WOLFS FANG RUNWAY

Initial Environmental Evaluation Report Final July 2016

For Submission to the UK Foreign and Commonwealth Office

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1 Introduction

This report has been prepared by White Desert Limited (White Desert) in relation to the proposed Wolfs Fang Runway development. It presents the findings of the environmental impact assessment carried out for the proposed development within an Initial Environmental Evaluation (IEE) Report. The IEE team which has completed the IEE Report comprises the following key staff:

Table 1.0:IEE Report Team	
Position	**Name /Role**
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Approver	Patrick Woodhead, Director of White Desert White Desert Ltd Contact: Patrick@white-desert.com

The proposed project is located in Dronning Maud Land (71'31"S, 08'48" E, Altitude above Sea Level: 1130m). The project is to re-establish a former blue ice runway site to provide access to Whichaway Camp and will comprise temporary staff and client accommodation, storage structures for plant and equipment as well as the re-established runway for seasonal use.

This IEE Report aims to study the environmental impact of re-establishing the blue ice runway to support the White Desert operation. It considers the foreseeable and possible changes to the logistic systems to support the operation as well as the client activities and their direct and cumulative impacts on the environment.

2 Legislative Context and Screening

In 1991 in Madrid, the Antarctic Treaty Consultative Parties have signed the Protocol on Environmental Protection to the Antarctic Treaty (the Protocol), which put forward the environmental protection issues as the most critical obligations of the Parties of the Antarctic Treaty. The Protocol designates Antarctica "as a natural reserve, devoted to peace and science". In January 1998 the Protocol came into legal force after being ratified by all Consultative Parties. According to the requirements of the Protocol, any activity in the Antarctic has to be preceded by an Environmental Impact Assessment (EIA) before its commencement.

The proposed project is considered to require an Initial Environmental Evaluation based on the nature of the project, the existing environment and environmental evaluation of similar schemes in Antarctica. Additional considerations were:

- The historic use of the site as a blue -ice runway
- The proposed site is currently not in use and waste from historical land use remains in situ
- The project comprises the relocation of an existing activity to an environment which can be directly managed by the operator White Desert Ltd
- The proposed site is not located within 100km of a protected or managed ecological area
- Limited potential for ecological disturbance due to nature of blue-ice
- Seasonal nature of operations and activities over the summer period November- completing by mid February

The IEE has been prepared in accordance with the Recommendations and Measures adopted at the Antarctic Treaty Consultative Meetings (ATCM) and within the frames of the procedures of EIAs as per Annex 1 to the Protocol. The level of detail in the environmental assessment approach is considered appropriate for an IEE.

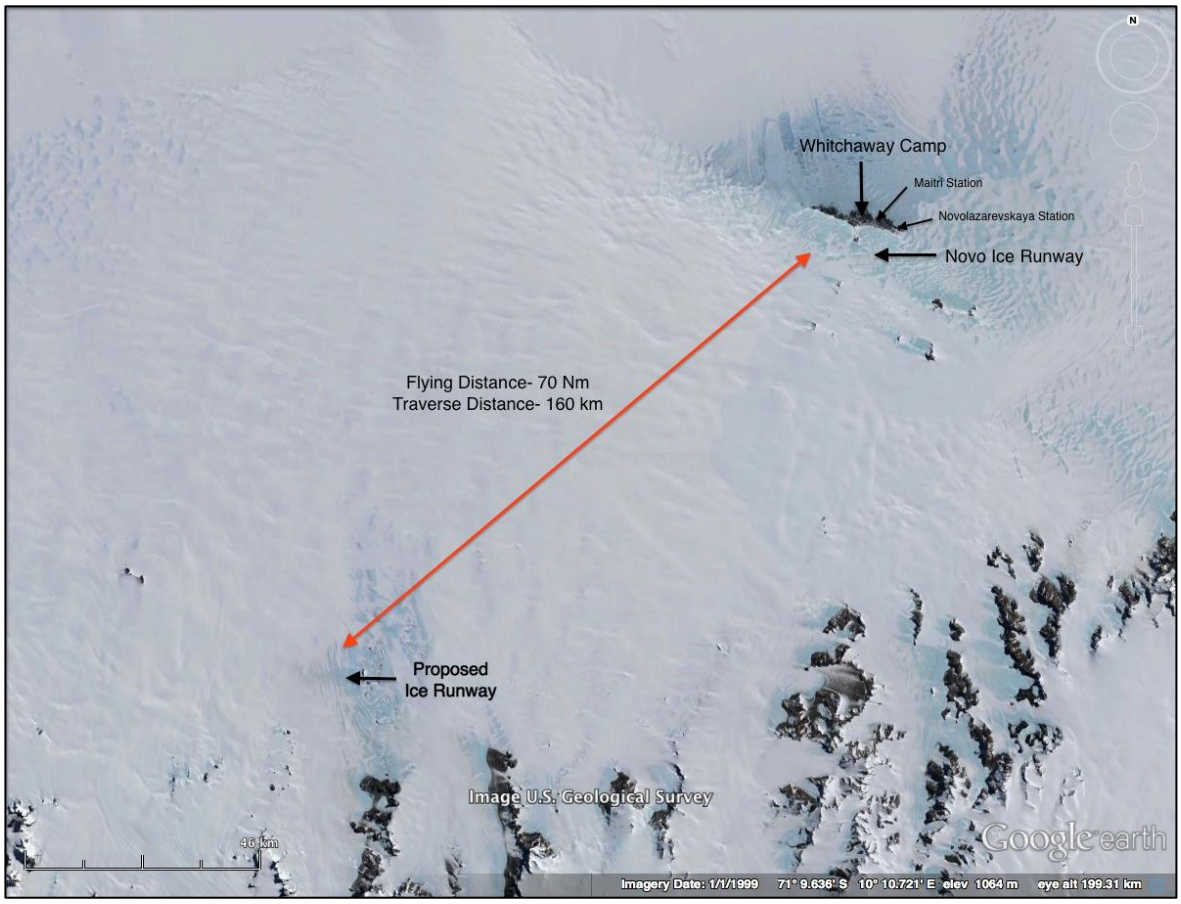
3 Background

White Desert Ltd has been operating a commercial tourism operation in Queen Maud Land since 2005. The operation runs over the summer period only and is based out of the temporary '*Whichaway'* Camp located on the Schirmacher Oasis. Clients are flown into Whichaway Camp by air for short duration visits between November and February each year. The operation offers small scale, bespoke experiences for clients with numbers limited to approximately 12 clients at any one time.

Logistic support for the operation is dependant upon The Antarctic Company (TAC), who are the non-governmental arm of Antarctic Logistic Centre International (ALCI). ALCI provide air transportation services between the nearby Novo Ice Runway and Cape Town, South Africa as well as intra-

continental transfers. This support is essentially provided on an opportunity basis whereby White Desert is able to utilise free capacity on aircraft not required by the national programs participating in Dronning Maud Land Air Network project (DROMLAN).

White Desert proposes to re-establish a former blue ice runway site to provide access to Whichaway Camp. The independent operation of a runway will provide greater flexibility in scheduling client flights. A reconnaissance of the Henrickson Nunatak area in December 2014 identified the site as suitable for the re-establishment of a blue ice runway. This site was used for intercontinental flights by the US based Adventure Network International (ANI) (a subsidiary of Antarctic Logistics Expeditions LLC) up to 2001 and possibly by the Russian Antarctic programme (RAE) in the 1980s. The location of the runway site relative to Whichaway Camp can be seen at Map 1.



Map 1. Map showing relative location of Wolfs Fang Runway and the Whichaway Camp.

4 Purpose and Need

White Desert provides highly tailored, Antarctic experiences to very small groups of clients over the austral summer period. Aside from providing the clients with an exceptional touristic experience, White Desert also puts substantial emphasis on broadening the client's understanding of Antarctica in an effort to inculcate them with a sense of the continent's beauty, fragility, and value. With such influential clientele visiting the camp, we believe this is an important opportunity get global 'thought leaders' to become advocates of Antarctic protection.

White Desert is seeking to develop an independent method of entry into Dronning Maud Land for the following reasons:

1) It will reduce scheduling conflicts, as ALCI's transport assets are heavily subscribed with governmental programmes.
2) It will facilitate more efficient scheduling as traditionally, most personnel from national programmes wish to enter Antarctica at the beginning of the summer season and return 3-4 months later in February before winter. Science projects often take multiple weeks to complete, whereas White Desert's programmes require regular 8-day flight rotations as tourists only wish to spend a maximum of 7-10 days on the continent.
3) A dedicated touristic runway will provide greater delineation of the boundaries and areas of responsibility between governmental programmes and touristic ones.
4) It will allow White Desert to operate a self-reliant and small scale tourism operation, reducing the dependence on the ALCI operation.
5) It will provide a significant reduction in the fuel and atmospheric emissions generated in bringing clients to Whichaway (reduced by 29% on a per client basis).
6) The re-establishment of a high elevation runway will greatly improve access in January when the ALCI runway at Novo is often closed due to warm temperatures. This is also the peak demand period for clients.
7) It will provide an effective inland alternate runway to the ALCI runway that could be used in emergency situations.
8) The operation will utilise a dedicated business jet, which will be on constant 'standby' in Cape Town, South Africa. The plane can be called upon in a matter of hours to support a medical evacuation for either tourist programmes or governmental ones operating in the Droning Maud Land region. Currently, for a significant proportion of governmental programmes, the only means of an air evacuation is by using ALCI's Illuyshin-76TD. This plane is designed to transport up to 80 passengers and uplifts approximately 18 tonnes of fuel (from limited resources in situ in Antarctica) and so, is an inefficient use of resources to evacuate one or two injured personnel. A business jet would cost less, impact less on the environment and be far more suited to the rescue mission in hand.
9) Depending on the business jet utilised, it will have no 'Point of No Return', unlike the flight plan currently operated by the IL-76TD. Approximately one hour from their destination, the pilots of the IL-76TD must decide to

continue or, should weather conditions be marginal, return to Cape Town. The business jet, with its greater range, will be able to perform the entire journey without refuelling, therefore providing an additional and important safety aspect to each flight rotation.

Client groups are conducted as "micro expeditions", whereby groups are deployed to Antarctica with all their food. This limits the accumulation of stores in Antarctica. While on the continent, they are accommodated in the temporary infrastructure of the Whichaway Camp and supported by camp based staff.

Some clients groups undertake additional excursions away from Whichaway Camp to locations such as the South Pole or Atka Bay (to view the Emperor Penguin colony nearby). All travel to the continent and all flights within it are provided by ALCI via their commercial subsidiary, TAC.

A summary of key operational metrics is provided in Table 2. These numbers are based on averages between the November to February period.

Table 2.0 Key operational metrics of White desert's current operation

Number of clients per season	40 to 100
Number of staff days in Antarctic per season.	672 days (8 staff for 12 weeks)
Energy consumption in Antarctica per season (not including air travel)	Propane- 300 L Diesel fuel- 2,400 L Gasoline fuel- 200 L
Waste generated	Returned to SA- 3,000 kg Buried by TAC- 2,700 kg Grey Water 1875 kg Black Water
Energy consumption on air travel	Intercontinental- 71 tons jet fuel[1]. Intra-continental- 24 tons jet fuel. White Desert carbon emissions are offset through the Carbon Neutral Company since 2007.

The White Desert operation and its impacts on the environment can be broken down into a number of components to allow for a more detailed analysis. Current operations will be examined as follows:

- Whichaway Camp, including its establishment and ongoing operation.
- Client activities, outside of the Whichaway Camp.
- Logistic support, including the intercontinental movement of passengers, cargo and wastes.

[1] Based on proportion of capacity used on TAC flights. 80 seat capacity. 1 x staff flight with 8 WD staff. 5 x client flights with 12 clients. IL-76 fuel burn rate of 7.6 tons/hr and 11 hr flight time.

4.1 Whichaway Camp

Whichaway Camp has been in operation since 2006. A separate IEE for the camp was submitted to the British FCO in 2008 and assessed the operation and activities as having no more than a 'minor and transitory' impact. An updated IEE for Whichaway Camp[2] was prepared and submitted in 2011.

Located at 70°45'51"S, 11°37'04"E on the Schirmacher Oasis, the camp can accommodate up to 12 clients and ten staff. It is the base of operations for clients who participate in a range of activities such as snow shoeing, trekking, photography etc in close proximity to the Camp.

The camp comprises two large dome tents for communal areas and eight fiberglass InterShelter™ domes. Six domes are for sleeping accommodation, one is used for a kitchen and the last is used as an ablution block. All domes and tents are located on timber platforms. Three 20' ISO-containers are used for storage. The camp occupies an area of approximately 100m X 100m (1 hectare).

The operating period for the camp is between November and February. During this period, the camp consumes approximately 2400l of diesel and 300l of propane. Non-combustible waste is returned to South Africa, while grey water and faecal matter is disposed of in an ice pit by TAC in accordance with the ALCI/ TAC waste management plan.

There is no proposed change to occur to the operations at Whichaway Camp. The information presented in the most recent Whichaway Camp IEE (2011) has been updated to take into consideration the proposed Wolfs Fang Runway operations in the Cumulative Impacts Section (refer to report Section 12).

4.2 Client Activities

White Desert clients may undertake excursions to Atka Bay to view wildlife and/or to the South Pole. Travel to these locations is by ski equipped aircraft such as DHC-6 Twin Otter or BT-67 Basler operated by TAC. These excursions may be supported by field camps run by TAC and IEEs have been previously submitted to ascertain the impact of these transitory camps.

Approximately four or five return flights are made to Atka Bay each season and the same number to the Geographic South Pole. This equates to approximately 57-95 hours of flying depending on the number of trips.

4.3 Logistic Support

Access to and from the content is provided by TAC. TAC is a branch of ALCI that supports non-governmental clients. ALCI, in turn, is a South African business established to support the Antarctic community to access the continent from

[2] Whichaway Camp Activity IEE, White Desert Ltd, 2011

Cape Town, South Africa and primarily deals with national programmes through the DROMLAN network.

Continental access is predominantly by an IL-76 TD aircraft but, on rare occasions, other aircraft have been used in past for White Desert's tourist operations, such as a Gulfstream IIB, Gulfstream III and Super Boeing 727. The IL76 TD aircraft is stationed at Cape Town International Airport during the season and performs approximately 10-12 rotations to Novo Runway in Antarctica. The plane is a 'combi' aircraft, flying both cargo and passengers on the same flight. White Desert is allowed to add passengers and cargo to these flights, however they are subordinated to the requirements of the DROMLAN network and other national programmes.

Flights schedules are developed during the pre-season and are demand driven. This creates a degree of uncertainty as to when flights will occur and what capacity will be available in any given season. The capacity of the aircraft dictates that flights are not flown at high frequency. This is not ideal for a commercial operation as the duration of stay in Antarctic can vary from group to group. There is also considerable pressure to get on key flights at the start and end of the season and also around Christmas.

All cargo and stores to support the White Desert operation are facilitated through TAC and the IL-76 service. This includes back loading of non-combustible wastes.

While no shipping activities directly support the White Desert operation, the IL-76 routinely uplifts fuel at Novo. This fuel is delivered annually as part of the over-ice resupply for Novo. Typical fuel uploads are believed to be 20,000 l per flight when fully loaded.

The proposed activity of the re-establishment of Wolfs Fang Runway will fundamentally change the logistic support arrangements for White Desert's operation. TAC/ALCI flights will only be used to bring in staff at the beginning of the season and extract them at end. Clients will be brought to Antarctic via a business jet operated by White Desert and they will land at an ice runway that was formally used by commercial operators in the 1990s.

5 Environmental Impact Assessment Approach

5.1 Consultation and Stakeholder Engagement

White Desert has undertaken consultation and stakeholder engagement throughout the feasibility and IEE process.

Following the feasibility / options appraisal stage, a feasibility report for reactivating the redundant runway (formerly known as Blue One) was submitted to the British Foreign and Commonwealth Office (FCO) for comment in March

2015[3]. The feasibility report identified safety considerations, reducing conflict with government operations and opportunities for co-operation among the advantages of reactivating the runway and set out a proposed way forward for the operation of the runway.

Following submission of the feasibility report, the Wolfs Fang Runway operations and environmental considerations were presented to the FCO by White Desert. White Desert considered that the project's environmental impacts can be categorised as minor and transitory, requiring the preparation of an IEE Report, in accordance with the Annex I of the Protocol. This is also in line with environmental assessment of similar schemes, and ATCM meeting and research undertaken to define the category of minor and transitory[4].

A Draft IEE Report was submitted to the FCO in July 2015 and comments received from the FCO and British Antarctic Survey Environment Officer have been addressed in this updated Final IEE Report.

At the request of the FCO a report has been prepared covering the conduct of resupply activities and the traverse to the Wolfs Fang site from the coast. Feedback from the FCO and the British Antarctic Survey on these plans were received in June 2016. The report, entitled Logistics and for the Wolfs Fang Runway has been updated and is attached to the IEE as Appendix I/ a stand alone document.

5.2 Relevant Guidance and Legislation

- Protocol on Environmental Protection to the Antarctic Treaty (1991): Article 3 Environmental Principles, (2) (a)- (2) (e) Activities should be planned and conducted on the basis of 'information sufficient to allow prior assessments of, and informed judgements about, their possible impacts on the Antarctic environment'. The aim of the Environmental Protocol is to ensure 'the comprehensive protection of the Antarctic environment'.
- Article 8 relates to Environmental Impact Assessment and defines three levels: less than a minor or transitory impact, minor or transitory impact or more than a minor or transitory impacts. One of its guiding principles is that an Environmental Impact Assessment must be carried out before any activity is allowed to proceed.
- Protocol on Environmental Protection to the Antarctic Treaty (1991), Annex I Environmental Impact Assessment
- Guidelines of Environmental Impact Assessment in Antarctica

[3] Project South, Patrick Woodhead, White Desert Ltd, March 2015
[4] Finding of meetings summarised in Environmental Impact Assessment in Antarctica application of minor or transitory impact criterion, GCAS, Tarasenko, 2008-2009

5.3 Approach and Methodology

The report has been carried out to meet the requirements set out in the Protocol on Environmental Protection to the Antarctic Treaty (1991). The overall approach to the assessment methodology is based on the Guidelines for Environmental Impact Assessment in Antarctica.

In addition to mandatory requirements, and the assessment of similar schemes in Antarctica, UK best practice and industry recognised, current and upcoming technical guidance in relation to EIA has been employed to inform the assessment process. These best practice guidelines include the UK Amended Circular on Environmental Impact Assessment[5], the Explanatory Memorandum to the EIA Regulations[6],IEMA Guidelines for EIA[7], DMRB Assessment and management of Environmental Effects[8] and the European EIA Directive 2011/92/EU.

In accordance with the Guidelines for EIA in Antarctica, the assessment process considers the *outputs of activities* associated with the reactivation of the blue ice runway. It also considers the *exposure of environmental elements* (environmental elements are often referred to as environmental resources/receptors in EIAs*) to the outputs of activities.*

The nature of each impact is assessed taking into consideration a number of factors, as required by the Protocol. This includes the impact's likelihood, potential consequences, whether the impact would be permanent or temporary, intensity, duration, reversibility spatial extent of the impact, and whether it is direct, indirect or cumulative. The magnitude of impacts can be described as negligible/ minor moderate/major.

The *overall significance* is then identified. In accordance with the Protocol and Guidelines, the overall significance of potential impacts is described using one of three levels:

- Less than minor or transitory
- Minor or transitory or
- More than minor or transitory

The Protocol and Guidance do not prescribe a methodology for the determination of overall significance .There is no consensus agreement on the definition of the term "minor or transitory" and it is currently based on professional judgement, previous assessments and is considered on a case by case basis. To supplement this process, this report has determined the significance of impacts by also considering standard UK EIA approach.

[5] Amended Circular on Environmental Impact Assessment, A Consultation Paper, Department for Government and Local Communities, 2006
[6]The Explanatory Memorandum to the Town and Country Planning (Environmental Impact Assessment) (Amendment) (England) Regulations 2008
[7] Institute for Environmental Management and Assessment Environmental Impact Assessment Guidelines.
[8] Design Manual for Roads and Bridges, Highways Agency, ,Department for Transport, Volume 11, Part 5 Assessment and management of environmental effects and Part 6 Reporting of environmental effects

The approach takes into consideration the sensitivity of environmental elements and the nature of the potential impact in order to derive the overall significance, i.e. environmental elements which are designated are considered to be of very high sensitivity. The table below describes the general categories used to identify the sensitivity of environmental elements:

Table 3.0 General Guidance Developed for Assessment Process	
Value or sensitivity of environmental element	Description of criterion and examples relevant to assessment
Very High-High	Very high importance and rarity, international scale and very limited potential for substitution
	Designated sites Antarctic Special Protected Areas (ASPA), Antarctic Special Management Areas (ASMA) Historic Sites and Monuments (HSM) Ecosystem Monitoring Programmes (CEMP) sites
	Area of international or continent importance, loss would be significant for overall environment and ecology in Antarctica and on a wider scale (fauna)
	Very high wilderness and aesthetic value with absence of manmade structures or infrastructure
Medium	Habitat suitable for flora and fauna such as breeding, nesting or feeding sites such as freshwater lakes, coastal areas, ice-free ground and mountainous regions
	Area of regional wide importance and rarity, limited potential for substitution
	Areas which are of high sensitivity in terms of impacts on human activity such as research stations, infrastructure and traverse routes (human receptors)
	Area of high wilderness and aesthetic value
Low	Area does not provide a habitat suitable for flora and fauna. Natural environment across Antarctica is protected under Protocol
	Area of local importance
	Area of medium wilderness and aesthetic value reduced by presence of human activities such as abandoned sites

Guidance for description of magnitude	
Magnitude	**Description**
Negligible	No discernible impacts or impacts of very limited extent or duration, very minor loss to one or more characteristics, features or elements
Minor	Temporary short term disturbance to the physical status, dynamics or function of the receptor. A reduction in the receptor, but no significant habitat loss. Minor loss or alteration to one or more feature or element
Moderate	Partial loss of, temporary damage to or medium term disruption to physical status, dynamics

	or function of the receptor. Loss of resource but not adversely affecting integrity
Major	Complete loss of, permanent damage to, degradation of or long term disruption to integrity, physical status, dynamics or function of the receptor

Professional judgement is used to determine the overall significance of impacts, the table below has been developed as a general guideline or basis.

Table 4: 0 Determining Overall Significance of Impacts

	MAGNITUDE OF IMPACT (DEGREE OF CHANGE)				
VALUE / SENSITIVITY ENVIRONMENTAL ELEMENT RECEPTOR OR RESOURCE		**No change**	**Minor**	**Moderate**	**Major**
	Very High	*Less than minor or transient*	*Minor or transient*	*More than minor or transient*	*More than minor or transient*
	High	*Less than minor or transient*	*Minor or transient*	*More than minor or transient/ Minor or transient*	*More than minor or transient*
	Medium	*Less than minor or transient*	*Minor or transient / Less than minor or transient*	*Minor or transient*	*Minor or transient*
	Low	*Less than minor or transient*	*Less than minor or transient*	*Less than minor or transient Minor or transient*	*Minor or transient*

Source: Tables adapted from DMRB[9].

Where potential impacts are identified, appropriate mitigation, enhancement measures or monitoring measures are described in order to reduce the likelihood or consequence. Mitigation measures which have already been incorporated into the design of the proposed scheme are also identified.

5.4 Study Area

The immediate study area is defined as the proposed development site as delineated by the operational site boundary. This encompasses the temporary transit site and staff accommodation structures, equipment/plant storage and the runway itself. The extent of the wider study area varies according to the requirements of specific topics, in order to encompass the direct and indirect impacts of the project.

5.5 Establishment of Baseline Conditions

The baseline conditions for the immediate and wider study area have been established using a desk-based review of published sources as well as a site survey.

[9] Design Manual for Roads and Bridges, Highways Agency, Department for Transport, Volume 11, Part 5 Assessment and management of environmental effects

The desk-based review included research of published information sources available on-line, carried out in June 2015, and a detailed review of Antarctic information resources carried out at the Scott Polar Research Institute, University of Cambridge, carried out March 2016. Information sources are referenced in the individual topic sections and listed in the Reference Section at the end of the report.

Site specific information has been obtained during the feasibility / options appraisal stage of the project, through a detailed site reconnaissance and site survey carried by White Desert Ltd in December 2014[10]. This survey was undertaken in the Henrickson nunatak area and had used satellite based data and mapping produced by the by the Thuringian Institute for Sustainability and Climate Protection (Think).

Image 1. An IL76 at Blue 1 in 1999 – believe to have been operated by ANI at this time.

6 Proposed Activity

The proposed activity involves the reactivation of an ice runway at Henrickson Nunatak to allow White Desert clients to access the continent via a more regular weekly service. This runway was formally known as 'Blue One' but it proposed to be called 'Wolfs Fang' (named after a mountain that dominates the skyline of the site). A business jet, such as a Falcon 900LX, 7X or Gulfstream V, will operate the service providing a much greater level of fuel efficiency compared to the IL-76TD. The need to upload fuel in Antarctica will also be greatly reduced, if not entirely avoided depending on the exact aircraft used, prevailing winds and payload. A theoretical flight plan has already been run for a Gulfstream V from Cape Town International to Wolf's Fang runway and, with full seating capacity and 'average'

[10] Wolfs Fang Runway, Reconnaissance Report of Findings, Stuart McFadzean, White Desert Ltd, December 2014

prevailing winds, the plane can achieve a return flight without the need for uplifting fuel in Antarctica.

Client accommodation will continue to utilise Whichaway Camp and client activities will remain unchanged, as per the existing IEE for White Desert. New client transit accommodation will be established at Wolfs Fang for flexibility in scheduling transfer flights between Wolfs Fang and Whichaway – and also for weather delay periods whereby flights are postponed or schedules changed due to availability of aircraft and changes in forecast. Ferry flights between Wolf's Fang and Novo Runway will be facilitated by DHC-6 Twin Otter or BT-67 Basler aircraft.

A typical rotation of clients will be as follows:

- 12 clients (Group 1) staying at Whichaway Camp will transfer via 4x4 vehicle to Novo runway.
- Group 1 clients then fly 30-mins to Wolf's Fang in a Twin Otter. Clients accommodated in Wolf's Fang's transitory camp.
- The Falcon arrives from Cape Town on its scheduled intercontinental flight with 12 new clients (Group 2).
- Group 2 immediately transfer onto waiting Twin Otter and ferry across to Novo Runway and ultimately Whichaway Camp.
- After two hours on the ground, Group 1 board the Falcon and return to Cape Town.

These changes will enable more clients to visit the continent each season but for a shorter duration. The maximum number of clients overnighting in Antarctica at Wolfs Fang will be twelve. White Desert does not envisage expanding the client numbers beyond twelve for each group given the following limitations:

a) The seating capacity for the Falcon intercontinental flight will be 12-14.
b) Due to payload restrictions, the BT-67 Basler can only accommodate 12 clients to Atka Bay and the South Pole.
c) Whichaway Camp has only 6 sleeping pods with two clients in each, thereby creating a maximum of 12 guests.

Therefore, the total client capacity of the White Desert operation, in terms of Antarctic client days, will also not increase significantly.

Broadly, the new activities being proposed can be categorised as follows:

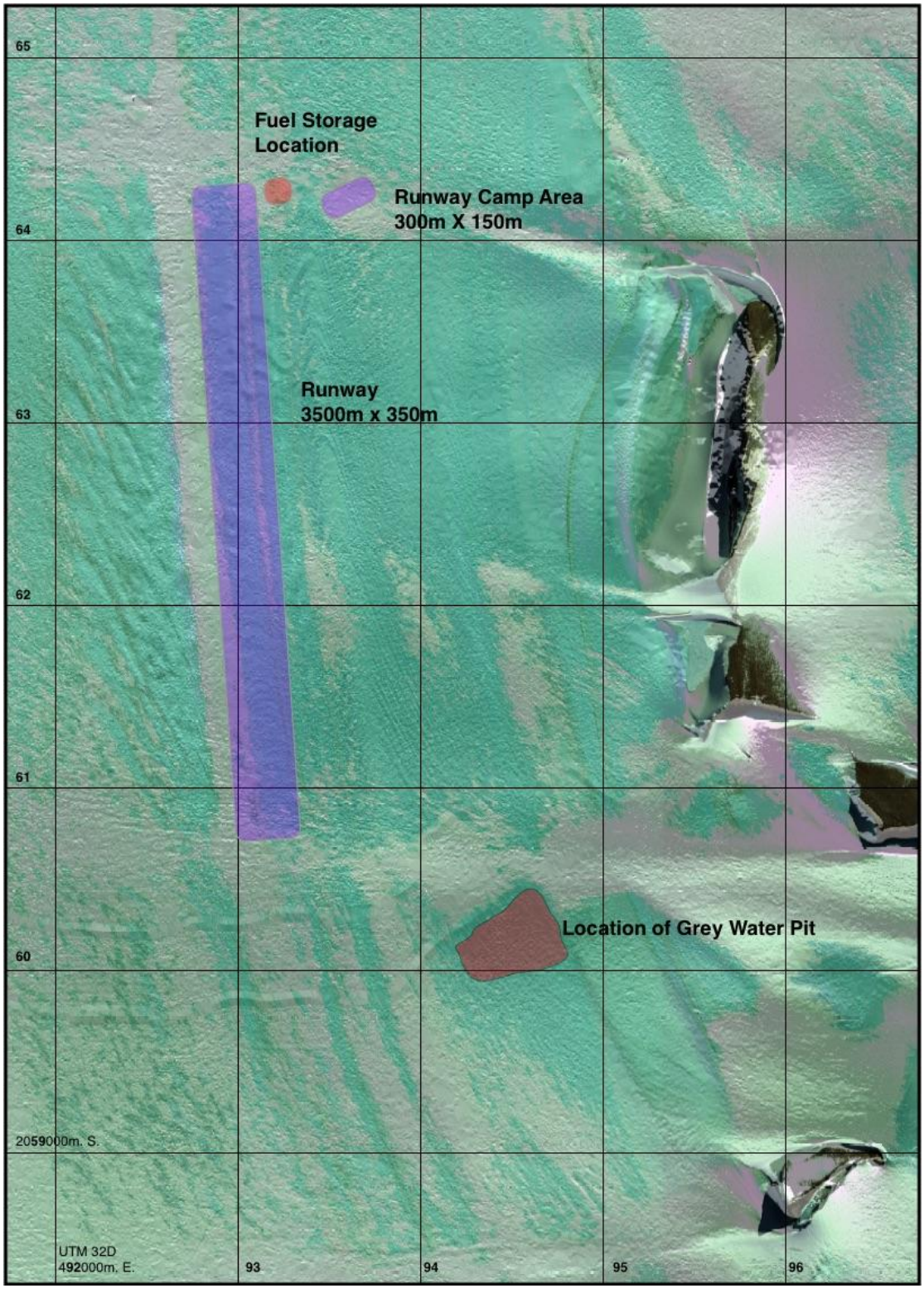
- Ongoing operation of Wolfs Fang Runway.
- Ongoing conduct of intercontinental flights (business jet).
- Ongoing changes to client visitation patterns and intra-continental (transfer) flights.
- Once off re-establishment/commissioning activities and once off decommissioning and remediation activities.

6.1 Operation of Wolfs Fang Runway

Wolfs Fang Runway will serve as a point of entry and departure for White Desert clients. Inbound clients will fly from Cape Town to the runway by business jet, (approximately 5-hours). From the runway, they will then be transferred to the Novo runway by light aircraft, such as BT-67 Basler or DHC-6 Twin Otter operated by TAC (flight time: 30-minutes). From Novo they will be taken to the Whichaway Camp by wheeled vehicle. Outbound passengers will fly from Novo to the runway several hours prior to the planned intercontinental flight. This is to minimise the potential for delays and to ensure the business jet stays on the ground in Antarctica for the shortest possible duration.

The establishment and operation of ice runways has become a routine activity for Antarctic programs with several in operation around the continent. The site proposed for Wolfs Fang Runway was previously used by the US based company ALE during the late 1990s and early 2000s. It is also likely the site was used by the Russian Antarctic program (RAE) in the 1980s for inter-continental flights. The last inter-continental flight to the site are believed to have occurred in 2002. A survey of the site was undertaken by White Desert in December 2014 which confirmed the site as being suitable.

The selected site is a glacial blue ice field located about 70Nm (130km) southwest of the Schirmacher Oasis. The runway area will be approximately 3500m long and 350m wide, see Diagram 1. The northern end of the runway is in the vicinity of UTM 32D 492800 2064400 and the eastern end of the runway is in the vicinity of UTM 32D 493200 2060800. The location is approximately 2.5km distant from Henrickson Nunatak which lies adjacent and parallel to the runway centre line. The area is a natural ablation zone with a surface of hard glacial ice and a minimal snow cover. The location is on the inland ice plateau, at around 1100m elevation. Melt streams running parallel to the runway centre line flow around the base of the Henrickson Nunatak approximately 2km to the West. No crevasses are evident in the immediate area. An overview of the site and the proposed runway location is shown at Map 2.



Map 2. Site layout showing locations of runway (including berms), the runway camp (including transit accommodation, stores and vehicle park) and known location of crevasses for grey water disposal.

At the start of each summer, the runway will require annual clearing of sun-cupping and any snow accumulation to produce a smooth surface. During the summer, ongoing maintenance of the surface may be required to clear the runway of snow accumulation, to increase surface friction, and to ensure the snow berms at the side of the runway are reduced in size so that they do not cause windborne snow to accumulate in their lee. These activities will be undertaken by two snow groomers fitted with blades and tillers.

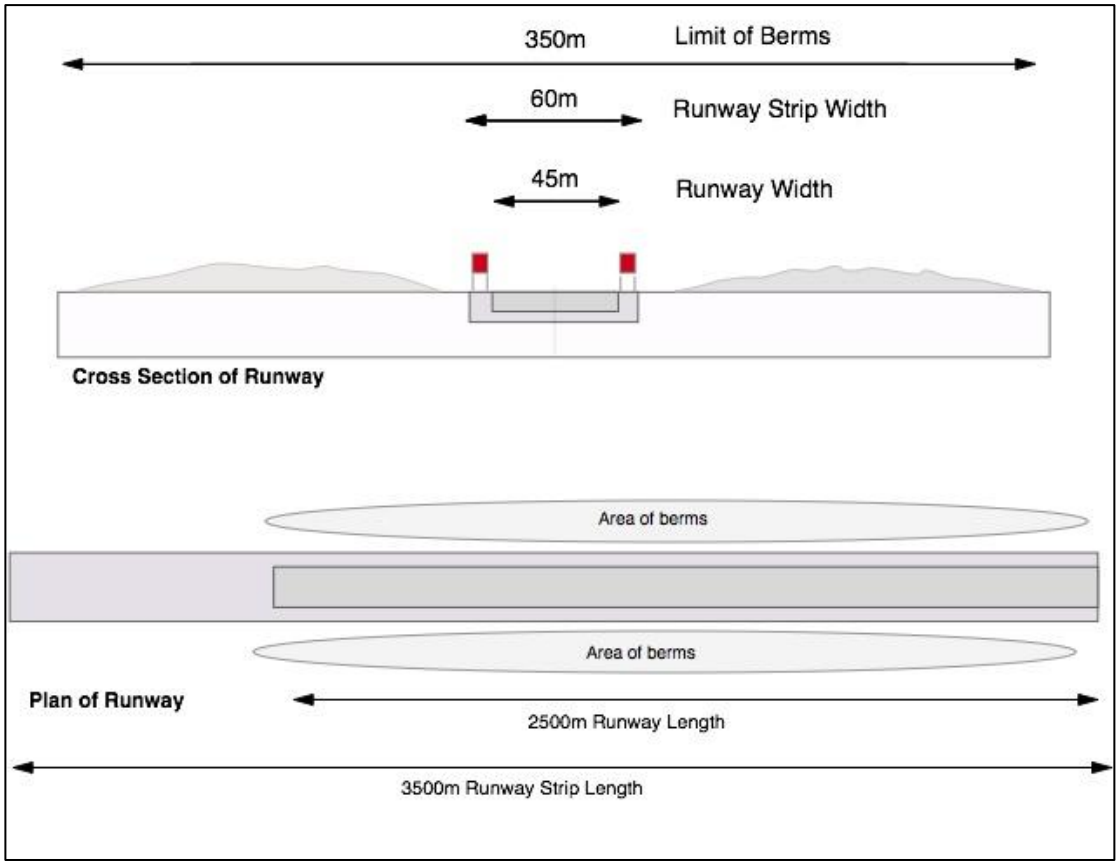


Diagram 1. Runway dimensions. The runway is shown within a wider strip or overrun area. Beyond the strip is an area where cleared snow is likely to accumulate.

The runway will be marked by temporary markers on either side of the runway. Portable lights may be used to mark the ends of the runway to assist pilots identifying the runway on approach. A windsock will be established at one end. These will be removed during periods when flights are not planned to occur.

Image 2. A snow groomer tills the surface for greater friction and removes snow accumulation. Two of these machines will be based at the runway.

Image 3. Novo Runway showing markers along northern edge.

The runway will be manned by a crew of 8-10 staff including an 'aerodrome manager', trained and licensed radio operator, plant operators, mechanic, Fire & Safety crew, medic, and general hand. The staff will remain on site throughout the summer operating period. There are a number of skills and capabilities that must be maintained at the runway to support the operation varying from weather observations, aerodrome procedures, crash rescue and fuel handling. Seasonal training will be conducted to 'cross train' all staff to ensure all staff can perform multiple functions. This will reduce the number of staff required and provide a level of redundancy across the runway team.

At the end of each summer, all tents will be removed and all vehicles and vans closed up for winter. This will include covering all glass with shields, closing all openings such as vents, and removing unnecessary attachments. The vehicles and vans will be laid up away from the runway location on a snow berm. The exact location of the berm is to be determined once more weather data is available. It will be downwind from the runway (likely to be North to West) approximately 1000m. The berm location will change each winter to enable previous sites to remediate.

Mobile plant and equipment to support the runway will include snow groomers, light vehicles, automated weather station, emergency response sled, fuel pump, communications equipment, limited aircraft spares, generators, and camp equipment. This equipment is detailed in Table 5 below.

Table 5.0 Major plant items to be located at Wolfs Fang Runway.

Plant Item	Description	Use/Purpose
3x Snow groomer	Pisten Bully 300 and 100	Runway maintenance. Client ground transport. Traverse tractor.
1x Snowblower	Zaugg or equivalent. For mounting on groomer.	Runway maintenance.
1x 4x4	Hilux or equivalent	Ground transport around runway. Client ground transport. Runway surface friction measurements.
2x ATV	Polaris/skidoo	Staff transport around site.
4x Sledges	15 & 25 ton traverse sledges	Resupply of runway with fuel. Equipment storage. Over winter storage.
3x 20' Iso	Side opening containers on beam sledges.	Storage of runway and ground handling equipment. Over winter storage of tentage and plant.
1x 20' Iso	Reefer, modified. On beam sledge.	Office and medical facility.
Fuel pump	200 lpm fuel pump and hoses. On small sledge.	Aircraft refuelling
36x 1500l IBC 3x 20' Iso	Fuel Storage	IBC for transport of fuel to Runway. Iso Tanks for depot fuel on Coast vicinity SANAE IV.
Emergency Cart	Extinguishers, entry kit, medical kit, ground matting, spill kit . On sledge.	Emergency response.

Image 4. Novo runway as seen on final approach.

Accommodation for the runway crew will be in mountain tents that are erected when in use. Client accommodation will be in seven 16' X 12' tents. An additional 10' X 16' tent will be used as a communal mess and kitchen. Three 20' ISO containers will be used for storage and housing the waste incinerator, generator, ablutions, and a shower. An indicative camp layout is at Diagram 2.

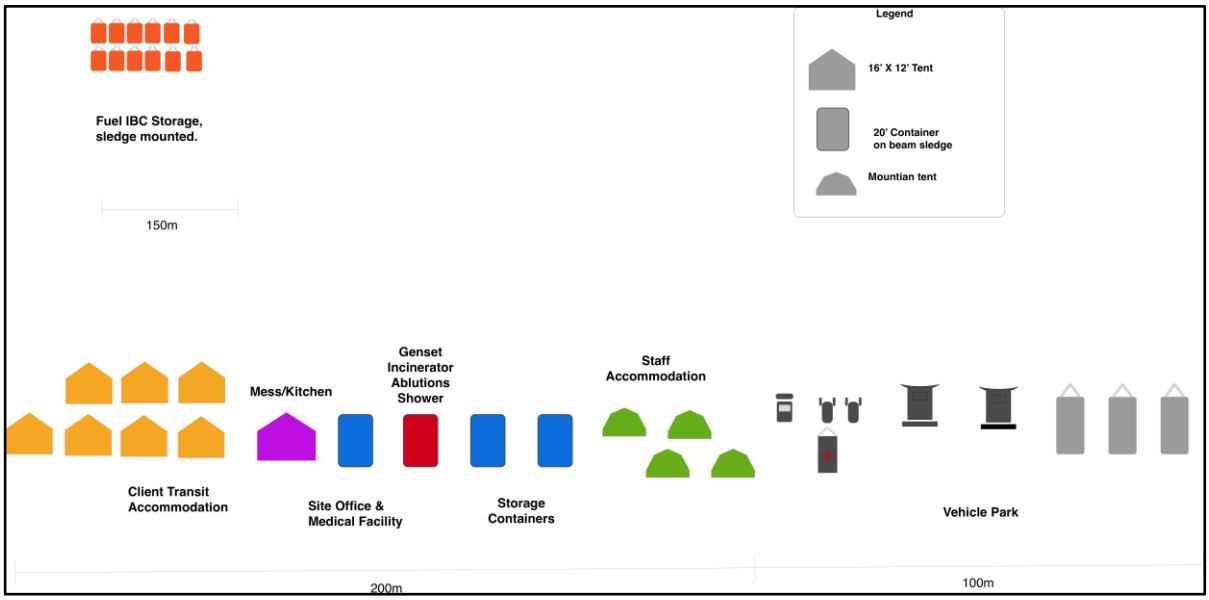


Diagram 2. Indicative camp layout.

Resupply of the runway camp will occur progressively throughout the season utilising space on the business jet service. Heavy and bulky items, may be delivered via TAC's IL-76 service to the Novo runway and then a ground traverse. Backloading is available via the same route at the end of the season.

6.1.1 Fuel Handling

Further details can be referred to in the Logistics and Traverse Plan for the Wolfs Fang Runway, which can be referred to in Appendix I/as a standalone document.

Fuel will be delivered by ship each year and traversed from the coastal resupply point to the runway in either 20' ISO tanks or in 1500l IBCs. Resupply shipping relies upon 'piggybacking' on a national program with initial

The seasonal operation of the site is expected to consume approximately 10,000 l of ground fuel each year. This is predominantly consumed in the groomers and generators. Up to 50,000 l of jet fuel will be using to support inter and intra continental flights to the runway. Up to 20,000 l will be required by traverse tractors to bring this fuel to site. Total fuel consumption by the system is therefore up to 85,000 l per summer.

In subsequent seasons, the expected use of a longer-range aircraft (such as Gulfstream 550, or Falcon 7X) with full return range capability will reduce the average annual fuel consumption considerably to around 20,000 l.

A quantity of aviation fuel will be stored at the runway for emergency purposes. This may be up to 20,000 l which is sufficient to allow a C-130 Hercules or IL-76 TD to return to Cape Town which is the most likely evacuation option should a mass casualty incident occur. Ground vehicles and generators will run on aviation fuel so that the store of emergency fuel will be regularly drawn upon and replenished as a part of the normal fuel holding. This will also mean that only one type of fuel will be held at the runway to simplifying logistics.

Fuel will be delivered and stored in either 1500l IBCs drums or in 20' bulk Iso tanktainers. All IBCs and bulk tanks will have all foot values, drains and any penetrations below the full supply level removed or permanently sealed. Additionally, an empty unit will remain on site to ensure there is sufficient 'decant' space available should a problem develop with a tank so that it can be completely emptied.

Fuel will be transported to the site and empty containers backloaded via a traverse conducted through the summer. The frequency of resupply traverses is dependent upon number of flights undertaken and the type of aircraft used. The Falcon 7X could se resupply traverse occurring every 3-4 season. The Falcon 900 EX would require an annual traverse for fuel.

6.2 Ongoing Conduct of Intercontinental Flights

6.2.1 Flight Frequency

Once established, the runway has the potential to support a high frequency of flights. The runway is expected to operate over a 17-week period from November to February each summer. At the start of each season, the operating

period is limited by the ability to get runway staff onto the site, which in turn, is dependant upon the intercontinental flight operation run by ALCI at Novo.

During the operating period, windows to conduct flights are expected to occur on average at weekly intervals. The effort to open the runway is significant and staff fatigue is likely to be another limiting factor in flight frequency. The likely number of flight windows is expected to be between 10-20 per summer. This is consistent with other ice runway operations in Antarctica.

The expected demand for flights however is considerably less and between 7-10 flights are estimated in the initial seasons of operation. These will occur approximately weekly with periods of reduced flight activity around Christmas and blizzard events.

6.2.2 Runway activity

Prior to each flight it is likely that machinery will need to be used to prepare the runway surface. This may involve scarification of the surface to improve surface friction and the removal of any drifting snow. Snow berms or accumulations on either side of the runway will also be flattened and pushed outwards, away from the runway.

Runway markers will be set out and checks on the runway will be made such as friction measurements, surface temperatures, and monitoring of any surface movement or cracking in the underlying ice.

These activities are expected to use 800 l of fuel for each intercontinental flight.

The intercontinental flight will coincide with one or two ferry flights to Novo Runway by ski plane. These will bring clients to and from Whichaway Camp. This changeover of clients will temporality increase the number of persons living at Wolfs Fang runway to approximately 20 in total (8 staff plus 12 clients).

Emergency response capabilities will be maintained on site to respond to a variety of incidents including - lost personnel, fuel spills, aircraft immobilisation on site, wheel and engine fires and aircraft crashes. Response equipment will be deployable by sled towed by a 4x4.

6.2.3 Flight activity

Flights to the runway will originate from Cape Town. No aircraft will overnight at the runway and all will return to Cape Town after a brief turn around of less than 3 hours. The return flight is a distance of 4560 Nm.

Flight operations at the runway will be restricted to avoid overflying nunataks. These controls will include restricting circling approaches to proving flights and

ski equipped aircraft only. Intercontinental flights will use straight approaches only. The runway will only use right hand circuits to ensure aircraft stay at least 2000m away from the nearest ice free land.

Noise modelling undertaken by the Australian Antarctic Program's ice runway project found that 65dBA sound pressure levels from a Falcon aircraft extend laterally out from the runway centreline by up to 1000m[11]. Sound pressure levels at the closest ice free land to the Wolfs Fang Runway are greater that 2000m away and therefore are not expected to exceed 65dBA.

Fuel consumed per flight is quite variable depending upon the aircraft type, weather conditions and payload. A typical flight of a Falcon will burn 12,650 l of fuel for the round trip. Of this, approximately 8,770 L will be consumed above the 60°S Parallel. Approximately 500 L will be burned below 2000' altitude during the landing, taxi, while on the ground, and the take off.

Each supporting transfer to Novo will consume approximately 440 l of fuel (DHC-6 Twin Otter- Novo to Runway and return).

6.3 Ongoing changes to Client Numbers and intra continental Transfer Flights

The re-establishment of the runway will enable clients to access the continent more frequently. While the core product (trip duration) offered by White Desert will remain unchanged, the improved access will also enable shorter duration trips to occur, such as a one day trip. These are unlikely to ever be a significant proportion of trips conducted each season given the high costs involved in accessing the continent. The average duration of stay is therefore anticipated to remain unchanged at 8 days.

Anticipated client numbers are show in Table 6 below. The Anticipated numbers and based on the foreseeable demand over the next 3 years and commercial considerations. The Maximum numbers are based on theoretical limits given the infrastructure and staffing proposed.

Table 6 Proposed Change in Operations

	Current Operations Range of Values	Future Operations Anticipated/ Indicative Numbers Range of values/ Projected maximum
Total number of clients per season	80-100	Anticipated- 150 Maximum- 200
Size of Groups	12	Anticipated-12 Maximum- 14

[11] Australian Government, Australian Antarctic Division, Air Transport System IEE, 2003.

Total number of groups per season (rotations)	6	Anticipated 10 Maximum 20
Total number of days spent in Antarctica per group	Average 8 Maximum 10 Day trips and three day trips organised	Average 8 Maximum 10 Day trips and three day trips organised
International return flights per season	6 (fractional use of TAC IL-76 aircraft)	Anticipated- 10 Maximum- 20 (dedicated business jet)
Client destinations	Atka Bay South Pole	Atka Bay South Pole Unchanged
Internal return flights	8-10	Anticipated- 10 Maximum- 20

6.4 Once Off Establishment Activities and Decommissioning /Remediation Activities

Establishing an ice runway at this site requires relatively little effort. The natural ice surface requires minimal modification to be suitable for landing an aircraft. The site has previously been used by military style aircraft (IL-76 and C-130) without any modification.

The development of the proposed activity is likely to be spread over two summers with the bulk of activities occurring in Season 1. The season objectives are as follows:

Season 1

- Delivery of personnel, equipment and stores by vessel to point of entry
- Commission groomers and towing sleds.
- Establish crevasse-free traverse route between point of entry and Wolfs Fang using satellite mapping and ground penetrating radars.
- Undertake a secondary site survey.
- Conduct traverse to Wolfs Fang.
- Establish Wolfs Fang camp.
- Establish Runway.
- Undertake proving flights.
- Winterise Wolfs Fang

Season 2

- Establish client accommodation.
- Complete fuel traverse.
- Reopen runway
- Undertake first client flights.

6.4.1 Season 1

Further details can be referred to in the Logistics and Traverse Plan for the Wolfs Fang Runway, in Appendix I/stand alone document.

A traverse route between the cargo delivery point and Wolfs Fang will be reconnoitred in November-December by a private company called Arctic Trucks using ground penetrating radar and supported by space based investigations conducted previously by the Thuringian Institute for Sustainability and Climate protection. Building upon known safe routes, this may take as long as 10 days. The traverse team will comprise 4-5 people.

Equipment delivery is to occur in December 2016 by the RSA Agulhas II. Delivery is to be to the RSA resupply unloading point on the ice edge at approximately, 70°15'S 2°37'W. This includes four traverse sledges and two tractors (snow groomers).

All cargo and some fuel will then be traversed to Wolfs Fang via the established route. This may require two round trips of two tractor trains depending upon the conditions encountered. This may take as long as three weeks and 4-5 staff will participate in the traverse.

A group of up to 4 personnel will also deploy directly to the Wolfs Fang site by ground traverse from Novo to commence construction activities. This traverse will use a single snow groomer (PB100) and it will accompany the Artic Trucks reconnaissance team as far as the runway site. This is likely to take 3 days and the team will be based at the runway site for the season.

Once the traverse arrives at Wolfs Fang, the establishment of the camp will commence concurrent to the second resupply traverse (if necessary). Runway set up and surface preparation will also occur.

Runway preparation involves grinding back the natural 'sun-cupped' surface using a combination of the blade and tiller on the snow groomers. The area cleared will be 3500m by 60m. Approximately 80mm (depth) of sun cupping will be removed. This equates to 8,400m^3 of ice. The resulting ice chips will then be cleared to the sides of the runway and spread out up to 100m either side of the runway. The movement and handling of the ice chips will result in a volumetric expansion of up to a factor of 50. This could result in up to 420,000m^3 of aerated ice or 'snow' being deposited in berms along the sides of the runway. These could be up to 600mm deep and 100m wide.

The clearing of the sun-cupping completes the establishment of the runway. There is no requirement to alter the natural shape of the terrain at the proposed site. Runway makers will then be set out before flights commence.

A number of proving flights must be conducted to the site to both validate the suitability of the runway, ground procedures and to familiarise aircrew with the runway properties. A proving program may involve flights from different types

of aircraft and a number of circuits (multiple landings) per flight. Initial flights will aim to use more robust 'military style' aircraft or lighter weight aircraft that have previously landed at the site when the surface was entirely unprepared. Later flights will utilise the same business jets that will be used to bring clients to the Antarctica.

Proving flights will commence with a BT-76 from Novo. If these are successful, the Falcon aircrew will return to Cape Town, via the TAC IL-76 service, to prepare for the first jet aircraft flights. This may occur up to 25 February 2017 at which time the runway must close to commence winterising the camp.

Wolfs Fang staff will return to Cape Town on the TAC IL-67 service around 28 February 2017.

6.4.2 Season 2

The Wolf Fang staff of 8 people will deploy to the site in early November 2017 via TAC BT-76 and IL-76.

De-wintering the camp and re-establishing the runway is expected to take 7-10 days. The establishment of the transit accommodation will take up to 15 days to complete but this will be concurrent with runway works. No specialist equipment is required to erect the pods as each one is modular in design and can be constructed with a minimum of 4 men with basic tools. The pods will be mounted on beam sledges.

The first client flight is expected in mid November. It is envisioned that 7 client flights will be conducted in Season 2 with the last occurring around mid February 2018

6.4.3 Decommissioning and Remediation

Should decommissioning be required, decampment would take approximately 20 days. The sledges and tractors on site are capable of returning all infrastructure to Novo or SANAE where they can be extracted via IL76 or ship to Cape Town. It would be planned to consume all fuel on site prior to decommissioning to minimise the quantities to be back loaded. However the seasonal maximum of fuel holding could exceed 85,000 L, which would require a separate traverse if this was to be backloaded.

The total backload tonnage, including all vehicles, sledges, vans etc but not including fuel would be approximately 137,000kg. It is envisioned that fuel could be provided to one of the national programs operating in the region.

Remediation of the site would include:

- the removal of all runway markers, AWS and survey targets
- The flattening of any snow accumulations, particularly the berms.

- The pack up and removal of all camp facilities, tents, transit accommodation, vehicles, stores and equipment.
- The removal of all solid wastes.

Upon completion of remediation efforts the following would be left on site or would be left visibly disturbed:

- Grey water (filtered) disposed in a deep crevasse would remain on site.
- The snow berms around the runway and the runway camp would be spread out but remain visible until they naturally ablated away. This is expected to take up to 5 years.
- The runway surface would be left to remediate naturally. It is expected to return to a natural sun cupped surface in less than 3 years.
- Particle and gaseous emissions from the incinerator and combustion engines would not be remediated.

7 Alternatives

Alternatives to increase the level of White Desert's self-reliance and to deconflict activities with the DROMLAND network are limited. The use of the runway at Novo for alternate aircraft has already been extensively investigated and RAE are disinclined to accept any other aircraft from 3rd party operators at their facility. The runway is also at a low elevation and therefore prone to closure during January due to low surface friction.

The Norwegian Antarctic program are similarly disinclined to accept private aircraft at their facility at Troll Station. There is also the added complication of the distance from Whichaway Camp.

Other runway locations are available but they provide no real point of differentiation to the Wolfs Fang runway site being proposed. The prior use of the Wolfs Fang site for runway operations makes it a logical place to reactivate for both environmental and operational reasons.

8 Description of Existing Environment and Baseline Conditions

8.1 Introduction

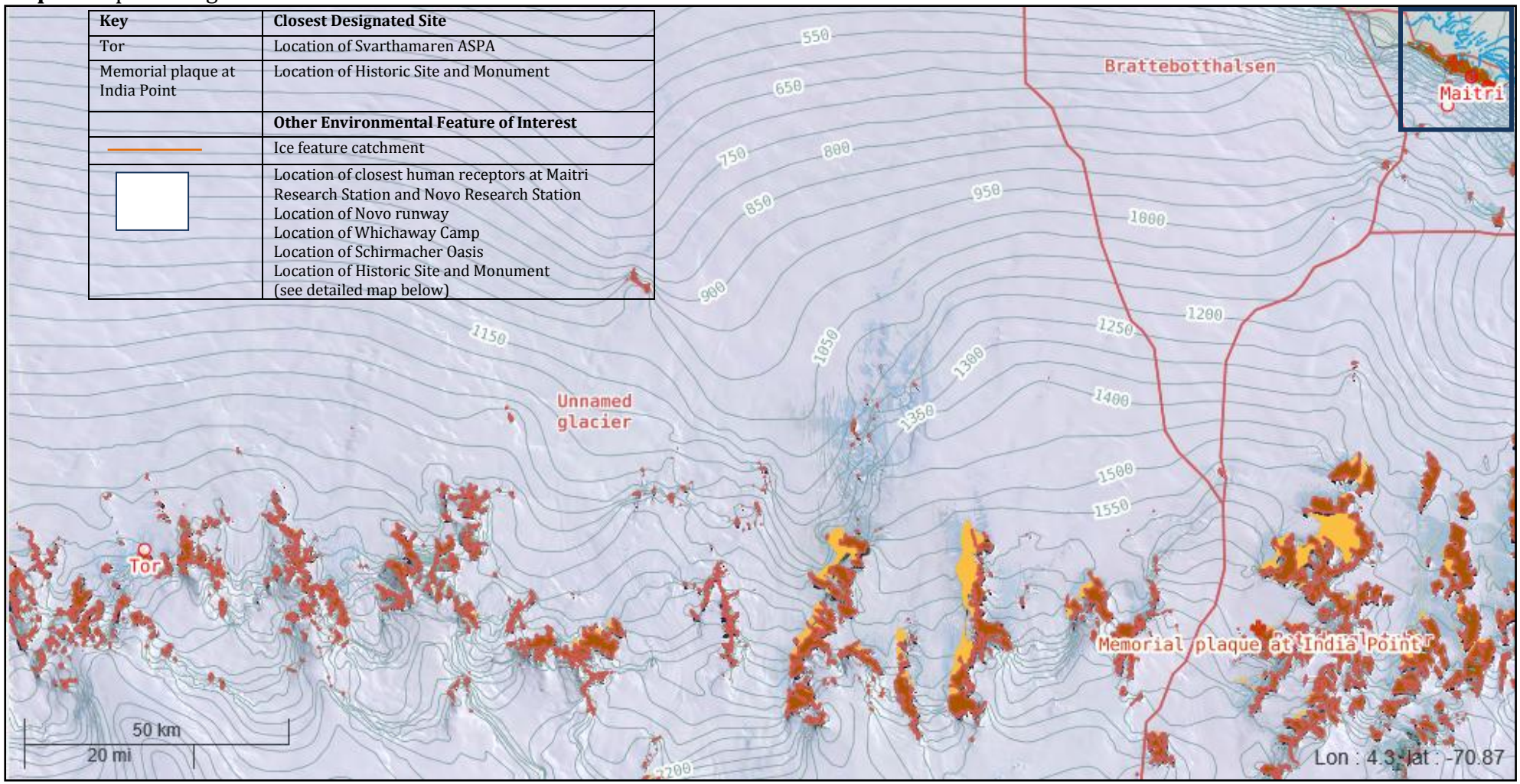
As set out in the Establishment of Baseline Conditions Section, the baseline conditions have been identified using readily available published information, supplemented by a publication review carried out at the Scott Polar Research Institute in March 2016, as well as well as a site reconnaissance survey carried out in December 2014 by White Desert.

The following sections describe the baseline conditions for each individual topic in the immediate study area (that of the Wolf Fang Runway Site) and the wider study area. The relevant legislation which should be considered for each topic is also identified. The wider study areas varies according to the requirements of specific topics, in order to encompass the direct and indirect impacts of the project.

The zone of influence is the area encompassing all predicted impacts from the proposed development, both those which may occur as a result of land-use and those which may occur indirectly.

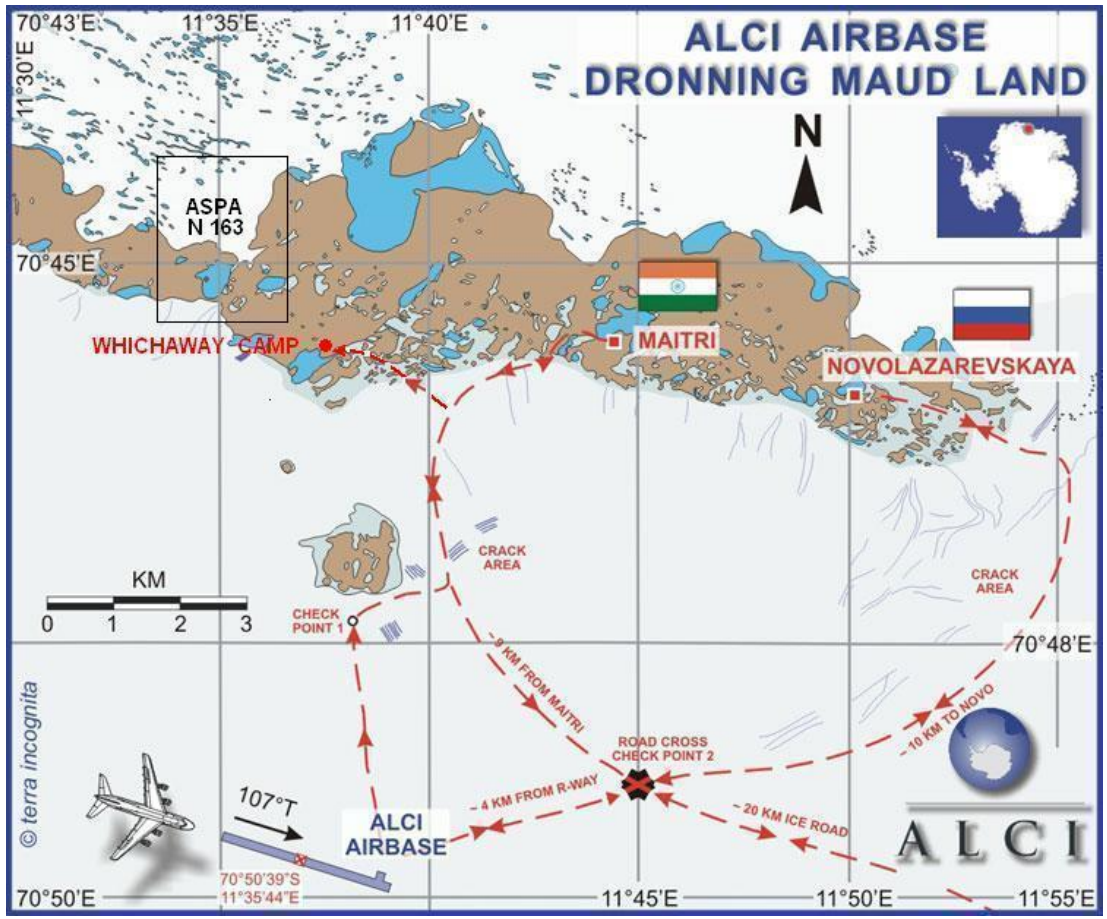
The location of the designated sites and environmental features of interest identified in this section can be referred to in the following maps.

Map 3: Map of Designated Sites and Environmental Features



Source of mapping: SCAR Antarctic Digital Database, obtained 24 March 2016

Map 4: Location of ASPA in proximity of Whichaway camp



Map 5 Ecology of Svarthamaren SPA and Surrounding area

Location	Published Ecology * Nature Environment Map	Location	Published Ecology
Svarthamaren ASPA	Antarctic Petrel=400,000, Snow Petrel=1000, South Polar Skua=100 Populations Mites, Collembola Lichen, Filamentous algae, cyanobacteria	Kvitholten	Antarctic Petrel=300, Snow Petrel=100, South Polar Skua =30 Populations

8.2 Physical Environment

Information on the physical environment and ground conditions has been obtained from the site survey report and feasibility study carried out in December 2014 by White Desert[12].

8.2.1 Wider Study Area

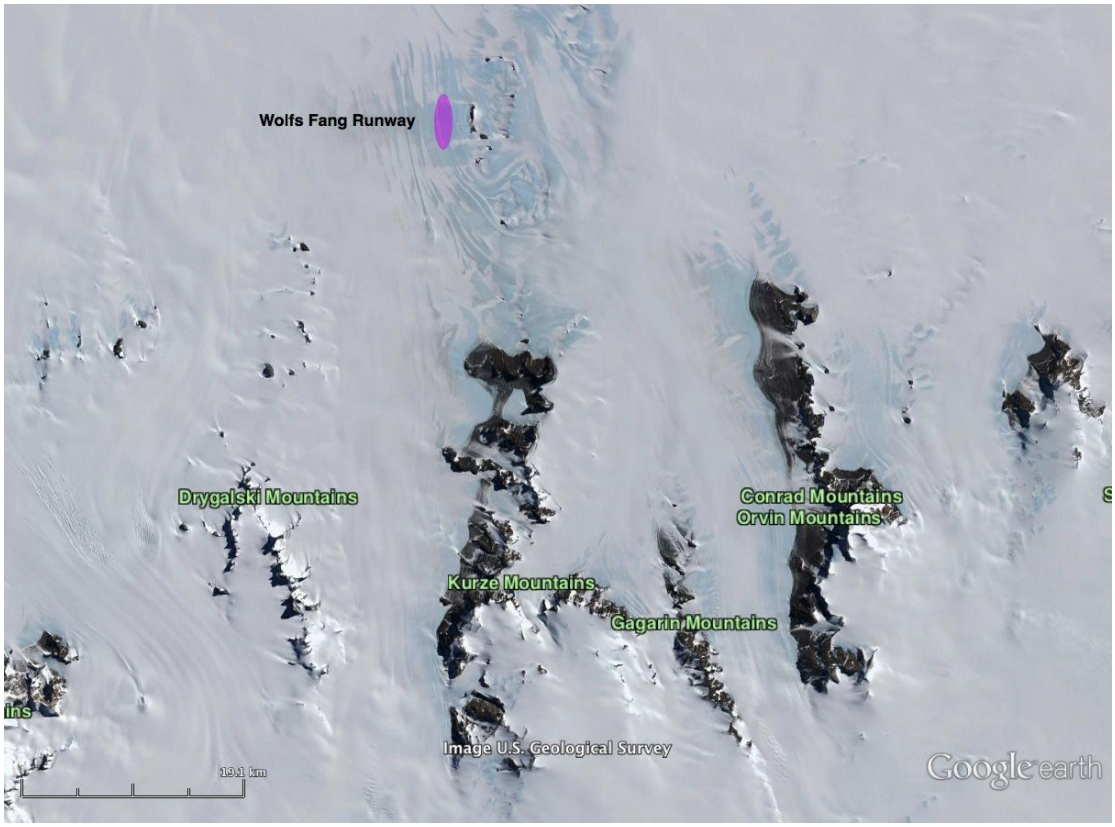
The nearest ice free land is the Henrickson Nunatak located approximately 2.5 km to the East of the Wolfs Fang Runway. It is a narrow blade of rock approximately 2 km long and 200m wide and 150m high. It is the largest and Western most nunatak in a group of approximately 20 nunataks that extend 12 km to the north, 11km to the South and 12 km to the East.

8.2.2 The Wolfs Fang Runway Site

The runway site is located on a vast expanse of blue glacial ice situated approximately 20 km north of the Kurze Mountains in Dronning Maud Land, (which can be referred to in Map 6). The coast is approximately 120 km distant to the North but due to the existence of fast ice, the closest open water in summer is some 160 km to the North. The site is 130 km southwest of the Schirmacher Oasis where the Whichaway Camp is located along with Novolazarevskaya (Russian) and Maitri (Indian) Stations. Troll Station (Norwegian) is located approximately 240 km to the southwest.

The northern end of the runway is in the vicinity of UTM 32D 492800 2064400 and the eastern end of the runway is in the vicinity of UTM 32D 493200 2060800. The location is approximately 2.5 km distant from Henrickson Nunatak, which lies adjacent and parallel to the runway centre line. This is the nearest ice free land.

[12] Wolfs Fang Runway, Reconnaissance Report of Findings, Stuart McFadzean, White Desert Ltd, December 2014



Map 6. The location of the Wolfs Fang Runway is shown relative to the Dygalski, Hurze, Gagarin and Conrad Mountains some 20 km to the South.

The area around Wolfs Fang Runway is generally flat (<2%) rising to the South with increasing steepness. The area is a natural ablation zone with blue ice predominating. The area is bounded by a line of nunataks to the East and gradually increasing snow cover to the South, West and North. Glacial movement is to the North and estimated at approximately 20m per year (55mm /day). There exist several minor features (ridges and gullies) that run through the area in a North-South alignment. Local gradients at these features are as steep as 4% in an East-West orientation.

Snow deposits are generally less that 300mm although greater depths were found in isolated locations along 'gullies'. The snow deposits were observed to be ablating from the top surface while simultaneously undergoing a melt/refreeze process at the snow-ice interface. The blue ice is thus overlaid with patches and stripes of 'firn' which are readily identifiable from the satellite images of the site. These firn deposits are generally less than 100mm deep and are located were isolated snow depositions have occurred in the past, possibly over winter.

Surface and sub-surface melting is not evident at the site, however large melt streams have occurred at the Eastern edge of the site, beneath the Henrickson Nunatak. These have deposited large boulders, up to 14m across, along the path of the melt steams to the North. These run in a North to South alignment and appear to originate from the Northern face of nunataks to the East and South.

Running across the site in a mostly South-East to North-Westerly direction are bands of cryoconite holes. These range in size from a few centimetres to around 1.5 meters in diameter. The majority however are around 300-400 mm and have a fairly uniform depth of between 500-600mm. The cryoconite holes have a solid layer of melt ice above the cryoconite layer, which in turn sits on blue ice.

The area is generally free of crevassing below / North of the 1150m contour. Crevassing to the South of the 1150m contour is generally sutured with widths less than 400mm.

Winds

An AWS has been on site for 12 months which is insufficient time to establish a high level of confidence in our understanding of site conditions. However, the 2015 summer was characterized by strong diurnal katabatic cycles with warm midday temperatures (seldom above -2°C) with light winds (often from the North) and then with lower sun angles bringing lower temperatures (-10 to -15°C) and stronger katabatic winds (10-20 kts) from a Southerly direction. Winds showed more directional variability but much less strength than anticipated over summer.

During the site reconnaissance in December 2014, sustrugi on site had formed from recent Easterly winds. Multi year blizzard deposits, possibly from winter storms, were also driven by Easterly winds. The prevailing winds while on site came from the South East. Surface deposits of white ice, formed from the melt/refreeze process occurring at the snow ice interface under snow drifts, appeared to have been deposited by South Easterly winds, see Image 5.

Image 5. The proposed Wolfs Fang Runway looking South. The slight bumps on the surface are white ice deposits formed by melt/refreeze processes under snow drift deposits which have since ablated away. The orientation suggests formation under South Easterly winds.

8.3 Land Use

The proposed Wolfs Fang Runway Site and immediately surrounding area is currently not in use. The site was used historically as a blue-ice runway for intercontinental flights between 1996 and 2001 by the American based company Adventure Network International (ANI) to support commercial tourism activities. It is also possible that the site was used by the Russian Antarctic programme (RAE) in the 1980s. Redundant equipment associated with the historical land use is currently present on the site, including 20 tonnes of camp equipment and 335 empty fuel drums.

8.4 Flora and Fauna

Information in relation to flora and fauna has been obtained from a review of published sources, as referenced, and supplemented with casual observations made during ground investigation site survey carried out in December 2014[13]. Additional information sources are listed in the Bibliography.

8.4.1 Wider Study Area

General description

The study area and zone of influence/spatial scope in relation to fauna is considered to extend across the region due to the potential routes of feeding, breeding and migratory birds.

The site is located within the Dronning Maud Land Antarctic Conservation Biogeographic Region. The site is located within the Dronning Maud Land, which consists of a series of nunataks and mountain ranges separated by glaciers or ice covered terrain. The region is not suitable for vascular plants[14] due to dry conditions and low temperature limitations and the nunataks inland are considered to represent the climatic limit of terrestrial life[15].

The coastal hills of the Schirmacher Oasis are located along the northern coastline, between the inland ice and the iceshelf, and provide habitat for lichen, moss and limnological communities. The main mountain range and nunatak area is located approximately 200km from the iceshelf edge and extends in an east-west direction.

The nunataks are exposed mountain peaks projecting from and surrounded by a glacier or ice sheet[16] and provide suitable habitat for breeding sea birds inland. Within the wider study area, there are three species of birds which are known to

[13] Wolfs Fang Runway, Reconnaissance Report of Findings, Stuart McFadzean, White Desert Ltd, December 2014
[14] Nature Environment Map: Dronning Maud Land 1: 100,000, Gjelsvikfjella and western Muhlig-Hofmannfjella, Sheet 1 and 2, 1999
[15] Census of breeding Antarctic Petrels and phuscal heatures of the breeding bird colony at Svarthamaren, Dronning Maud Land, Norsk Polar Institut, Mehlum et Al, 1988
[16] A complete guide to Antarctic Wildlife, the Birds and Marine Mammals of the Antarctic Continent and Southern Ocean, Hadoram Shirihai, Second Edition, 2007

breed in the inland nunataks, these are the Antarctic petrel (*Thalassoica antarctic),* the Snow petrel (*Pagodroma nivea)* and the South polar skua (*Catharcata maccormicki*)[17]. The table below summarises their habitat and distribution within the wider study area.

Published information[18] has been used in order to identify Important Bird Areas. The closest Important Bird Area (IBA) to the site is the Svarthamaren IBA (ANT112), which qualifies on the basis of the Antarctic Petrel and South Polar Skua and is located at a distance of approximately 120km South West of the proposed Wolfs Fang Runway site. The Jutulsessen Mountain IBA (ANT111) which is located in the area of the Troll Station , at a distance of approximately 200km South West of the site, which qualifies on the basis of the Antaractic Petrel colony present at the site. The Gruber Mountains IBA (ANT 113) is located at a distance of approximately 200km South East from the site and is designated for the protection of Snow Petrels.

Table 7: Avifauna within wider study area

Species	Habitat	Distribution
Antarctic Petrel (*Thalassoica antarctic)*	• Nests openly on the ground • Feeds on cephalopods, crustaceans and small fish • Breeding season from late November in colonies on level snow free surfaces often on slopes and cliffs	• Feeding is confined to the pack-ice zone in the Antarctic seas • Breeding is exclusively on the Antarctic continent, breeding colonies are located up to 200km in land • Most abundant of Dronning Maud land breeding seabirds • Conservation status- not globally threatened currently
Snow Petrel (*Pagodroma nivea)*	• The Snow petrel is known to nest in crevices • Feeds on cephalopods, crustaceans and fish • Breeding season from November-December onwards in colonies on cliffs and steep slopes using crevices and clefts under boulders	• Feeding is confined to the pack-ice zone in the Antarctic seas • Breeding is on the Antarctic continent, breeding colonies are located up to 400km in land • Forms large concentrations of breeding birds • Conservation status- not globally threatened currently
South Polar Skua (*Catharcata maccormicki*)[19].	• Nests openly on the ground in mountain • Feeds mainly on fish, can prey on penguin and petrel eggs or chicks • Breeding season from	• When feeding inland known to prey upon eggs or chicks of petrels, and can be found adjacent to petrel colonies • Breeding is on the Antarctic Continent and adjacent

[17] Nature Environment Map: Dronning Maud Land 1: 100,000, Gjelsvikfjella and western Muhlig-Hofmannfjella, Description, 1999

[18] Important Bird Areas in Antarctica 2015. BirdLife International and Environmental Research & Assessment Ltd., Cambridge., 2015

[19] Nature Environment Map: Dronning Maud Land 1: 100,000, Gjelsvikfjella and western Muhlig-Hofmannfjella, Description, 1999

	November onwards • Can be aggressive if nests are approached	islands • Conservation status- not globally threatened currently

Source: Information adapted from Complete Guide Antarctic Wildlife and Nature Environment Map

The closest nunataks to the Wolfs Fang Runway site are the Henrickson nunatak, located 2.5 km to the east, the Kurze Mountains, located approximately 18km to the south and the Conrad Mountains 30km to the southeast. Though no published information has been found in relation to these specific sites, it can be assumed that these sites may provide suitable habitat for these three species of birds.

Fauna (excluding birds) and flora in the wider study area have been identified from published ecological mapping [20] , though this does not extend to cover the immediate study area. The closest information to the study area is approximately 110 to the south west of the site (Sagladet and Cumulus region) and indicates that in terms of flora , moss cushion, fruticose lichen, epilithic lichen are present. In terms of invertebrates, mites and collemboia can be found at Svarthamaren. Terrestrial invertebrates of Dronning Maud Land are often associated with mosses, lichens, cyanobacteria and green algae found in this region. It is assumed that similar flora and terrestrial invertebrates can be found at the closest nunataks to the site, using a precautionary principle.

Designated sites

The Antarctic Protected Areas database[21] has been searched in order to identify the location of the Antarctic Special Protected Areas (ASPA) and Antarctic Specially Managed Areas (ASMA) within the study area.

The closest designated area to the site is the Svarthamaren ASPA (ASPA Area No.142), which is also an IBA. The site is located at a distance of approximately 120km South West of the proposed Wolfs Fang Runway site. It is part of the Mühlig-Hoffmanfjella mountain region, in proximity of the Tor research station, and consists of the ice-free areas of the Svarthamaren nunatak and their immediate vicinity. The 7.5 km^2 area has been designated in order to protect the presence of the Antarctic petrel colony, which is the largest known inland seabird colony of the Antarctic continent. In accordance with the management plan [22].of the site, the site also provides a habitat for the south polar skua and the snow petrel, is protected from human induced activity and provides ecological research and monitoring data for the population of these three species[23]. The sensitivity of the designated site is considered to be very high.

Dakshin Gangotri Glacier ASPA (ASPA No 163) is located 700-800 meters North West of Whichaway Camp, at a distance greater than 160km from the site.

[20] Nature Environment Map: Dronning Maud Land 1: 100,000, Gjelsvikfjella and western Muhlig-Hofmannfjella, Description, 1999
[21] http://www.ats.aq/devPH/apa/ep_protected.aspx?lang=e, data obtained in March 2016
[22] Svarthmaren Management Plan for Antarctic Special Protection Area number 142
[23] Svarthmaren Management Plan for Antarctic Special Protection Area number 142

8.4.2 The Wolfs Fang Runway Site

The blue-ice field can be considered to be an abiotic environment in terms of flora. This was also confirmed by the preliminary environmental assessment carried out for the previous use of the site as Blue One runway[24]. There are no surface water bodies, exposed ground or nunataks within the site. Taking these factors into consideration, there is limited potential for terrestrial invertebrates or flora to be present at the site.

There are no designated ecological sites located within the proposed Wolfs Fang Runway Site or within the immediate vicinity of the runway. There are no open water bodies or nunataks and the site itself is not considered to provide suitable habitat as a breeding ground or feeding ground for avifauna. Overall, the sensitivity of the site in terms of ecological habitat is considered to be low.

However, taking the information which is available for these species within wider study area into consideration, there is low potential to encounter individual Antarctic petrel, South Polar skua and Snow petrel on site as they may use the site for resting or be passing through the site (using a precautionary principle). During the site survey carried out over a period of seven days, a total of three individual Snow petrels were observed within the immediate study area.

8.5 Cultural Heritage

Designated cultural heritage sites and features of interest were identified through the list of Historic Sites and Monuments list published on the Antarctic Protected Areas database[25] website. There are no designated sites located within the Wolfs Fang Runway Site or the wider study area. The closest designated site is the Memorial Plaque at India Point, Humboldt Mountains, Wohlthat Massif, which is located more than 80km from the site and considered to be outside the zone of influence or spatial scope of the proposed site and site operations, in terms of cultural heritage.

The site is not considered to be sensitive in terms of cultural heritage.

8.6 Wilderness and Visual Amenity

The spatial scope and zone of influence in terms of wilderness and visual amenity is considered to be the Wolfs Fang Runway Site, (which encompasses all supporting accommodation structures, plant and equipment storage as well as the runway itself) and the immediate study area surrounding the site.

The site is not visible from any designated ecological or heritage sites and is not located within a designated site. Due to the absence of other existing human visual receptors (such as research stations, or existing traverse routes) and the

[24] Dronning Maud Land Air Link, Preliminary Assessment of Environmental Impact, Poles Apart, Cambridge UK, 1996
[25] http://www.ats.aq/devPH/apa/ep_protected.aspx?lang=e, data obtained in March 2016

remoteness of the site, it is considered that no significant wilderness and visual impacts would be experienced outside the immediate study area.

Though the Site is currently not in use, the site was previously used between 1996 and 2001 as the Blue One runway.

Though the immediate study area surrounding the proposed Site is undisturbed and is of wilderness and aesthetic value, the presence of previous human activities are visible on site itself and can be seen with satellite imagery. An ANI equipment cache remains on the site from 2001, which is estimated to contain 20 tonnes of camp equipment and 335 empty fuel drums.

Taking these factors into consideration, the value of the wilderness and visual amenity of the Site is considered to be medium/low while with immediate study area is considered to be medium in value or sensitivity.

8.7 Noise, Vibration and Local Air Quality

The wider study area for noise, vibration and local air quality impacts arising from construction, operation and maintenance vehicles and plant is considered to be a 300m buffer from the Wolfs Fang Runway Site. This distance takes into consideration the low existing background noise levels, types of proposed activity and published guidelines used in the UK for the assessment of noise and vibration UK[26].

In terms of the noise, vibration and local air quality impacts associated with aircraft, the sensitive receptors which are potentially impacted by the flight path and runway have been identified using a 1000m buffer from the runway (as the worst case scenario).

Sensitive receptor sites within the buffer zones have been identified from published base mapping of the area through the Antarctic Database Mapviewer website[27] and the ecological baseline information described above.

The human receptors would comprise the visitors and staff of the Wolfs Fang Runway itself. In terms of ecology, there is potential for individual South Polar skua, Antarctic petrels and Snow petrels to be present (passing through/resting at the site).

In the wider study area, the Henrickson nunatak, Kurze mountains and Conrad mountains are considered to be potential ecological habitats of medium habitat, suitable for three bird species, terrestrial invertebrates and fauna, assuming a precautionary principle. Their presence and location would need to be taken into consideration during the operation, maintenance and construction activities in relation to traverse routes.

[26] BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise Part 2: Vibration.
[27] http://www.add.scar.org/home/add7

There are no other receptor sites of high sensitivity in terms of noise and vibration impacts, including designated ecological receptor sites or human receptors in the wider study area. The closest human receptor sites are the Maitri and Novolazervskaya research stations, which operate all year round and are located approximately 160km to the North East of the sites, in the Schirmacher Oasis. In terms of ecological receptor sites, the Svarthamaren SPA is the closest, at a distance of 120km.

The background noise levels are considered to be low and the background local air quality is considered to be high as the closest human activity is located approximately 160km from the site at the Maitri and Novo research station.

9 Analysis of Potential Impacts

9.1 Introduction

This section describes the potential environmental impacts which can arise during the establishment/ construction, operation and maintenance of the runway.

Potential impacts take into consideration proposed activities (Section 6), the baseline environmental conditions and sensitivity of environmental features (Section 8). The nature of each impact is assessed taking into consideration a number of factors, which are described in more detail in the Approach and Methodology section (Section 5). This includes the impact's likelihood, spatial and temporal extent. The magnitude of impacts can be described as negligible/ minor moderate/major.

9.2 Physical Environment

9.2.1 Snow and ice quality

The construction and operation of the runway and the seasonal traverse of supplies to the runway will modify the physical surface of the snow and ice. The area of modification is a relatively very small proportion of the surrounding surfaces. The modifications are not permanent, and without ongoing modification / maintenance, the affected area will revert back to its original condition through natural processes.

The dispersal of soot, zinc rubber from tyres and pollutants from machinery operating at the site is likely to accumulate on the surface of the snow and ice locally. This will occur at the surface and is a very small proportion of the ice cap volumetrically. Due to ongoing surface preparation and snow clearing activities, these contaminate are likely to be contained to the snow berms.

Fuel spills are the greatest source of potential contamination. Minor fuel spills (less than 5 L) are an almost inevitable consequence of refuelling and vehicle servicing activities. The ability to contain and remediate these spills is

fundamental to reducing the impact of these spills. Fuel absorbents will be used to contain minor spills. Spilt fuel and contaminated snow will be collected, separated and stored for future consumption in ground vehicles or backloading. The use of small containers (1500l IBCs) on the traverse and at the runway will reduce the likelihood of a larger fuel spill.

Potential impacts on water quality would be reduced with the use of filtration of grey water prior to disposal and it is considered that this impact would be minor and of a local scale. Further information is provided in the Fuels and Oils Storage and Handling and the Waste Management sections below.

The physical environment within the site requires protection as the entire environment in Antarctica benefits from protection under the Protocol, as a nature reserve. Potential impacts on the physical environment in terms of snow and ice quality would be of a local scale and temporary.

The potential impacts associated with an accidental spillage or leak would vary depending on the quantity released into the environment. With the implementation of appropriate mitigation measures, the likelihood of accidental spillage is reduced and associated impacts on the physical environment are reduced to minor. Appropriate mitigation measures are set out in the Mitigation Section 10.

9.2.2 Ice Free Surface Interference

The proposal for the Wolfs Fang Runway does not include the use of ice-free ground during construction, operation or maintenance.

9.3 Flora and Fauna

The assessment of the potential impacts of the proposed development needs to take into account both on-site impacts and ecological features that may occur in the immediate or wider study area.

Potential impacts on nature conservation features have been characterised based on predicted changes as a result of the proposed activities. In order to characterise the impacts on each feature, the following parameters are taken into account:

- The magnitude of the impact
- The spatial extent over which the impact would occur
- The temporal duration of the impact
- Whether the impact is reversible and over what timeframe and
- The timing and frequency of the impact

Taking the baseline environment and proposed site activities into consideration, there will be no direct impact on flora and fauna in terms of the following:

- As the footprint of the proposed development is not within a habitat which is considered suitable for breeding, feeding or nesting of birds there will be no direct loss of suitable habitat. There is very limited potential for other species of flora and fauna to be present at the blue-ice field.

- There will be no direct impact on designated ecological sites and habitats (ASPAs or ASMA), as the closest is located more 120km from the proposed site

- There will be no foreseeable fragmentation and isolation of designated or managed habitat areas

- There will no changes to key habitat features

Potential direct impacts have been identified as:

- *Low potential for disturbance to birds within immediate study area, due to human presence.* Taking the information which is available for designated sites, habitats and species within wider study area into consideration, there is potential to encounter individuals of three bird species (Antarctic petrel, Snow petrel, South Polar skua) on site, whilst resting or passing through. As the site is not considered to provide a suitable habitat for these species , the number of birds are anticipated to be low. In addition to physical disturbance of birds, there is potential to impact through ingestion of litter or entanglement with plastic waste. Skuas are also known to feed on kitchen refuse[28].

- *Low potential for bird strike risk which would give rise to collision or strike injuries*. Based on the assumption outlined above, there is potential for the bird movement between the coastal area and nunataks inlands for feeding and breeding, which would present a low potential risk for bird strike. Research of published information did not identify any issues associated with bird strike during the previous use of the site as the Blue One runway[29].

- *Introduction of non-native species*. The establishment of the runway and the conduct of flights will provide improved access between Cape Town and Antarctica. With improved access there is potential for seeds, spores, and other biological matter to be introduced into Antarctica. Organisms can be introduced in clothing, baggage, on shoes, and in cargo of staff and visitors. The increased number of flights to Antarctica also increases the

[28] A review of the diets of southern hemisphere skuas, Reinhardt et all, 1998
[29] Dronning Maud Land Air Link, Preliminary Assessment of Environmental Impact, Poles Apart, Cambridge UK, 1996

risk that introduced organisms spread and become established in Antarctica. The runway location is effectively isolated from other communities and is free of soils. There is also very limited opportunities for foreign organisms to reach ice free areas downwind of the runway. This reduces the likelihood of the runway to become a vector for the introduction of foreign organisms into Antarctica. There is however, a low potential arising from off-site activities.

- *Disturbance to bird species present in the wider study area*, such as at nunataks, from noise, vibration and visual stimuli arising from vehicles, plant and equipment as well as aircraft. This is assessed in further detail in the section below.

- *Limited changes to local air quality arising from emissions* of vehicles, plant and equipment. This is assessed in further detail in the section below.

With the implementation of appropriate mitigation measures, the potential impact is considered to be minor, temporary and of a local scale.

9.4 Cultural Heritage

There are no potential impacts in relation to cultural heritage due to the absence of designated sites in the immediate or wider study area. During the operational phase of the scheme, the Sites and Monuments Records would be checked prior to the commencement of operations each season in order to ensure that any traverse routes do not impact on designated sites.

9.5 Wilderness and Visual Amenity

Potential direct impacts have been identified as:

- *Re-introduction of structures and facilities associated with the Wolfs Fang Runway Site into the landscape.* Even though the immediate study area is not used for human activities and therefore has medium wilderness and aesthetic value, there is visual evidence of the previous land-use on site, which slightly reduces the wilderness and aesthetic value of the site itself. The reactivation of the blue-ice runway and presence of structures associated with the operation of the new runway will re-introduce human presence into the landscape. There are no existing visual receptors (accommodation, traverse routes) which would look onto the site within the immediate study area and would be directly impacted by the introduction of human presence into the landscape. Visitation to the area is also considered unlikely. The magnitude of the impact taking the above factors into consideration, is a minor adverse impact of temporary, seasonal and reversible nature.

- *Beneficial view of wilderness and natural landscape from the site for the visitors and users of the site.* The location of the runway and transit accommodation would provide an opportunity for visitors to look at onto

wilderness and undisturbed landscape. This is considered to be a minor beneficial impact for the staff and visitors of the site whilst at the site. This is also in line with the ethos of White Desert eco-tourism activities, and furthering IAATO ambassador programme, which aim to increase environmental awareness of Antarctica.

9.6 Noise and Vibration

There are potential noise and vibration impacts arising from the following proposed activities:

- Noise associated with aircraft flight path during operation. (This assessment considers Intercontinental flights between South Africa and Wolfs Fang, intra-continental transfer flights between Wolfs Fang and the ALCI Airbase at Novo).
- Noise and vibration associated with aircraft use of runway landing/take off during operation
- Noise and vibration associated with use of snow vehicles, plant and equipment during construction, operation and maintenance on site
- Noise and vibration associated with the use of snow vehicles off site in order to access the site during construction, operation and maintenance.

Taking the noise sensitive receptor sites and proposed site activities into consideration, there will be no direct impacts from noise and vibration in terms of the following:

- There will be no direct impacts on the closest designated ecological site (Svarthamaren ASPA or Dakshin Gangotri Glacier ASPA) or permanent human residential receptors (Maitri and Novolazervskaya research station) *associated with the aircraft use of the runway*. This is due to their distance from the site at more than 160km.
- There will be no direct impacts on the closest designated ecological sites (Svarthamaren ASPA or) or permanent residential receptors (Maitri and Novolazervskaya research station) *associated with the use of vehicles, plant and equipment at the site during construction, operation and maintenance*.
- There will no direct noise and vibration impacts on habitat or birds of the designated ecological sites as this can be avoided though flight path planning.

There are potential impacts in terms of noise and vibration arising from:

- Maitri and Novolazervskaya research station human receptors, and other non-designated potential bird habitats (nunataks in the wider study area) through flight path.

- Low potential for disturbance to Antarctic Petrel, Snow Petrel, South Polar Skua from noise, vibration and visual impacts arising from vehicles, plant and equipment during construction, operation and maintenance both at the site and to access the site.

The implementation of appropriate mitigation measures would reduce potential impacts further and impact is considered to be minor, seasonal and its effects would be temporary in nature.

- Low potential for disturbance of individual birds (Antarctic Petrel, Snow Petrel, South Polar Skua) arising from landing and take-off of aircraft at the Wolfs Fang runway during operation. The presence of birds can be discouraged through appropriate food storage and litter manage, there would be a residual impact which is considered to be minor and temporary in nature.

9.7 Local Air Quality and Atmospheric Emissions/Carbon

There are potential local air quality impacts or atmospheric emissions arising from the following proposed activities:

- Atmospheric and carbon emissions associated with aircraft during operational phase
- Local air quality associated with aircraft use of runway landing/take off during operation
- Local air quality associated with use of snow vehicles, plant and equipment during construction, operation and maintenance on site
- Local air quality associated with the use of snow vehicles off site in order to access the site during construction, operation and maintenance
- Local air quality associated with the use of incinerator for waste disposal

Emission estimates of the proposed system are provided in Table 7. These are compared with the existing emissions produced.

Table 8: Atmospheric emissions for current and forecasted fuel consumption

		Existing System		Proposed System	
	Fuel	**consumption**	**Emission[3]**	**Forecast consumption[2]**	**Emission[3]**
Units:		kL	Kg CO_2-e	kL	Kg CO_2-e
Ground Vehicles[4]	Avtur	1.4	3,525	30	75,540
Ground Equipment[5]	Avtur	1.2	3021	2	5,036
Intercontinental Flights	Avtur	88.7[1]	223,346	126	317,268
Transfer Flights	Avtur	30.0	75,540	50	125,900
Total		**121.1**	**305,459**	**208**	**523,744**
Average client numbers		50	50	120	120
Total Per Client		**2.4**	**6109**	**1.7**	**4,364**

1. Current emissions for intercontinental flights are based on a fractional percentage of passengers on the ALCI IL-76 operation.
2. Based on 10 flights per season using a Falcon 900LX @1150 l/hr
3 Based on 2.518 kgs CO^2 equivalent gases per litre.

[4] Includes an annual resupply traverse and runway maintenance activities.
[5] Camp generators primarily.

The construction and operation of the runway is not considered to be significant in terms of local air quality. Dispersal of local pollutants downwind will occur quickly and the associated impacts are considered negligible.

Exhaust emissions from aircraft are much greater source of pollutants however the vast majority of these are produced at altitude. The accumulation of these pollutants is likely to be extremely low due to the extremely large area over which they are produced and the resulting atmospheric dilution.

Atmospheric emissions and air quality impacts are assessed as low. From a total system perspective, the proposed operation results in a 29% reduction in emissions on a per client basis ,compared with the current operation. This is primarily a result in the move away from the IL-67 operation to the use of a business jet for intercontinental travel.

Local air quality impacts associated with waste incineration would be minor and of a local scale. Potential impacts can be reduced with the procurement of a high specification incinerator, which is described in the mitigation section below.

In terms of emissions from ground vehicles, plant and equipment used during construction, operation and maintenance, on site and off site potential impacts can be reduced with the implementation of appropriate mitigation measures and are considered to minor and of local extent.

Residual impacts are mainly associated with aircraft fuel use in terms of local air quality emissions and atmospheric emissions. These includes nitrogen dioxide, particulate matter (mainly PM 2.5) at ground level and carbon dioxide, ,nitrogen oxide emissions in the lower atmosphere which can contribute to ozone production. Carbon emissions will be offset through an accredited scheme.

9.8 Fuels, Oils Storage and Handling

9.8.1 Resupply

White Desert's resupply activities will intensify as a result of the proposed activity. The supply of fuel to the runway is the most significant commodity that will require delivery to Antarctica by ship. Approximately 80,000 l of fuel is to be delivered over summer and White Desert will 'piggyback' on existing resupply services. The incremental impact of this on shipping activities is difficult to quantify but it is considered minor. A number of traverses will then be conducted over the summer to position fuel to Wolfs Fang Runway.

The backloading of empty fuel containers or empty tanktainers will occur through the same system. Given the surplus payload available on northbound shipping this is also considered to be a minor impact.

The resupply of foodstuffs, repair parts, and other consumables will utilise surplus capacity on the client flights or a dedicated resupply flight. The back loading of general waste will also utilise this capacity. These impacts are considered to be minor.

9.8.2 Environmental impact of aircraft crashes

Increased flying within Antarctic also increases risk of aircraft accidents and the associated environmental impacts of these. As this operation will be conducted under the jurisdiction of civil regulators, the flight risk profile is comparable to domestic charter aircraft operations. On this basis, crash statistics would suggest one crash is likely to occur every 200,000 departures. Despite the low likelihood, significant effort in mitigating this risk are to be implemented, including crash recovery capabilities.

In the event of a crash, it is unlikely that local resources will be able to adequately remediate the site and a multi-season clean-up expedition would be required. Despite these limitations, the environmental risks associated with an aircraft accident are considered minor.

9.9 Waste

There would be an increase in the total client numbers which would give rise to the following impacts associated with waste:

- Potential direct impacts on the quality of the physical environment in the immediate study area associated with the increase in the total volume of waste (solid and liquid) produced
- Filtered grey water would be disposed of in a crevasse which has been identified within the immediate study area (refer to location indicated on Map 2)m which would lead to a minor decrease in the physical environment at this location
- Low potential direct impacts on individual birds at the site associated with direct ingestion of litter or entanglement in debris
- Hazardous waste streams are required to be disposed of outside Antarctica

An appropriate waste management strategy and site specific mitigation measures have been identified in order to reduce the potential impacts on the physical environment and wildlife (these are identified in the mitigation section below). With the implementation of these measures the likelihood of impacts is reduced to low and potential impacts would be minor, of a local scale.

There would be no additional impacts associated with waste on the physical environment in the wider study area, including designated areas or ecological habitat areas (nearby nunataks) as waste would be appropriately stored within the Wolfs Fang Runway site.

9.10 Indirect impacts

The proposed runway will lead to a change in the activities conducted by White Desert and they support requirements provided by TAC. These are summarised in Table 8.

Table 9. Summary of Indirect Impacts				
Proposal Element	**Indirect Impact Area**			
	Whichaway Camp	**Resupply and Waste**	**Biosecurity**	**Visitation to Pole and Atka Bay**
Operation of Runway	NA	Low	NA	NA
Conduct of Flights	NA	Low	Low	NA
Change in Client Numbers	Low	Low	Low	Low-Medium
Establishment	NA	Low	Low	NA

9.11 Direct impacts

Direct impacts are summarised in Table 9 and the risk matrix used for assessment is at Table 10.

Table 10. Summary of Direct Impacts							
Proposal Element	**Direct Impact Area**						
	Noise and Vibration	**Atmospheric emissions**	**Surface interference**	**Flora**	**Ice free land**	**Birds**	**Wilderness / visual**
Operation	Low	Low	Low-Medium	NA	Low	Low	Low

of Runway							
Conduct of Flights	Low	Low	NA	NA	NA	Low	Low
Change in Client Numbers	Low	Low	Low	Low	Low	Low	Low
Establishment	Low	Low	Low	Low-Medium	Low	Low	Low

Table 11: Consequence/likelihood impacts table

Likelihood	**Consequence**				
	Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Certain	Medium	Medium	High	High	Extreme
Likely	Medium	Medium	Medium	High	Extreme
Possible	Low	Medium	Medium	High	High
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Low	Medium	Medium

Consequence

Insignificant – recoverable damage or impact
Minor – small fuel spill (20L or less), loss of individual plants
Moderate – Moderate fuel spill (approximately 100L), injury or behavioural disturbance to an animal
Major – Large fuel spill (greater than 100L), loss of localised plant communities
Catastrophic – local extinction of a species, establishment of exotic invasive species, loss of human life or permanent injury.

Likelihood

Certain – the impact will be the outcome of the activity.
Likely – there is a good chance that the impact will occur as a result of this activity, however it will not always be the case.
Possible – the impact may occur, but it is not expected to be the outcome of the activity. (e.g. person dependent – human error)
Unlikely – minor chance that the activity will result in the impact.
Rare – extremely unlikely

10 Mitigation Measures

10.1 Introduction

This section identifies the appropriate mitigation and monitoring measures which will be undertaken during construction, operation and maintenance for the potential impacts identified in the section above.

The measures take into consideration relevant legislation, published guidance site- specific requirements and best practice measures relevant to ice runways.

10.2 Physical Environment

- The mitigation measures required to reduce the risk of contamination of the physical environment and minimise the potential impacts as far as reasonably practical are related to the safe storage and handling of fuels and oils, as well as the appropriate waste management. These measures are identified below.

10.3 Flora and Fauna

10.3.1 Potential Impact

- Low potential for physical disturbance to birds within immediate study area due to human presence.

10.3.1.1 Relevant Legislation

- Antarctic Treaty (1959)
- Protocol on Environmental Protection to the Antarctic Treaty (1991) Annex II Conservation of Antarctic Fauna and Flora. This is the key legislation in relation to the protection of the environment. It prohibits harmful interference by flying aircraft in a manner that disturbs concentrations of birds, wilfully disturbing breeding or moulting birds or concentrations of birds by persons on foot.
- Protocol on Environmental Protection to the Antarctic Treaty (1991) Annex V Area Protection and Management, Environmental Protection
- The Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) (1982)

10.3.1.2 Mitigation measures

- Appropriate storage of all waste and materials in enclosed containers to reduce potential impact from entanglement or ingestion of litter and debris, particularly plastic debris
- Operate ground vehicles using appropriate speed in areas where birds are likely to be present on the ground in order to reduce risk of collision and strike injuries of birds
- Use of designated paths within the runway site
- Implement measures to minimise disturbance of wildlife by visitors and staff during trips off-site and whilst on site. Disturbance can also arise

through stress reactions. These measures include maintaining an appropriate distance from wildlife, no feeding, maintaining low noise levels, minimising visual disturbance and no interference with wildlife behaviour
- Measures to reduce impacts on birds and the environment arising from noise , vibration and local air quality (set out in the sections below)

10.3.2 Potential Impact

- Low potential for bird strike risk which would give rise to collision and strike injuries
- Low potential for disturbance of individual birds (Antarctic Petrel, Snow Petrel, South Polar Skua) arising from landing and take-off of aircraft at the Wolfs Fang runway during operation.

10.3.2.1 Relevant Guidance

- Guidelines for the operation of aircraft near concentrations of bids in Antarctica
- International Association of Antarctic Tour Operators (IAATO) guidance

10.3.2.2 Mitigation Measures

- Discourage presence of birds on site through appropriate management of the site, including appropriate and secure storage of food and litter within enclosed areas.
- Set a 2000m no fly zone around sensitive habitats of the wider study area, such as the Henrickson nunatak. This will need to be carried out in conjunction with the aircrew as part of the initial proving flights to the runway. This will ensure that aircraft approaches and departures, where potential impacts are greatest, are controlled.
- Aircraft flight path above 6000 feet is not considered to give rise to noise and vibration impacts on the ground

10.3.3 Potential Impact

- Introduction of non-native species. This would present a risk of non-native species becoming established in Antarctica. There is no ice free ground or flora within the proposed site, there is a potential risk when visiting ice free areas and wildlife areas.

10.3.3.1 Relevant Guidance and Legislation

- Non-native species manual, Committee for Environmental Protection, Secretariat of the Antarctic Treaty[30]

10.3.3.2 Mitigation Measures

- Best Practice mitigation measures which are currently used by White Deserts operations to reduce the risk of the introduction of non-native species into Antarctica will continue to be implemented with the operation of the Wolfs Fang Runway

[30] Non-Native Special Manual, Committee for Environmental Protection, Secretariat of the Antarctic Treaty, Edition 2011

- These measures take the above guidance into consideration and are based on the prevention, monitoring and response.
- Measures would include, and would not be limited to:
  - Intercontinental aircraft are checked and treated as necessary where applicable to ensure they are insect free
  - Informing clients and training of site staff in relation to the risks associated with the introduction of non-native species to ensure awareness
  - Check client luggage and cargo to ensure it is visibly clean of contamination
  - Cleaning of foot-wear prior to departure and between sites within Antarctica
  - Decontamination measures for boots, clothing and equipment prior to arrival
  - Regular inspection of ground vehicles which are used off-site
  - Monitoring measures and measures to be put in place in order to report any non native species found, early warning system would be implemented

10.4 Cultural Heritage

No potential impacts have been identified in relation to cultural heritage.

10.4.1.1 Relevant Guidance

- List of Historic Sites and Monuments

10.4.1.2 Mitigation Measures

- Prior to each operational season, the List of Historic Sites and Monuments will be consulted in order to ensure that there are no new listings located along the routes used to access the runway which should be taken into consideration.

10.5 Wilderness and Visual Amenity

10.5.1 Potential Impact

- Re-introduction of structures and facilities associated with the Wolfs Fang Runway Site into the landscape
- Beneficial view of wilderness and natural landscape from the site for the visitors and users of the site

10.5.1.1 Relevant Legislation

- Protocol on Environmental Protection to the Antarctic Treaty (1991), Article 3 Environmental Principles, "protection of the Antarctic environment and dependent and associated ecosystem and the intrinsic value of Antarctica, including its wilderness and aesthetic values..."

10.5.1.2 Mitigation Measures

- The overall footprint of the operational elements associated with the runway (transit accommodation, staff accommodation, materials, plant and equipment store) has been reduced as far as reasonably practical in

order to reduce potential impacts on the wilderness and visual amenity of the immediate study area. This has already been incorporated into the design of the site

- It will be ensured that there is no littering off site or on site through appropriate enclosed waste storage containers. In the event of accidental dispersal of litter, it would be removed immediately.

10.6 Noise and Vibration

10.6.1 Potential Impact

- Potential disturbance to Maitri and Novolazervskaya research station human receptors, and other non designated potential bird habitats (nunataks in the wider study area) through flight path.

10.6.1.1 Relevant Guidance and Legislation

- Guidelines for the operation of aircraft near concentrations of bids in Antarctica

10.6.1.2 Mitigation Measure

- Set a 2000m no fly zone around sensitive habitats of the wider study area, such as the Henrickson nunatak. This will need to be carried out in conjunction with the aircrew as part of the initial proving flights to the runway. This will ensure that aircraft approaches and departures, where potential impacts are greatest, are controlled.

10.6.2 Potential Impact

- Low potential for disturbance to bird species (Antarctic Petrel, Snow Petrel, South Polar Skua) from noise and vibration arising from vehicles, plant and equipment during construction, operation and maintenance both at the site and to access the site.

10.6.2.1 Relevant Legislation

- Protocol on Environmental Protection to the Antarctic Treaty (1991) Annex II Conservation of Antarctic Fauna and Flora. This is the key legislation in relation to the protection of the environment. It prohibits harmful interference by flying aircraft in a manner that disturbs concentrations of birds, wilfully disturbing breeding or moulting birds or concentrations of birds by persons on foot.

10.6.2.2 Mitigation Measures

- Discourage presence of birds on site through appropriate management of the site, including appropriate and secure storage of food and litter within enclosed areas.
- Plan traverse routes used to access the site during construction, operation and maintenance to avoid being within 1000 meters of designated ecological sites
- When planning traverse route, avoid other non designated nunataks such as Henrickson Nunatak which may provide suitable habitat for birds as

far as possible and remain at least 300 meters away from potential bird habitat, (unless require for health and safety reasons)
- Ensure that there is no unnecessary idling of snow vehicles or plant to reduce noise levels during construction , operation and maintenance
- Maintain appropriate speed for snow vehicles on as well as off-site to reduce risk of bird strike from ground vehicles.

10.7 Local Air Quality and Atmospheric Emissions/ Carbon

10.7.1 Potential Impact

- Atmospheric and carbon emissions associated with aircraft during operational phase
- Local air quality associated with aircraft use of runway landing/take off during operation

10.7.1.1 Mitigation Measures

The following measures have been integrated into the design of the operations in order to reduce these impacts:

- Aircraft selected for intercontinental flights have been selected for fuel efficiency with low smoke emissions and are considered to be more efficient than current aircraft used for intercontinental flights
- All carbon emissions associated with proposed air travel and camp operations will be offset by White Desert using the Carbon Neutral Company. White Desert has been a fully accredited member of this company since May 2007 and will continue to offset emissions for all new operations at Wolfs Fang runway.

10.7.2 Potential Impacts

- Local air quality associated with use of snow vehicles, plant and equipment during construction, operation and maintenance on site
- Local air quality associated with the use of snow vehicles off site in order to access the site during construction, operation and maintenance
- Local air quality associated with the use of incinerator for waste disposal

10.7.2.1 Relevant Legislation

- Protocol on Environmental Protection to the Antarctic Treaty (1991), Article 3 Environmental Principles, (2) (b) "activities in the Antarctic Treaty area shall be planned and conducted so as to avoid (ii) significant adverse effects on air or water quality (iii) Significant changes in the atmospheric, terrestrial (including aquatic) glacial or marine environments

10.7.2.2 Mitigation Measures

- Plan routes used to access the site during construction, operation and maintenance to avoid being within 500 meters of designated ecological sites

- Construction works plan to be prepared in advance of construction phase which will maximise efficiency in fuel-use and therefore reduce emissions and local air quality impacts
- When planning access route, avoid other non designated nunataks such as Henrickson Nunatak which may provide suitable habitat for birds as far as possible and remain at least 300 meters away from potential bird habitat, (unless require for health and safety reasons)
- Ensure that there is no unnecessary idling of snow vehicles or plant to reduce emissions during construction , operation and maintenance
- Regularly inspect and maintain vehicles , plant and equipment to ensure air emissions are appropriate
- A high specification incinerator has been identified for the incineration of waste at the site. The incinerator has been approved by DEFRA, has low energy consumption, and CE (low Nitrogen Dioxides (NOx)) certification. In addition, the average emissions are below the EU air quality standards (1/2 hour average is used in mg/m^3) for incinerators in relation to total dust, nitrogen dioxide, sulphur dioxide and carbon monoxide, according to the emissions report[31].

10.8 Emergency Preparedness and Response

10.8.1 Potential Impact

- Potential direct impacts on the quality of the physical environment resulting from a aircraft crash of incident.

10.8.1.1 Mitigation Measures

- Preventative controls will stem from the aviation regulatory system under which all flight and runway operations are conducted.
- Additional operating controls are outlined in Section 13.2.4 This includes provisions for:
    - documentation of procedures
    - local operating procedures
    - staff and aircrew training
    - emergency response capabilities
- Emergency response equipment will include fire suppression equipment, and fuel spill containment and clean-up equipment. This is described at Section 10.10.

10.8.1.2 Relevant Legislation

- Protocol on Environmental Protection to the Antarctic Treaty (1991), Annex VI Liability Arising from Environmental Emergencies

[31] Top Load Waste Incinerator, Model I8-40A. Emissions data: http://www.inciner8.com/emissions-report.php

10.9 Waste Management

10.9.1 Potential Impact

- Potential direct impacts on the quality of the physical environment in the immediate study area associated with the increase in the total volume of waste (solid and liquid) produced
- Low potential direct impacts on individual birds at the site associated with direct ingestion of litter or entanglement in debris

10.9.1.1 Relevant Legislation and guidance

- Protocol on Environmental Protection to the Antarctic Treaty (1991) Annex III Waste Disposal and Waste Management
- IAATO Guidelines in relation to tourist activities
- White Desert Environmental Policy

10.9.1.2 Mitigation Measures

- Implementation of a waste management strategy. The waste management strategy at the site would be based on the principles of eliminate, reduce-re-use-and recycle, as described in the Sustainability of White Desert section. The table below summarises the proposed waste management strategy. The strategy considers relevant legislation and the White Desert environmental policy. The strategy will form the basis of the waste management plan, (as required by Article 8 Waste Management Planning of Annex III Waste Disposal and Waste Management) and will be part of the Wolfs Fang Operating procedures.

Table 12.0: Waste Management Strategy

Waste Stream Description Category According to Protocol	Storage/ Handling	Legislative Requirement Management / Final Disposal
Grey Water (shower water, urine, kitchen waste water) Group 1- sewage and domestic liquid waste	Oil residues from kitchen waste water are removed using grease trap Grey water (excluding urine) is filtered using biofilter (Biolan filter)	*Deep ice-pits can be used where such disposal is only practical option* Following removal of oil residues and filtration, grey water is disposed of in a deep ice pit as disposal at sea is not an option Suitable deep ice pit has been identified in proximity to site, it is not located within known ice-flow lines which terminate at ice-free areas. Only one site will be used and will result in grey water to be contained in a frozen state. Grey water production may be up to 4 L/person/day or 4700 L per year. The grey water deposit will be entrained in the glacial flow and will eventually make its way to the coast in several hundred years. Local glacial flow

		rates are approximately 40m per year.
Blackwater Group 1- sewage and domestic liquid waste	Dry toilets are in use reducing water use Waste is sealed in plastic bags	*Combustible waste can be incinerated* Waste disposal by incineration Disposed of in high specification incinerator (refer to Sustainability of White Desert Operations section)
Food waste Non recyclable plastic bags used for food Group 3- Solids to be combusted	Stored in enclosed containers, in doors to reduce risk of dispersal and potential impacts to wildlife	*Combustible waste can be incinerated* Waste disposal by incineration Permissible plastics disposed of in high specification incinerator (refer to Sustainability of White Desert Operations section)
Packaging waste Recyclable materials aluminium Plastic (excluding plastics banned from Antarctica)	Stored in enclosed containers, in doors to reduce risk of dispersal and potential impacts to wildlife	*Combustible waste can be incinerated* Food is re-packaged into vacuum packed plastic bags prior to arrival, reducing amount and volume of recyclable materials imported to Antarctica Any residual recyclable materials are returned to Cape Town for recycling
Food packages	Food within vacuum packed plastic bags is transported in reusable plastic boxes	Re-use of plastic boxes Returned to Cape Town for re-use
Incinerator Ash- dry ash residue Group 4 other solid waste	Stored in an appropriate enclosed container and treated as hazardous waste	*Dry ash residue is required to be removed from Antarctic Treaty Area*
Empty fuel drums Group 2 Other liquid wastes including fuels and lubricants	Remaining oil is siphoned off, containers sealed to minimise risk of spillage	*Required to be removed from Antarctic Treaty Area*
Waste oils, waste lubricants and waste fuels Group 2 Other liquid wastes including fuels and lubricants	Stored in appropriate secured containers	*Required to be removed from Antarctic Treaty Area*
Materials contaminated with waste oil/ fuels Group 4 Other solid wastes	Stored in appropriate enclosed containers to prevent contamination or dispersal	*Required to be removed from Antarctic Treaty Area*
Hazardous waste Light bulbs, electrical batteries Waste containing harmful metals or persistent compound Group 4 Other solid wastes	Stored in appropriate enclosed containers Stored on an impermeable base to prevent contamination or dispersal	*Required to be removed from Antarctic Treaty Area*

10.10 Fuels Oils and Materials Storage and Handling

Following approval, a site specific Fuel, Oil and Materials Storage and Handling Plan would be prepared as part of the Wolfs Fang Operating Procedures. This would include as a minimum:

Appropriate storage and handling measures such as-

- Fuel and oils to be stored in 1500l IBC containers or 20' ISO tanktainers.
- Remove all penetrations below full supply level of storage containers. Alternatively, provide bunding with 110% capacity.
- Traversing inland from the coast is to only use IBC containers.
- Ullage space should be provided at each fuel storage location so that a damaged bulk container can be emptied.
- Storage on an impermeable base where possible.
- Use of mat or drip dray to collect drips during re-fuelling activities.
- No refuelling to be carried out outside designated areas.
- Regular used hose fittings should be 'dry break'.
- Regularly inspect and maintain fuel handling equipment, vehicles, plant , equipment to ensure that there are no leaks.
- Twice daily inspection of bulk fuel tanks for leaks and water accumulation.
- Spill kits will be provided within close proximity to fuel and oil storage areas and operatives will be trained in their use.
- Containers will be maintained in good condition, fitted with lids, seals and labelled to indicate the contents.
- Provide snow melter and fuel/water separator on site.

- Fuel and oil spill contingency plan and spill response strategy with measures for:
- Containing the spill (use of a spill response kit/ absorptive materials indoor)
- Removal of contaminated snow or other material
- Storage of contaminated material within appropriate drums for disposal off-site
- Spill prevention measures when refuelling
- Site staff training

11 Environmental Enhancement Opportunities

11.1 Removal of redundant equipment.

11.1.1.1 Relevant Guidance

- Committee for Environmental Protection Clean Up Manual

Following the termination of activities at Blue One runway, a number of waste fuel drums were left in situ and are visible above the surface. In accordance with the Article 2 of Annex III of the Protocol on Environmental Protection to the Antarctic Treaty, abandoned work sites of Antarctic activities are required to be cleaned up by the generator of the waste and the user such sites. It is anticipated

that there will be an opportunity to remove the redundant drums from site as part of White Desert overland supply route.

11.2 Sustainability of White Desert Operations

White Desert has been successfully operating tourist programmes in Antarctica since its inception in 2006. During this time, it has taken over 500 clients into the interior of Antarctica in small, well-managed groups. After gaining permission from the FCO, a tourist camp was established, which is an example of next generation eco-tourism, with high-tech materials and powered by solar panels. It also adheres to environmental policies, while the company has been carbon neutral since May 2007.

White Desert operates environmental policies which aim to minimise environmental impacts and apply to all aspects of its direct operations in Antarctica. By providing an independent runway site, the project would enable the environmental policies to be rolled out to the flight operations. Currently, flight operations are not within the direct management or control of White Desert and this would provide a beneficial environmental impact above the current baseline. The policies aim to go beyond minimum legislative compliance, apply international best practice and are based on sustainability principles. The current policies which would rolled out to the Wolfs Fang Runway are summarised below:

Policy: Use of renewable energy sources

- Up to 90 % of heated water required is provided through *solar heated water tubes*
- The high efficiency of the solar heated tubes reduces the requirement for heating water through a propane burner
- White Desert has designed and implemented *solar air heaters* for heating the accommodation pods (see image below), which are currently in the trial phase. It is estimated that these can provide between 50-75% of heating requirements.
- (The remaining electricity required for heating is provided through a combination of JETA 1 heater, electric (using Veito Blade Electric Wall Mounted Heater) which will then be powered by a 60kw generator using about 15-18 barrels of JETA 1 per season)
- *Photovoltaic panels* are used to generate power for low wattage items such as laptops, phones

Image 6: Solar Air Heater in use for accommodation pods at Whichaway Camp

Policy: To off- set carbon emissions associated with operations

- Operations are designed to minimise fuel use within the direct control of White Desert, as far as reasonably practical. As fuel use is inherently higher for all activities within Antarctica due to its isolation, it has been a policy of White Desert to offset carbon emissions since 2007
- All carbon emissions associated with this proposed air travel and camp operations will be offset by White Desert using the Carbon Neutral Company. White Desert has been a fully accredited member of this company since May 2007 and will continue to offset emissions for all new operations at Wolfs Fang runway.

Policy: Waste management is based on the principles of eliminate, reduce-re-use-and recycle

- The total quantity and volume of food packaging transported to Antarctica is reduced by transferring food to vacuum packed and sealed plastic food bags prior to departure in Cape Town
  - These are transported in plastic boxes which are re-used
  - The disused plastic food bags are then incinerated in Antarctica
- These measures minimise the amount of waste arisings
- The quantity of waste water produced is reduced by returning laundry to Cape Town

Policy: To reduce the environmental footprint of camp activities through the use of a sustainable supply chain

- Best available technology is employed for camp activities through a sustainable supply chain. This includes
  - *Use of a high specification waste incinerator.* A high specification incinerator has been procured for the incineration of waste at the site. The incinerator has been approved by DEFRA[32], has low energy

[32] Department of Environmental Food and Rural Affairs United Kingdom

consumption, and CE (low Nitrogen Dioxides (NOx)) certification. In addition, the average emissions are below the EU air quality standards (1/2 hour average is used in mg/m^3) for incinerators in relation to total dust, nitrogen dioxide, sulphur dioxide and carbon monoxide, according to the emissions report[33].

- *Use of dry toilets*, reducing water use and providing ability of incinerating the vacuum sealed waste
- *Filtration of grey water prior to disposal.* Any waste oils are removed from kitchen waste water through grease traps. All grey water is filtered with the use of a biofilter, which is a small purification plant for treating grey wastewater

- Use of biodegradable shower gel/shampoo products

[33] Top Load Waste Incinerator, Model I8-40A. Emissions data: http://www.inciner8.com/emissions-report.php

12 Cumulative Impacts

Cumulative impacts can be described as the interactions between topics on a particular resource or receptor (inter-topic interactions) or the potential cumulative impacts and interactions of the project with other known projects or activities (intra-project interactions).

The Cumulative Impacts Section considers the cumulative impacts of the proposed activities at the Wolfs Fang Runway and the potential interactions with activities at Whichaway Camp. The activities at the two sites cannot be considered in isolation from one another.

The interactions of the Wolf Fangs Runway activities with the Whichaway Camp activities takes into consideration the information presented in the IEE Report for Whichaway Camp Activity, 2011 [34]. The client accommodation has remained the same as that presented in the Whichaway Camp IEE, with six fiberglass domes measuring 6m in diameter. Since 2011, the client and staff facilities have been replaced due to ware and tare, and pods have replaced tents. The client facilities/communal areas comprise three interconnected, 8m diameter client pods, (in place of two 8m x 5m diameter dome tents connected by a tunnel), the kitchen pod 8 m in diameter (in place of the kitchen tent which had measured 8m by 5m) and an ablution pod (8 m diameter) is also provided for clients. There are 10 mountain tents (in place of 5 clam tents, which were larger in size) which provide accommodation for staff members. In summer 2016, the existing shower facilities will be located within a separate and additional pod, within the boundaries of the existing camp. The camp occupies an area of approximately 100m X 100m (1 hectare).

This section provides an update in terms of the environmental impact of the Whichaway Camp, identifying any new potential impacts which may arise as a result of the Wolfs Fang Runway operations. It identifies identifying appropriate mitigation measures to reduce potential impacts.

The consideration of cumulative impacts with Whichaway Camp within this IEE Report eliminates the requirement to update the Whichaway Camp Activity IEE and provides relevant information in a single document.

Cumulative impact assessment has been carried out as required by the Article 8 of the Protocol and follows the general guidance set out in the Guidelines for Environmental Impact Assessment in Antarctica. Recognised published methodology and guidance for the assessment of cumulative impacts has also been used[35].

[34] Whichaway Camp Activity IEE, White Desert Ltd, 2011

[35] Design Manual for Roads and Bridges, Highways Agency, Volume 11, Part 5 Assessment and management of environmental effects and Part 6 Reporting of environmental effects, Amended Circular on Environmental Impact Assessment, A Consultation Paper, Department for Government and Local Communities, 2006

[35]The Explanatory Memorandum to the Town and Country Planning (Environmental Impact Assessment) (Amendment) (England) Regulations 2008

12.1 Whichaway Camp

- Potential impact from increase in client numbers at Whichaway Camp

The construction and operation of the runway will occur independently from the existing Whichaway Camp operation conducted by White Desert. The Runway will facilitate a greater throughput to the camp each summer and this throughput will have an impact on the camp particularly the tasks associated with client change overs.

The increase in client numbers would result in an increase in the total quantity of waste produced, the total quantity of wastewater, an increase in water use and an increase in energy demand. White Desert implements environmental policies to minimise impacts on the environment, as set out in Sustainability of White Desert Operations section. The potential impacts arising from these increases would be reduced. The size of each individual group will remain the same, limited to small groups of between 10-12 individuals.

The environmental policies would also be implemented to the activities associated with the Wolfs Fang Runway, a beneficial impact in relation to the current flight activities which are outside the control of White Desert Operations.

With the implementation of the proposed waste management strategy and the White Desert environmental policies, the potential impacts associated with an increase in client numbers would be reduced. The residual impact would be a low adverse impact.

- Potential environmental impact in the client visits off site

The overall total of visitor days is anticipated to increase. However, the size of each individual group will remain the same, limited to small groups of between 10-12 individuals. This would be the result of increased efficiency in client transfers.

There are no new areas to be visited under the current proposal. To reduce the potential impact of increased footfall of walking tours, the existing paths and roads will be followed and precautionary measures according to the Guidance for Visitors to the Antarctic (approved by XVIII ATCM) will continue to be implemented. Due to the group size the magnitude of the potential impact of the group visits would remain the same as the current level.

White Desert recognises the potential cumulative impacts of tourism and as members of IAATO would continue to implement established IAATO guidelines and procedures for tourism activities off site and off site trips.

12.1.1 Relevant Guidelines

- IAATO General Information for Wildlife Watching (updated October 2013)
- IAATO Bird Watching Guidelines (updated October 2013)
- IAATO Emperor Penguin Colony Visitor Guidelines

- At the 2011 Antarctic Treaty Consultative Meeting (ATCM XXXIV, Buenos Aires), Treaty Parties adopted new general guidelines for visitors to the Antarctic (Resolution 3).
- Guidelines for Visitors to the Antarctic which include recommended measures to Protect Antarctic Wildlife, Respect Protected Areas, Respect Scientific Research, Be Safe, Keep Antarctica Pristine

12.1.2 Relevant Mitigation Measures

- All activities will continue to be undertaken under the supervision of a trained guide and IAATO representative
- Continue to raise awareness of clients prior to arrival in Antarctica in relation to sensitivity of the environment
- On-going training and awareness of new and existing site staff
- Measures to minimise disturbance of wildlife during trips, including to maintain an appropriate distance from wildlife, no feeding, maintaining low noise levels, minimise visual disturbance and no interference with wildlife behaviour
- Measures to avoid disturbance of wildlife habitat, including no trampling outside dedicated routes, all human waste and litter would be securely collected and taken off site, no removal of vegetation or stones
- There are no new areas proposed for visits at this stage
- Awareness of location of Nunataks and ice-free ground and measures to avoid impacts on areas of ice-free ground

By continuing to implement these appropriate mitigation measures, as group size will remain small, the overall impact associated an increase in the number client visits off site is considered to be minor, temporary and seasonal (November- February). There would be no disturbance during other periods and site recovery can occur when routes are not used by tourists and visitors outside the season.

- Potential increase in use of ground vehicles for client transfers

The use of ground vehicles will increase to transfer clients to and from the Novo Runway. This increase would result in an increase in overall fuel use. Efficient vehicles, plant and equipment in addition to an efficient logistic strategy would be implemented to reduce this impact.

In term of noise and vibration, local air quality and fauna the mitigation measures outlined in Mitigation Section 10, would be followed. A residual impact remains which is associated with the noise, vibration and local air quality associated with the increase in fuel use, which is considered to be a minor adverse impact.

Dakshin Gangotri Glacier ASPA (ASPA No 163) is located 700-800 meters North West of Whichaway Camp, at a distance greater than 160km from the site. It is not visited. All guides have to be familiar with management plan of the ASPA and a copy of this plan can be found in an easy accessible location at the camp. All visitors will be instructed by the guides not to enter the area and will be informed about its location. On this basis, the Whichaway Camp IEE did not

identify potential adverse impacts on the ASPA and the historic monument within the Whichaway camp area in relation to transfer to and from the Novo runway. The proposed increase in client numbers would not alter this assessment.

- Interactions with other known or planned activities

There are no known or planned activities within the wider study area which have potential adverse interactions with the Wolfs Fang runway. The runway would provide an alternative site within the region to be used in case of emergency, providing a beneficial impact.

Table 13.0 Proposed Change in Operations

	Current Operations Range of Values	Future Operations Anticipated/ Indicative Numbers Range of values/ Projected maximum
Total number of clients per season	80-100	Anticipated- 150 Maximum- 200
Size of Groups	12	Anticipated-12 Maximum- 14
Total number of groups per season (rotations)	6	Anticipated 10 Maximum 20
Total number of days spent in Antarctica per group	Average 8 Maximum 10 Day trips and three day trips organised	Average 8 Maximum 10 Day trips and three day trips organised
International return flights per season	6 (fractional use of TAC IL-76 aircraft)	Anticipated- 10 Maximum- 20 (dedicated business jet)
Internal return flights per season	8-10	Anticipated- 10 Maximum- 20
Destinations	Atka Bay South Pole	Atka Bay South Pole Unchanged

12.2 Inter-topic interactions

The traverse routes which will be used to access the runway during construction operation and maintenance are a geographical area where there are potential cumulative impacts as a result of interactions between a number of topics ('wilderness and visual amenity',' local air quality' and 'ground vehicle noise') on a specific receptor, (wider study area). However, as the potential increase in movements during both construction and operation are considered to be low, and as there are no ASPA, ASMA or Heritage Sites and Monuments potential

cumulative impacts are also considered to be minor, local in nature and temporary.

The area within the proposed site boundary is another geographical area where there are potential cumulative impacts as a result of interactions between topics. There would be a minor adverse impact in terms of aircraft noise from the site during operation and this would have a cumulative impact on the low number of birds.

13 Outline Environmental Management Plan

13.1 Introduction

The table below summarises the potential adverse impacts identified in the sections above, the relevant legislation and guidance which will taken into consideration and the mitigation or monitoring measures required to reduce the potential measure to an appropriate level.

The mitigation measures form the basis of an outline Environmental Management Plan. The summary table will be taken forward and developed further during the construction, operation and maintenance of the Wolf Fang runway and included within the Wolfs Fang Operating Procedures.

Table 14.0 Outline Environmental Management Plan			
Potential Impact (with mitigation measures) Summary	Mitigation Measure	Phase	Monitoring/ Implementation
Flora and Fauna			
Low potential for bird strike risk *Low risk* *Minor impact* *In the case of direct bird strike -permanent* *Localised*	Appropriate storage of all waste and materials in enclosed containers to reduce potential impact from entanglement or ingestion of litter and debris, particularly plastic debris	Operation Maintenance	Regular inspections by environmental manager
Low potential for disturbance of individual birds (Antarctic Petrel, Snow Petrel, South Polar Skua) arising from landing and take-off of aircraft at the Wolfs Fang runway during operation *Low risk* *Minor impact* *Temporary* *Localised-would only occur on site*	Use of designated paths within the runway site	Operation Maintenance	Training and regular inspections by site staff
	Measures to minimise disturbance of wildlife by visitors and staff during trips off-site. These measures include maintaining an appropriate distance from wildlife, no feeding, maintaining low noise levels, minimising visual disturbance and no interference with wildlife behaviour	Operation	Site and client training Guide supervision
	Discourage presence of birds on site through appropriate management of the site, including appropriate and secure storage of food and litter within enclosed areas.	Construction Operation Maintenance	Training and regular inspections by site staff

Table 14.0 Outline Environmental Management Plan			
Potential Impact (with mitigation measures) Summary	Mitigation Measure	Phase	Monitoring/ Implementation
	Set a 2000m no fly zone around sensitive habitats of the wider study area, such as the Henrickson nunatak. This will need to be carried out in conjunction with the aircrew as part of the initial proving flights to the runway. This will ensure that aircraft approaches and departures , where potential impacts are greatest, are controlled	Detail design requirement Prior to operation	Project manager to ensure this is implemented at the next stage
Introduction of non-native species *Low risk with mitigation* *Can impact other regions in Antarctica*	Intercontinental aircraft are checked and treated as necessary where applicable to ensure they are insect free	Operation Maintenance	Regular inspections by site staff or crew
	Informing clients and training of site staff in relation to the risks associated with the introduction of non-native species to ensure awareness	Construction Operation Maintenance	Site, air crew and client training Guide supervision
	Check client luggage and cargo to ensure it is visibly clean of contamination	Operation	Regular inspections by site staff or crew Client training and pre-flight briefing
	Cleaning of foot-wear prior to departure and between sites within Antarctica	Construction Operation Maintenance	
	Decontamination measures for boots, clothing and equipment prior to arrival	Construction Operation Maintenance	
	Regular inspection of ground vehicles which are used off-site	Construction Operation Maintenance	

Table 14.0 Outline Environmental Management Plan			
Potential Impact (with mitigation measures) Summary	Mitigation Measure	Phase	Monitoring/ Implementation
	Monitoring measures and measures to be put in place in order to report any non native species found, early warning system would be implemented	Construction Operation Maintenance	Regular inspections by site staff and reporting by Operations Manager
Cultural Heritage	Prior to each operational season, the List of Historic Sites and Monuments will be consulted in order to ensure that there are no new listings located along the routes used to access the runway which should be taken into consideration	Operation	Project manager to ensure this is implemented at the next stage
Wilderness and Visual Amenity *Minor* *Local, only visible within immediate study area* *Seasonal Reversible as structures can be removed*	The overall footprint of the operational elements associated with the runway (transit accommodation, staff accommodation, materials, plant and equipment store) has been reduced as far as reasonably practical in order to reduce potential impacts on the wilderness and visual amenity of the wider study area. This has already been incorporated into the design of the site	Already integrated into scheme design	Project manager and project director to ensure this is implemented at the next stage
	No littering off site or on site through appropriate enclosed waste storage containers. In the event of accidental dispersal of litter it would be removed immediately	Construction Operation Maintenance	Regular inspections by site staff Client training and pre-flight briefing
Noise and Vibration *Low* *Temporary* *Local* *Seasonal*	Set a 2000m no fly zone around sensitive habitats of the wider study area, such as the Henrickson nunatak. This will need to be carried out in conjunction with the	Detail design requirement Prior to operation	Project manager to ensure this is implemented at the next stage

Table 14.0 Outline Environmental Management Plan			
Potential Impact (with mitigation measures) Summary	Mitigation Measure	Phase	Monitoring/ Implementation
	aircrew as part of the initial proving flights to the runway. This will ensure that aircraft approaches and departures, where potential impacts are greatest, are controlled.		
	Discourage presence of birds on site through appropriate management of the site, including appropriate and secure storage of food and litter within enclosed areas.	Construction Operation Maintenance	Regular inspections by site staff
	Plan traverse routes used to access the site during construction, operation and maintenance to avoid being within 1000 meters of designated ecological sites	Detail design requirement Prior to operation	Project manager to ensure this is implemented at the next stage
	Plan traverse route to avoid other non designated nunataks such as Henrickson Nunatak which may provide suitable habitat for birds as far as possible and remain at least 300 meters away from potential bird habitat, (unless require for health and safety reasons)	Detail design requirement Prior to operation	Project manager to ensure this is implemented at the next stage
	Ensure that there is no unnecessary idling of snow vehicles or plant to reduce noise levels	Construction Operation Maintenance	Regular inspections by site staff
	Maintain appropriate speed for snow vehicles on as well as off-site to reduce risk of bird strike from ground vehicles.	Construction Operation Maintenance	Operations manager to ensure this is adhered to by site staff Staff training
Local Air Quality *Minor* *Local*	Plan routes used to access the site during construction, operation and maintenance to	Detail design requirement Prior to operation	Project manager to ensure this is implemented at the next stage

Table 14.0 Outline Environmental Management Plan			
Potential Impact (with mitigation measures) Summary	Mitigation Measure	Phase	Monitoring/ Implementation
Temporary Atmospheric Emissions/Carbon Minor Global Longer term	avoid being within 500 meters of designated ecological sites		
	Preparation of Construction Logistics Plan to maximise efficiency in fuel-use and therefore reduce emissions and local air quality impacts	Detail design requirement Prior to operation	Project manager and project director to ensure this is implemented at the next stage
	When planning access route, avoid other non designated nunataks such as Henrickson Nunatak which may provide suitable habitat for birds as far as possible and remain at least 300 meters away from potential bird habitat, (unless require for health and safety reasons)	Detail design requirement Prior to operation	Project manager to ensure this is implemented at the next stage
	Ensure that there is no unnecessary idling of snow vehicles or plant to reduce emissions	Construction Operation Maintenance	Operations manager to ensure this is adhered to by site staff
	Regularly inspect and maintain vehicles , plant and equipment to ensure air emissions are appropriate	Construction Operation Maintenance	Operations manager to ensure this is adhered to by site staff
	Use of high specification incinerator The incinerator procured has been approved by DEFRA, has low energy consumption, and CE (low Nitrogen Dioxides (NOx)) certification. In addition, the average emissions are below the EU air quality standards (1/2 hour average is used in mg/m3) for incinerators in relation to total dust, nitrogen dioxide, sulphur dioxide and carbon monoxide, according to the	Operation	Already identified for use on site

Table 14.0 Outline Environmental Management Plan			
Potential Impact (with mitigation measures) Summary	Mitigation Measure	Phase	Monitoring/ Implementation
	emissions report36.		
Protection of Physical environment			
Waste Management	Implement Waste Management Strategy	Operation Maintenance	Project manager to design Operations manager to implement
	White Desert Environmental Policies	Operation	Operations manager to implement
Fuel, Oils and Materials Storage and Handling	Fuel, Oil and Materials Storage and Handling Plan	Operation Maintenance	Project manager to design Operations manager to implement
	Fuel and oil spill contingency plan and spill response strategy with measures	Operation Maintenance	Project manager to design Operations manager to implement
Tourism impacts associated with Whichaway Camp	All activities will continue to be undertaken under the supervision of trained guide	Operation	Guide supervision Subject to Audits as IAATO member
	White Desert Environmental Policies	Operation	Project Director
	Continue to raise awareness of clients prior to arrival in Antarctica in relation to sensitivity of the environment	Operation	Site and client training Guide supervision
	On-going training and awareness of new and existing site staff	Operation	Staff Training Operations manager
	Measures to minimise disturbance of wildlife during trips, including to maintain an appropriate distance from wildlife, no feeding, maintaining low noise levels, minimise visual disturbance and no interference with wildlife behaviour	Operation	Guide supervision Subject to Audits as IAATO member
	Measures to avoid disturbance of wildlife habitat, no trampling outside dedicated routes, all human waste and litter would be	Operation	Regular inspections by site staff Subject to Audits as IAATO member

[36] Top Load Waste Incinerator, Model I8-40A. Emissions data: http://www.inciner8.com/emissions-report.php

Table 14.0 Outline Environmental Management Plan			
Potential Impact (with mitigation measures) Summary	Mitigation Measure	Phase	Monitoring/ Implementation
	securely collected and taken off site, no removal of vegetation of stones		
	There are no new areas proposed for visits at this stage. Any future changes would require a separate assessment	Operation	Project Manager

13.2 Wolfs Fang Runway Operational Requirements

In addition to the environmental mitigation measures, White Desert would incorporate the following procedures and control measures into the safe construction, operation and maintenance of the Wolfs Fang Runway

13.2.1 General controls

- All activities are to be conducted in accordance with the Protocol on Environmental Protection to the Antarctic Treaty.
- Procedures for the conduct of the runway and aircraft operations will be developed to ensure that safety and environmental risks are minimised. These will be reviewed annually.
- All staff and clients participating in the activity will be educated on the potential impacts and controls relevant to their work.
- Records will be maintained of all activities undertaken each season, including the quantity of staff and material that is moved by or in support of the activity.
- Only the minimum quantity of personnel, stores and equipment necessary to support the client operation will be deployed to Antarctica.

13.2.2 Establishment of Runway

- The procedures to establish the runway will be monitored and documented.
- The movement of snow, ice or rock will be minimised as far as practicable. Only the minimum quantity of material will be disturbed and relocated as short a distance as possible to allow the runway to be established.
- Personnel and vehicle movement across the site will be limited to established routes.
- All construction and packaging wastes will be returned to Cape Town.

13.2.3 Operation of Runway

- Only essential staff will be accommodated at the runway.
- Emergency response capabilities will be maintained at the runway, including the capability to response to fuel spills. Annual exercises will be conducted with staff and this will include responding to a fuel spill.
- Fuel storage locations will be centralised and inspected/maintained on a twice daily basis.
- Snow berms will be battered as soon as practicable to a slope that does not cause windborne snow to accumulate in the lee of the berms.
- Incinerator ash, empty fuel drums and all solid waste will be returned to Cape Town.

13.2.4 Conduct of Flying Operations

- A training regime will be developed as a pre requisite for pilots flying in Antarctica for White Desert.
- Flight paths will be developed and adhered to for all movements to and from the Runway. All flight paths will not encroach within 1000m of any nunatak, ice free land, or open coastline.

- Circuits at the runway will be restricted to the Right Hand direction (clockwise) only.
- The runway will be restricted to Visual Meteorological Conditions.
- The runway will not be published in aviation navigational databases, publications or charts to discourage unauthorised use.
- Biosecurity procedures will be developed to ensure the introduction of foreign organisms on aircraft, people or cargo is minimised and monitored.
- Aircraft will undergo disinsectation treatments prior to the commencement of the summer flying program.

13.2.5 Changes to Client Numbers and movement Patterns

- Records of client numbers and movements will be maintained.
- Clients will be educated on the potential for environmental impacts and how they can be minimised.
- Procedures will be put in place to minimise the risk of introduced species to Antarctica. This will include equipment inspections and decontamination processes.

13.2.6 Records

The following records will be generated and maintained at the runway:

- operations log,
- detailed passenger and cargo manifests for all flights,
- logs of fuel consumption and waste incineration,
- logs of grey water disposal, and
- Metrological and wildlife observations.
- Photographic monitoring (camp site before and after) and compliance monitoring (including invited experts and IAATO audits) will take place.

14 Conclusion

14.1 Summary

Beneficial impacts

- Implementation of White Desert Environmental Policies to flight activities which are not currently under White Desert direct control
- Beneficial view of wilderness and natural landscape from the site for the visitors and users of the site
- Potential opportunity to remove redundant equipment from site will be investigated

Low risk

- Associated with bird strike and collision injury
- Disturbance of bird at the site caused by human presence
- Fuel and oils spills impacting on ice quality

Minor impacts

- Noise, vibration and local air quality impacts associated with traverse routes and use of ground vehicles, plant and equipment during construction and aircraft landing and take off
- Wilderness and visual amenity- introduction of human structures into a site that is currently disused but was previously used as a runway

Residual minor impact

- Atmospheric emissions associated with increased fuel use of aircraft
- Physical environment impact with increase in waste water volume

No impacts

- There are no ASPAS, ASMAS, or Historic Sites and Monuments which would be directly or indirectly impacted by the proposed activities at the Wolfs Fang runway

While the proposed activity has the potential to cause adverse environmental impacts the nature of the risks are well understood and controllable. The likely impacts of the proposal are “minor or transitory” in character and it is therefore recommended that that the activity proceed, in the manner described and with adherence to the identified measures for mitigation.

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16 Appendix I

Logistics and Traverse Plan
For the
Wolfs Fang Runway

For submission to the UK Foreign and Commonwealth Office

WOLFS FANG RUNWAY

Logistics and Traverse Plan May 2016

Author	**White Desert Ltd**
Date of Issue	May 2016
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17 Introduction

In response to the Final Wolfs Fang Runway IEE, submitted to the British Foreign and Commonwealth Office (FCO) on 21 April 2016. The FCO has sought additional information on the proposed logistic systems and associated over snow traverse. The aim of this document is to detail the proposed logistic system to support the runway. This will be as definitive as possible, however there remains some areas where definitive plans are not yet developed. This is primarily owing to uncertainties about the terrain, which must be traversed to conduct a resupply and the exact aircraft type that is to be used to access the runway. Where uncertainty exists, possible alternatives will be described or the procedures to determine the way forward have been described.

The description of the existing environment and baseline conditions, analysis of potential environmental impacts and mitigation measures relevant to the proposed logistic systems and snow traverse can be referred to in the Final Wolfs Fang Runway IEE report. This includes potential impacts associated with noise, vibration and local air quality, flora and fauna, cultural heritage and the physical environment.

The provision of services required for the logistic system and snow traverse is currently out to tender. For this reason, the information contained within the document is considered commercially sensitive and remains the property of White Desert Ltd. The information provided within this document is for information purposes to support the FCO consideration of the Wolfs Fang Runway IEE Report and is not intended for publication.

18 Demand Analysis

The physical resources required to support the runway includes food, spare parts, fuel and waste recovery. Estimates of demand have been calculated based on a future usage with aggressive utilisation assumptions. This is necessary to ensure that the logistic system can support the runway into the future, without the need for augmentation of expansion. Estimated demands are show below.

Table 1.

Estimate of Annual Resupply Demands

Commodity	Annual consumption	% of total
Foodstuffs	1380 kg	2 %
Consumables	68 kg	> 1%
Linen and clothing	140 kg	> 1%
Spares and rotables	150 kg	> 1%
Heavy oils	40 kg	> 1%
LPG	140 kg	> 1%
Avtur	30,000 to 80,000 l	97 %
Total packaged	**2 tons**	

items		
Total bulk fuel	**30 to 80 kl**	
Assumptions: 6 staff on site for client season (1 Dec – 18 Feb). 4 commissioning staff on site 10 days either end of client season. 10 client flights with 14 pax. 50% of flights result in two day stay at runway. Low fuel figure based on 7X aircraft. High fuel figure is based on 900LX aircraft.		

As can be seen from Table 1. The vast majority of resupply effort will be to deliver fuel. All other commodities make up a small fraction of the total annual resupply stock. The annual requirement for fuel is also presented as a wide range, from 30 to 80 kl. This due to the current uncertainty around aircraft type that will deliver clients to the runway. One aircraft being considered, at least initially, is a Dassault Falcon 900LX which will require to uplift fuel at the runway. A more preferable aircraft is the Falcon 7X, which will only require occasional fuel uplifts.

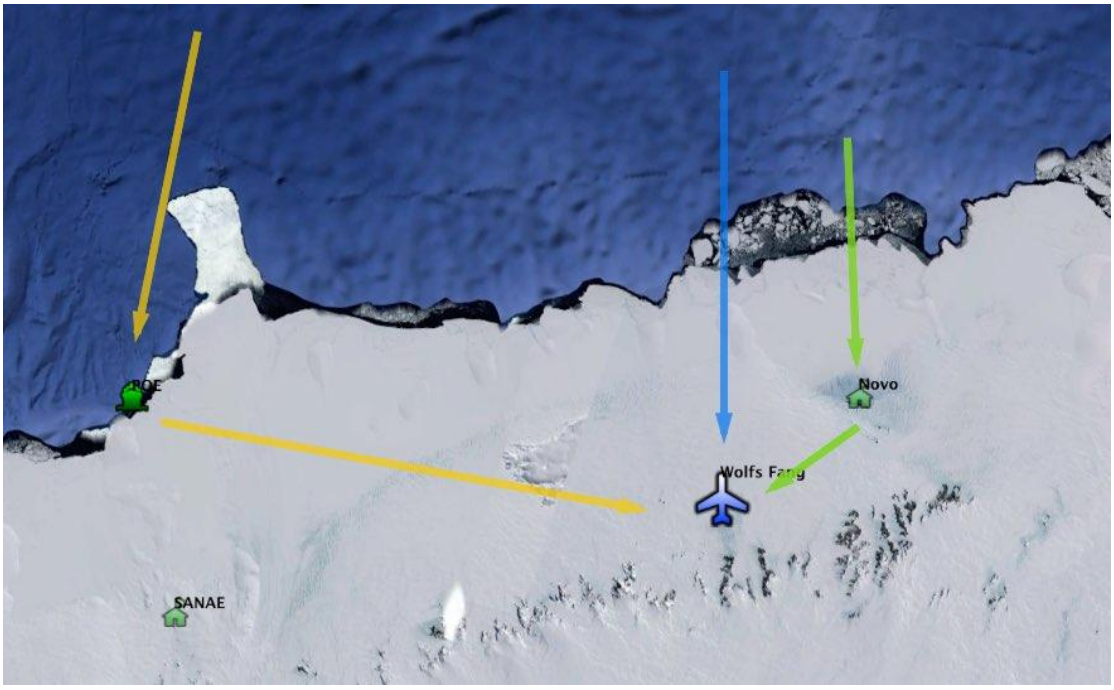
Wastes generated on site will be either incinerated or compacted and returned to Cape Town. It is estimated that once operating, the runway will produce 250 kg of waste for back loading each season.

19 Resupply Strategy

Resupply will be via three primary routes shown in Map 1.

Map 1.

Resupply Routes



Ship (In Yellow):

- Spare capacity on board the SANAP resupply vessel SA Agulhas II will be charted to access the continent.
- Cargo unloaded at RSA using the ships crane to load sledges.
- Two snow groomers (PB300) will traverse with four Lehmanns sledges to Wolfs Fang. The Traverse route is some 650-1000km depending upon the route.
- This route will be used for heavy cargo including the initial in load of equipment and the subsequent resupply of fuel.

Light Aircraft (In Blue):

- The Falcon aircraft operated by White Desert has the capacity to bring in up to 14 passengers or approximately 2000kg of stores.
- Once operational, this will be used to transfer staff at the ends of the season and small critical equipment items such as spare parts.
- During the season it will transport clients and small quantities of foodstuffs and spare parts items.

Heavy Aircraft (In Green):

- The IL-76 operated by TAC (ALCI) has capacity to bring in large items on an opportunity basis or via a dedicated charter. Equipment will then be transferred to the Wolfs Fang runway by light aircraft (Twin Otter) or a ground traverse of approximately 145 km.
- This will be used in 2016 to bring in the runway crew and some equipment to build the runway.
- Once operational, this service will be used to transport the cast majority of foodstuffs, spares, oils, gas, and the return of waste material.

19.1 Frequency of Resupply

All consumable items, except fuel, will be resupplied annually or as required.

Fuel will be resupplied using spare capacity on the SANAP program but the frequency will be dependant upon the rate of fuel consumption by the operation. This is largely a product of the aircraft type and the number of flights conducted.

Fuel storage in Antarctica will be approximately 110,000 litres. With the use of a Falcon 7X, this would necessitate a resupply frequency of every 3 and possibly 4 years. The high utilisation of a Falcon 900LX aircraft however would require an annual resupply.

20 Fuel Storage

A single fuel system is to be adopted whereby all machinery, so far as is possible, will run on avtur. This simplifies the handling of fuel and reduces the need to duplicate fuel handling equipment such as pumps.

Fuel will be stored and moved in bulk utilising two types of containers. 20' tanktainers will be used to establish a fuel storage depot in vicinity of SANAE IV. Fuel will be transported forward of this depot to Wolfs Fang in smaller Intermediate Bulk Containers (IBCs).
It is necessary to establish a fuel depot because it is not possible to traverse all the fuel and equipment from the ice edge to Wolfs Fang in a single season. Significantly, the traverse tractors are the same vehicles that are required to maintain the runway and so it is not possible for them to undertake multiple traverses during the season as they are required at the runway.

The establishment of a depot will enable the resupply of IBCs to occur independently of the timing of a resupply voyage in subsequent years. It also reduces the frequency of ship based replenishment into the future.

At each location where fuel is stored and during the traverse, sufficient ullage space will be maintained so that if a leak develops in a container, the container can be decanted into other containers at that site. The only exception to this will be the first 10 hrs of the traverse when all IBC's on the traverse will be full.

20.1 Fuel Depot

3x 20' 'tanktainers' will be used to store fuel in vicinity of SANAE IV. These have a capacity of approximately 26,000 l but will be restricted to approximately 20,000 l due to the weight limits imposed by the ships crane and to provide ullage space for decanting if necessary.

These containers are UN approved and are similar to those used by many national Antarctic programmes. The containers will be modified, so as to remove the foot and drain valves from the containers so that the only penetration are from the top of the container. This removed the potential for leaks as a result of a valve failure.

The location of the depot is yet to be identified. It will need to be flat, exposed to minimal accumulation and stable ie on grounded ice, free of crevassing.

The tanktaniers would be replenished by replacing them with new containers and the old containers back loaded as a part of a ship based resupply. It is envisioned that the ISO tantainers will be replaced with bunded versions at the earliest opportunity. At the time of planning for the deployment the only type of containers that could be sourced were either bunded/double walled or UN approved for transport but not both.

20.2 IBCs

A total of 36 IBCs will be used to transport fuel forward of the depot location to Wolfs Fang. These are to be stainless steel, UN approved containers with a capacity of 1500 l. Like the tank tainers, these will have all openings located on the top so that a valve failure cannot cause a leak.

These are to be used as they make good use of space on sledges while not overloading them. They can also be easily loaded and unloaded from the sledge using vehicle based cranes. These will be stored on traverse sledges or on timbers if being placed on the ground.

They will be full on initial deployment to Antarctic and can then be filled at the depot, via the 20' tanktainers, or via ship based tanktainers during subsequent resupply voyages.

Double walled IBC containers were discounted as they take up a significantly greater amount of deck space on a sledge. This would mean a reduction in fuel capacity per sledge from 18,000 l to only 10,000 l. This would significantly increase the frequency of resupply traverses. The double walled container do not provide an appreciable increase in protection from impact and miss handling hazards. As such, double walled IBCs were assessed as increasing the likelihood of a fuel spill in this particular application.

20.3 Fuel Type and Quality

As the fuel may be located in Antarctica for a number of years before consumption, ensuring the quality of the fuel is paramount. The avtur specification to be used is a variant of Jet A-1 with additional requirements to include no synthetic products, maximised anti-oxidants, and MDA dosing. These addition requirements will maximise the time the fuel can be stored and remain within the Jet A-1 specification.

FSII will not be added to the bulk fuel due to the negative impacts on fuel properties and the hazards of it remaining in Antarctic as a contaminate when discarded with water drains. FSII inline dosing equipment will be available on the discharge pumpset should it be required by aircrew.

A sampling regime is to be implemented to monitor the properties of each batch of fuel while in storage. Filtering equipment will be provided to enable stored fuel to be treated/conditioned if required. Fuel handling equipment will be dedicated to a given fuel type to avoid contamination.

21 Traverse Routes

Three traverse routes will be used to resupply the runway. These are summarised below:

Table 2.

Route Summary

Route	Start, Ends	Description	Use, Traffic
Novo – Wolfs Fang	Novo Runway, Wolfs Fang Runway	145km, which includes 40km of new route. Over the pleateau up to 1040m. No ice free land or protected areas.	Initial deployment of equipment to Wolfs Fang. One light groomer (PB100) and Hilux.
RSA Ice Edge – Depot	Point of disembarkation	170km. Predominantly over ice shelf (glacial ice)	Used each 1-3 years for ship based replenishment.

	of SA Agulhas II, Fuel depot (vic SANAE IV)	and then glacier to SANAE IV. Exact location of depot TBC. No ice free land or protected areas.	Approximately 2 trips each of 2 tractors and 4 sledges. Total of 6 sledges of fuel.
Depot – Wolfs Fang	Fuel depot (vic SANAE IV), Wolfs Fang Runway	500-900km depending upon route. See text below.	Used each 2-3 years. One trip of 2 tractors and 4 sledges. Initial traverse accompanied by light reconnaissance vehicles.

21.1 Novo to Wolfs Fang Runway

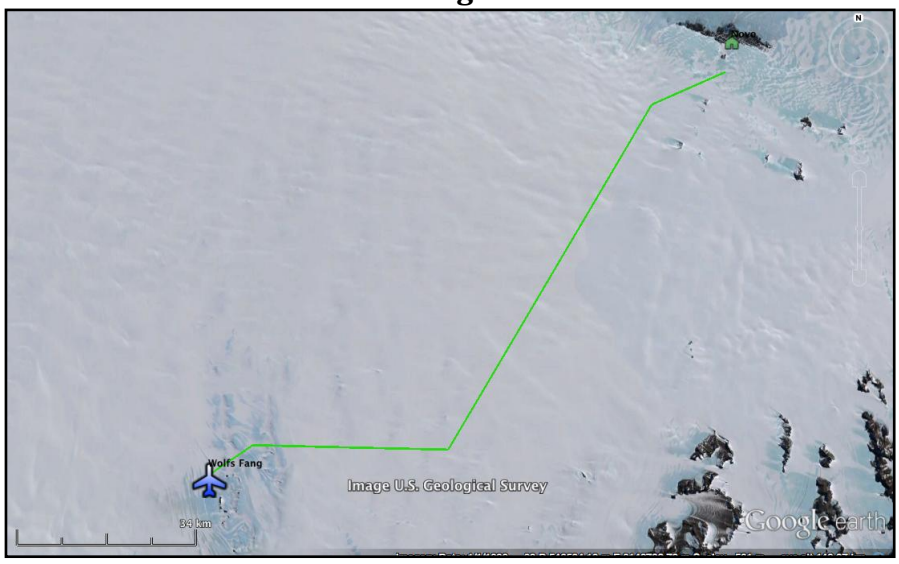
This route will be used to bring in vehicles and equipment during the initial construction phase of the first season. Subsequently it will receive little use due to the frequent flights between Novo and Wolfs Fang that have surplus capacity.

It is distance of 145km and for the most part is a proven route used by parties each year accessing the high plateau from Novo. The final 40km of the route is unproven and route finding will be conducted in 2016/17 to establish a safe route.

The closest the route comes to ice free land is where it terminates at Wolfs Fang. There are no specially protected areas along the route.

Map 2.

Novo to Wolfs Fang Traverse Route



21.2 RSA Ice Edge to Depot Location

This route will be used to bring in the fuel and material that is unable to be transferred to Wolfs Fang during the first season due to capacity limits on the traverse and time constraints. It will also be used to replenish fuel stocks at the depot by exchanging empty tanktainers with full ones as a part of resupply voyages each one to three years.

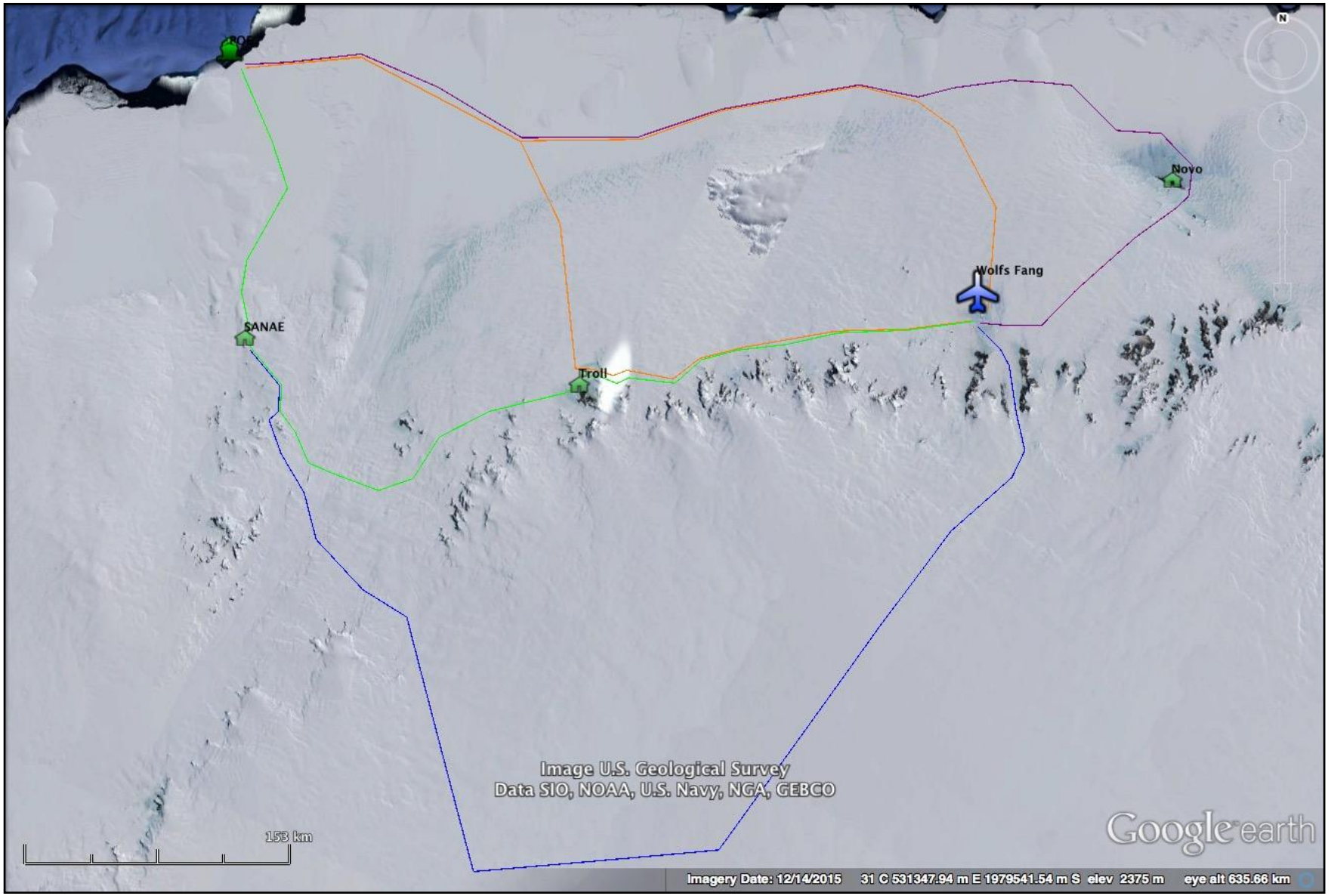
The route is used multiple times each season by SANAP with heavy vehicles and sledges. It is some 170km long and is generally well maintained. It is considered safe to transport bulk fuels.

21.3 Depot Location to Wolfs Fang Runway

The establishment of a safe, reliable and efficient route between the depot location and Wolfs Fang is essential and this is a key objective of the 2016/17 season for White Desert. Several broad route options are currently under investigation and these are shown below on Map 3.

Investigations of the routes will continue up to the deployment of the traverse team in December. For the 2016/17 season and separate reconnaissance team will investigate the route in detail and also lead the traverse.

Map 3. **Resupply Traverse Route Options**



21.3.1 Route South (Blue)

This route option uses known safe routes as far as possible. It is the longest at some 900km, all but 40km is on well proven traverse routes. Starting at SANAE IV it traverses south using the route used by both SANAE IV and Neumayer based expeditions to access the high plateau. It then links with the high plateau access route used by Novo based expeditions which passes within 40km of the Wolfs Fang Runway site.

This is the default route that will be used if shorter routes are not assessed as having an equivalent level of safety.

21.3.2 Route North (Purple)

This route has been planned to stay on the ice shelf for as long as possible before utilizing the Novo resupply route to access Wolfs Fang. The ice shelf is known to provide good traveling conditions. Crevassing is less common than on grounded ice. This is a long route at 730km and snow conditions during summer could be slow due to melt conditions at that time of year.

21.3.3 Route Troll (Green)

Light vehicles are known to have traversed between SANAE IV and Troll and from Troll to Tor some 90 km further East. This leaves approximately 250km of unknown route to reach Wolfs Fang.

Light vehicles will bridge hazards that a heavy traverse will not and so this route is not considered proven. It's proximity to the mountains is also likely to ensure that crevasse hazards are prevalent. Despite these concerns further investigation is of this route warranted.

This route will take into consideration the location of the Svarthamaren ASPA and the required mitigation measures set out in the Wolfs Fang Runway IEE Report.

21.3.4 Route Hybrid/Direct (Orange)

This route makes use of the ice shelf to progress Eastwards from the RSA unloading point. Opportunities to climb off the ice shelf onto the plateau are know to exist where the Norwegian Programme resupply Troll Station. They are also likely to exist further to the East before Novo. Routes across the plateau to Wolfs Fang would then need to be found.

This would be the shortest and most ideal route. The challenge in investigating this route is that there is such a large area to investigate. Information on

previous heavy traverse in the region is required and is currently being investigated.

This route will take into consideration the location of the Svarthamaren ASPA and the required mitigation measures set out in the Wolfs Fang Runway IEE Report.

22 Conduct of the Traverse

There will be three teams undertaking traverses for the 2016/17 Season:

- The Reconnaissance Team
- The Heavy Traverse Team, and the
- Light Traverse Team.

The purpose of splitting the work force into two teams is to enable runway preparation (Light Team) to occur concurrently to the main traverse (Heavy Team). This takes the time pressure of the Heavy Team and gives them the best chance of finding a safe and efficient traverse route.

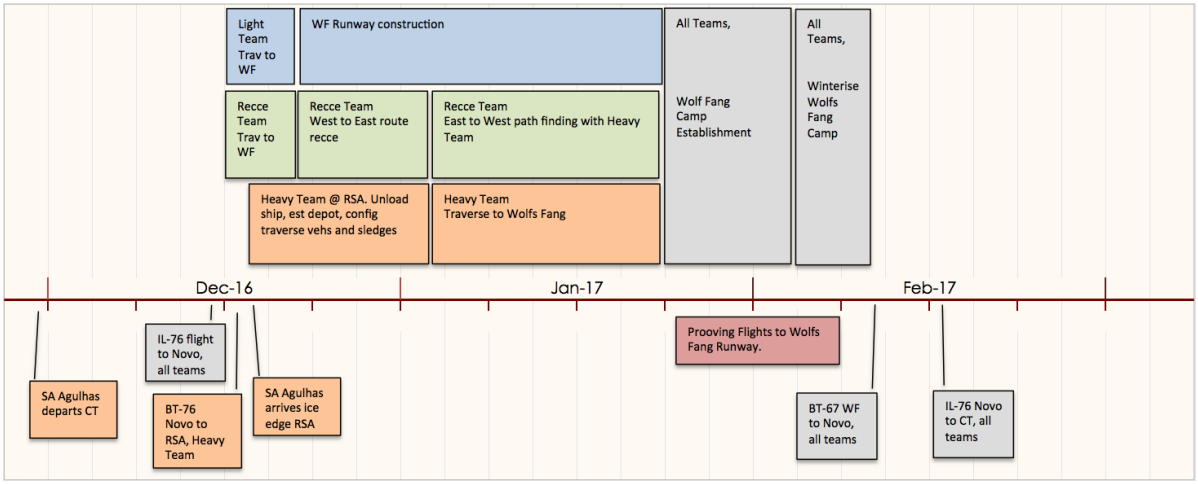
The bulk of both teams will arrive at Novo aboard the TAC 1 flight on 14 December.

The Heavy Team will then fly to the ice shelf unloading point to meet the S.A. Agulhas II. The Heavy Team will spend the next 10-14 days assisting with the unloading of tractors, sledges, fuel and equipment. They will establish the depot, and configuring the sledges and vehicles for the traverse to Wolfs Fang.

Concurrently, the Recce and the Light Team will traverse to Wolfs Fang. The Light team will remain at Wolfs Fang for the remainder of the season and undertake runway construction. The Recce Team will undertake a reconnaissance of the traverse route between Wolfs Fang and the depot. They will rendezvous with the Heavy Team around the end of December and commence the Traverse back to Wolfs Fang.

A time line of the major activities is shown below in figure 1.

Fig. 1 **2016/17 Season Activities**



22.1 Vehicle and Staffing composition

The Heavy Team will comprise:

- 1x traverse leader, 1x mechanic, 2x plant operators.
- 2x tractors- PB300 Polar vehicles, fitted with cranes and recovery equipment. These are newly reconditioned vehicles being delivered aboard the S.A. Auglhas II.
- 4x Lehmann sledges.
- Cargo:
    - 2x 20 GP Iso containers (runway equipment and spares)
    - 16x Fuel IBCs (24,000 l).
    - Beam sledges, ATVs and tillers.

The Recce Team will comprise:

- 1x team leader, 1x GPR operator, 2x drivers.
- 2x Arctic Trucks ' Hilux' vehicles with trailers. One vehicle is fitted with Ground Penetrating Radar.
- Cargo fuel, tools, spares and camp to remain self sufficient for duration.

The Light Team will comprise:

- 1x runway manager, 1x deputy manager, 1x mechanic, 1x operator.
- 1x tractor- PB 100.
- 2x light sledges (poly sledge)
- Cargo:
    - Tiller
    - 3200 l drum fuel.
    - tent camp for the team.

22.2 Route finding

Route finding for the traverse will occur in 4 phases.

22.2.1 Data Collection

This phase aims to establish the extent of any past expeditions that has successfully travelled the routes of interest. It involves the review of existing data sets, such as those maintained by National programmes, as well as by speaking to past expeditioners.

Also during this phase, a review of the space based data, including both optical and radar imagery will be undertaken. The aim of this search is to locate areas where there is sufficient data to support further analysis.

This phase will conclude with a prioritised list of route options and priorities list of geographic areas for spaced based data analysis. This is planed to conclude by the end of July 2016.

22.2.2 Space Based Data Analysis and Map production

The analysis is to be undertaken by the Thurigian Institute for Sustainability and Climate Protection (THink). THink will use space based data to assess areas of likely hazards, such as crevassing and melt streams. This is likely to be very targeted and key areas along the proposed routes. THink will also produce maps of the route identify topographical features that can assist with crevasse identification such as shear zones and convex slopes.

These maps will inform the Recce Team and allow a final prioritisation of proposed routes. This is expected to occur by the end of November 2016.

22.2.3 Reconnaissance

Arctic Trucks will form the basis of the Recce Team. They will deploy to Antarctica through Novo in early December and then accompany the Light Team to Wolfs Fang. From Wolfs Fang, the Recce Team will have approximately two weeks to investigate the proposed route for the Heavy Team. This will be conduced from light wheeled vehicles.

The objective of the Reconnaissance is to validate the prioritised route option, to provide greater resolution of the route (generation of detailed waypoints) and to identify any hazards.

The Recce team is planed to meet up with the Heavy Team at depot site near SANAE IV around 3rd January.

22.2.4 Route Finding.

The Recce Team will then lead out the Heavy Team, moving in front of the snow groomers, for the traverse back to Wolfs Fang. The Recce Team will use a GPR

where necessary and mark safe routes through any areas of uncertainty. The traverse will mostly drive through the 'night' when sun angles are lower providing better visibility of micro relief features.

The traverse is expected to take 17 days but the programme allow for up to 5 weeks of traversing.

22.3 Timing and fuel usage

Estimates for fuel consumption and traverse timings are provide in Table 3 below.

Table 3.

Traverse Resource Estimates

Route	Timings	Fuel Used	Comments
Novo – Wolfs Fang	145km in Total (105km know route @ 12kph = 9 hrs 40km unknown route @ 5kph = 8 hrs) 17 hrs driving or 2 day.	580 l (@ 4 l/km)	Depart with 3200 l End with 2600 l.
RSA Ice Edge – Depot location	170 km one way. 340 km round trip is 28 hours driving or 3 days.	4800 l (@ 7 l/km)	Start with 114,000 l End with 85,200 l.
Depot location – Wolfs Fang	900 km one way. 90 hours or 12 days.	12,600 l (@ 7 l/km)	Depart with 24,000 l End with 11,400 l.

22.4 Contingency plans and recovery

As a principle all aspects of the traversing operation will planned to be self sufficient. These means that fuel, spares, food, communications equipment, medical equipment, and the vehicles, will be prepared for the worst conditions that could reasonably be expected at that time of year. It is not however possible to be prepared for all eventualities. Be it a case of acute appendicitis or unseasonably severe melt conditions, there are some conditions that are best addressed by contingency plans. Detailed contingency plans will developed ahead of the deployment however an outline of key contingency plans follow.

22.4.1 Evacuation and Medical

Airborne search and rescue coverage of the activity will be provided by TAC (ALCI) and their fixed wing aircraft. Should it be necessary, it is possible to

recover the team and extract them to Novo. Snow groomers are available on all traverses to prepare a skiway is suitable terrain is not naturally available.

Evacuation from Novo to Cape Town can be facilitated via ALCI's IL-76 or by private charter. An aircraft will be on standby for proving flights from mid-January, which could fulfil this role.

Medical capabilities will include deep field first aid and trauma kits that are located with each group. Each group will have, as a minimum, one wilderness first aid qualification. A Doctor is located at White Desert's Whichaway camp and paramedics are available at TAC/ALCI. Doctors and limited medical facilities are also available at Novo and Matri stations.

22.4.2 Traverse Delays

The timing allocations for the traverse are not ambitious and a three week contingency is available in the program if required, however if excessive melt or mechanical issues waylay the traverse it is possible to overwinter the vehicles and sledges and recommenced the following summer.

Lay up areas will be identified that are free of crevassing. Vehicles and sledges will be parked on a low snow berm and prepared for winter. As there is no sea ice along the route this will not present any new risks to the project, but it will come at a delay and financial cost.

22.4.3 Fuel spills

Fuel spills are perhaps the most significant incident that may occur during the project. This risk is being reduced by the use of steel, UN approved, containers that only have valves and penetrations on the top. There is no potential for valves to leak.

Additionally, the IBC's carried on the traverse can be unloaded individually by crane should the fuel sledge become stuck in a crevasse. The traverse will carry a snow melter and a water filter separator to remediate any snow contaminated by a fuel spill. This system (Mohr Separations Research, MSR12) has been calculated to be able to remove fuel to less than 6mg/l under realistic Antarctic conditions.

An IBC spill (up to 1500l) could be remediated in approximately 5 days if it occurred on snow covered ice. On deep firm, such a clean-up is expected to take up to 3 weeks. Spills larger than 1500l will be contained and clean up activities planned for the following season with additional equipment.

22.4.4 Crevasse Rescue

All team members will be training and refreshed in glacial travel and crevasse rescue. Industrial rope access equipment will be carried on each traverse to effect a crevasse rescue.

All new traverse routes will be explored by the Recce Team in advance of the heavy vehicles. The Recce Team is equipped with a GPR to investigate any areas of uncertainty.

Heavy vehicle recovery equipment including anchors, hydraulic winches, blocks, dynamic straps etc will be carried by each traverse.