical simulation to predict effects. Use of passive systems such as sheet piles/cut-off slurry wall. Coastal location of the NPS.	Prior to construction Prior to operation	Geohydrologist to review monitoring data on a quarterly basis.	Reduction
Use of surface water	Tap into a regional supply scheme rather than a local scheme. Use desalinated water.	From start of operation Full scale plant established during construction		Avoidance
Source of sea water	Siphon-off from cooling water intake	From start of operation		
Disposal of brine	Disposal by mixing with cooling water discharge	From start of operation	Marine ecologist to monitor	Reduction
Atmospheric releases from the NPS (normal plant operation)	Coastal location of NPS. Design containment. Monitoring of atmospheric releases. NRR requirement for annual release limits.	From start of operation From start of operation	Daily evaluation of air emission monitoring data	Reduction
Release of liquid effluent (normal plant operation)	Coastal location of the NPS-only some coastal springs could be affected. Containment structures. Monitoring. Emergency containment plans.	From start of operation From start of operation From start of operation	On-site monitoring network evaluated on a weekly basis.	Rectification

6 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions are drawn from this specialist study into Fresh Water Supply:

(a) Thyspunt

- There is extensive use of groundwater in the surrounding area;
- There are coastal springs at the site;
- The surrounding towns are supplied with water from the Churchill and Impofu dams and groundwater;
- There is scope for further development of local groundwater resources for construction supply both on-site and in the surrounding area;
- Local and regional surface water resources are under stress and additional draw-off to supply a NPS would exacerbate this situation;
- The main option for surface water supply with least local and regional impact is import of water from the Orange River Scheme;
- Surface water and to a lesser extent groundwater is likely to be adversely affected by climate change;
- Desalination of sea water is the most viable option for an assured water supply with least environmental impact and would not be affected by climate change. This is Eskom's preferred option for freshwater supply.

(b) Bantamsklip

- There are no viable aquifers in the area;
- Local and regional surface water sources are fully utilized;
- The surrounding towns are supplied with surface water from Kraaibosch Dam and groundwater from springs and boreholes;
- Local and regional surface water resources are under stress and additional draw-off to supply a NPS would exacerbate this situation;
- The only option for surface water supply is import of water from the Riviersonderend-Bree scheme;
- Surface water and to a lesser extent groundwater is likely to be adversely affected by climate change;
- Desalination of sea water is the most viable option for an assured water supply with least environmental impact and would not be affected by climate change. This is Eskom's preferred option for fresh water supply.

(c) Duynefontein

- There is extensive use of groundwater in the surrounding area;
- The Aquarius Wellfield was previously developed to supply groundwater to KNPS but has not been used recently because of quality constraints. This wellfield requires extensive rehabilitation but could supply the required construction and partial operational demand;
- KNPS is connected to the municipal water supply scheme and Nuclear-1 water use would place an additional burden on this source;
- Additional surface water supply from existing municipal supply sources cannot be guaranteed;

- Surface water and to a lesser extent groundwater is likely to be adversely affected by climate change;
- Desalination of sea water is the most viable option for an assured water supply with least environmental impact and would not be affected by climate change. This is Eskom's preferred option for fresh water supply.

d) No go option

- In the event that the sites are not developed for NPSs, Eskom will sell the Bantamsklip and Thyspunt properties and non-essential parts of Duynefontein could also be sold. In this scenario the impact is seen to be *low* intensity, *neutral* consequence and *low* significance for the Bantamsklip site (no aquifers) but of *medium* intensity, *negative* consequence and *high* significance for the Thyspunt and Duynefontein sites as local groundwater resources could be exploited by private land owners/developers. The main mitigation measure for this scenario would be strict enforcement of conditions applicable to any approved future development of the sites.

The main mitigation measure required is that the brine produced as a by-product of the desalination process must be discharged in the surf zone during construction and mixed with the cooling water discharge during NPS operation to minimise any effects on the marine environment. The discharge must be monitored by a marine ecologist.

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