

# King Edward Point Wharf Redevelopment Project

## Environmental Impact Assessment



***BAS Environment Office***

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British Antarctic Survey

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**British  
Antarctic Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

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## Non-Technical Summary

### *Introduction*

This Environmental Impact Assessment (EIA) has been prepared by the British Antarctic Survey (BAS) to assess the potential environmental impacts associated with the construction works and operation of the facilities associated with the proposed King Edward Point (KEP) wharf redevelopment project. Over the next few years, the Antarctic Infrastructure Modernisation Programme (AIMP), funded by the Natural Environment Research Council (NERC), will transform how BAS research stations enable and support science in Antarctica and South Georgia.

The KEP wharf redevelopment project is the second AIMP funded project to take place in South Georgia, after the recent Bird Island station development project completed in 2018. BAS have appointed the civil engineering company BAM as their construction partner to deliver this project.

This EIA has been prepared following an EIA Scoping Exercise based on the European Commission Guidance on EIA Scoping (EC, 2001) and in accordance with the EIA Guidelines (ATS, 2016) prepared by the Committee for Environmental Protection (CEP).

### *Description of proposed development 1 - KEP Wharf and Associated Structures*

The existing wharf at KEP is over 30 years' old and showing signs of degradation and the slipway which supports the small boat operation is in a deteriorating condition and currently only supports the launching and removal of boats during spring tides. In addition, NERC have commissioned the construction of a new ship the Sir David Attenborough (SDA), which is a much larger research vessel than the current BAS ships, and in order for it to continue providing logistical support to the station, it will require a deeper and longer wharf at KEP. The mooring and berthing forces of the SDA will also be much higher and therefore the structural elements of the wharf will need strengthening.

The proposed solution at KEP involves retaining the existing wharf and extending it with a wraparound structure (widened by approximately 1m on each side and lengthened by 3m) with two new mooring bollards on the wharf and three new shoreline mooring points. A dolphin (a standalone, marine structure above the water level) with a mooring bollard will also be built to the south of the wharf to provide a fixed structure which will extend the berthing and mooring capabilities of the design. In addition, a new extended slipway into deeper water is also proposed.

The design of the extended wharf and dolphin is similar to the existing wharf structure and will be constructed by driving metal sheet piles into the seabed to form the external walls of the structures. The interior of the structures will be filled with locally sourced aggregate. The proposed construction should be completed in a single summer season in 2019-2020. Some minor preparatory works would start in November but full construction would start in late January with completion scheduled for June 2020.

### *Alternatives*

The 'do nothing' and 'do minimum' options were evaluated but would not enable safe and efficient berthing and mooring of the SDA so were rejected. A number of alternative designs were considered, including demolishing and rebuilding the existing wharf and rebuilding the wharf in a new location, but these were rejected due to cost, logistics, safety or environmental constraints.

### *Description of proposed development 2 – Quarrying for local rock*

Aggregate is required to fill between the new and existing walls of the wharf, and to provide fill for the mooring dolphin and slipway extension. In order to provide the fill material required for the KEP wharf extension, it is proposed to quarry rock from King Edward Cove. The proposed quarry location is on the track between KEP and Grytviken whaling station. Approximately, 10,412 tonnes (or 4,732 m<sup>3</sup>) needs to be excavated from King Edward Cove in order to produce the approximate required 5,727 tonnes (or 2,603 m<sup>3</sup>) of graded rock material for completion of the project.

The quarrying activities will involve excavation of material, screening to filter out the grades of material needed and potentially some crushing of larger pieces of rock (prior to screening). The processed material will be loaded into trailers and transported to the construction site where it will either be stored temporarily or used immediately for filling of the wharf structures.

#### *Alternatives*

Importation of aggregate from outside South Georgia was considered and rejected due to the increased biosecurity risk of the aggregate including non-native biological material such as soil, seeds, invertebrates and other propagules. Sourcing the aggregate from different locations in South Georgia was also considered but these were rejected due to a number of factors including: risk of spreading already established non-native plants, insufficient yield of the sites, greater haulage distance or difficulties in accessing the locations.

### *Description of the Support Activities*

Cargo, plant and equipment required for the KEP construction work will be transported to KEP on a commercial charter vessel at the start of the construction programme. The same charter vessel will return at demobilisation to remove construction equipment, plant and vehicles and to remove construction waste for appropriate disposal in the UK. Construction personnel (and supporting staff) will be deployed to KEP by BAS and GSGSSI logistics vessels. All cargo and personnel input to KEP will meet all necessary biosecurity precautions to prevent the introduction of non-native species.

All project personnel will be housed in existing accommodation at KEP. Fuel for powering plant and vehicles for construction activities will be provided by BAS and is already on site and stored within the existing station fuel storage. Water, electricity and sewerage for domestic use by project personnel will be provided by existing BAS services.

### *Description of the Environment*

King Edward Point (KEP) station has been used operationally since 1912. Originally, an administrative post for regulating the whaling industry it has been managed as a research station by BAS from 1969 - 1982 and again from 2001 to the present day.

KEP lies at the entrance to King Edward Cove, a small sheltered bay within Cumberland East Bay on the northern coast of South Georgia. It is an area of flat land at the head of the cove surrounded by mountains and cliffs on all sides rising steeply to an altitude of about 500m. The former whaling station at Grytviken lies about 750 m to the west of the KEP connected by a narrow track.

The environment within King Edward Cove is rich in biodiversity similar to other areas of mainland South Georgia. The dominant plant at KEP is tussock grass and where it has been damaged by seals there are also areas of bare hummocky ground. Vegetation along the track and near the cliffs is sparse. Some larger areas of flatter wet ground are dominated by grasses and mosses near Grytviken.

Several species of birds breed in the general area around KEP and Grytviken. Light-mantled albatross and white-chinned petrels can breed in nests or burrows in high ground away from buildings. Small petrels may breed in the slopes along the track and South Georgia pintail ducks can breed in the tussock grasses in King Edward Cove. Antarctic terns breed around Gull Lake and behind Grytviken. Non-breeding birds are also present throughout the seasons including King and Gentoo penguins, foraging in shallow waters on shorelines or resting on the beaches.

Elephant and Antarctic fur seals breed at King Edward Cove. Elephant seals breed on the flat grassy area on the seaward side of KEP station from August to September with weaned pups leaving the area in late January. Fur seals breed mainly on the southern side of the Cove but also near KEP station. Fur seal pups begin entering the waters during January and are weaned by late March.

Several species of fish are known to inhabit the waters of King Edward Cove. In the shallow waters closest to King Edward Cove rock cod such as the marbled rock cod (*Notothenia rossii*), humped rock cod (*Gobionotothen gibberifrons*) and the black rock cod (*Notothenia coriiceps*) are the most commonly encountered fish.

Rats and mice were introduced to South Georgia by the early sealers and whalers intentionally introduced reindeer. Following island-wide eradication efforts, South Georgia was declared free of invasive mammals in May 2018. However, up to 41 species of non-native plants have also been introduced to South Georgia through human activities. Several different species of non-native plant are established in the area of Grytviken but the dominant non-native plant species at KEP is bittercress. The GSGSSI is managing non-native plants through an active weed eradication programme. In addition, several non-native invertebrates have been introduced to South Georgia over the years it has been inhabited but no eradication measures have yet been attempted.

Recent site investigations at KEP discovered hydrocarbon contamination in the ground within the existing wharf and in the locations of the proposed wharf mooring points. The contamination is historic and is thought to have resulted from pollution incidents that occurred prior to 1985 when KEP was occupied by a British Military garrison.

### *Impact Identification & Mitigation*

A full assessment of the potential environmental impacts is included within this EIA. Most of the predicted impacts will be minimised by implementing existing BAS procedures or with the addition of specific mitigation and monitoring. The most significant potential impacts predicted are:

- Introduction of non-native species
- Spread of already established non-native species
- Removal of rock resulting in change in topography and aesthetics of King Edward Cove
- Loss of marine benthic habitat
- Loss of terrestrial nesting habitat
- Disturbance to wildlife from noise and physical interaction with construction activities
- Terrestrial or marine pollution from existing hydrocarbon contamination

The introduction of non-native species (and in particular rodents which have recently been eradicated) through importation of cargo and deployment of personnel could have a significant impact in the long term, but these impacts can be mitigated against through normal and enhanced biosecurity measures.

The extension of the wharf and slipway and construction of the dolphin will cover and destroy a small area of the marine benthic habitat. Alternative designs that affected larger areas of the seabed have been rejected. A survey of the benthos will be carried out post-construction works to evaluate the degree of change to the marine benthic community.

A small area of tussock grass will potentially be lost at the quarry site through excavation works to produce local fill material. The tussock and topsoil will be removed prior to any works and replanted after completion of the quarrying works. If it survives then the nesting habitat will be preserved.

Disturbance or harm to marine mammals on land and in the water from noise produced by vehicles and piling activities and by physical interaction with vehicles could result in avoidance behaviour, hearing damage or injuries. However, the mitigation measures outlined will be adhered to, to ensure the risk of this occurring is minimised and avoided wherever possible.

Piling activities may increase the risk of existing historic hydrocarbon contamination being released to the marine environment. However, this will be mitigated against by using precautionary spill response equipment to contain and collect any released oil to the water in the areas of operation during piling activities. Excavation of the ground on the shoreline in the areas of hydrocarbon contamination will be avoided wherever possible. However, if excavation of small quantities of ground is necessary to remove obstructions during piling activities then the excavated material will be contained in a bund and then returned to its location once the obstacle has been removed. Staff and vehicles will use suitable spill response equipment and ensure it is disposed of appropriately, if contaminated.

The most significant potential impact, which will lead to permanent change, is the removal of rock for use in the wharf redevelopment. This will potentially alter the aesthetic value for King Edward Cove. However, the decision to quarry locally at KEP was influenced by the need to reduce the risks associated with the importation of large quantities of aggregate that have the potential to introduce non-native species.

### *Monitoring & Audit Requirements*

A monitoring plan has been produced which defines the monitoring activities to be undertaken during the project. Monitoring activities fall into three different categories:

- Short-term monitoring - activities which could result in an immediate impact on the environment and can be modified during the construction period to reduce or eliminate the negative impacts.
- Long-term monitoring - activities which could result in long-term impact and are unlikely to be modified during the construction period.
- Environmental management activities – these will be undertaken by the construction partner throughout the construction period and the findings reported to the BAS Environment Office on completion of the project.

The BAS Environment Office will undertake an audit during the construction works to ensure the actions and mitigation measures committed to in the EIA are being adhered to.

### *Gaps in Information & Uncertainties*

The information provided in this EIA represents the 65% design stage. Over the next few months, the design will be refined and finalised and some minor changes are expected. However, the overall environmental impacts identified are not anticipated to change.

The detailed site set up at KEP during the construction period has not yet been decided and identified. Further discussions are required to finalise the detailed storage of locations of plant, equipment and containers.

Changes in logistics and changes related to weather conditions may impact the final construction programme. However, 2 weeks demurrage has been included in the construction programme to deal with unexpected delays.

The quantity of material that needs to be excavated from the quarry site at KEP cannot be confirmed accurately as it will depend on how much material needs to be crushed and screened to produce the required quantity of graded fill material. Therefore, the final landscaped profile of the quarry site cannot be accurately assessed until the volume of excavation is known.

Scour protection of the seabed from the SDA operation has not been included in the design of the wharf. Instead, the development of scour will be controlled through restricting engine power of the SDA during berthing operation. Scour development will be monitored over the next few years and, if required, scour protection of the seabed will be installed at a later date.

### *Conclusion*

Having completed a full EIA it is considered that the majority of the potential impacts will be successfully minimised as long as the mitigation measures are implemented successfully. It is also acknowledged that some activities will have a greater impact than others with a longer-term effect. However, the environmental impacts are considered acceptable considering the significant operational and scientific advantage that will be gained as result of the completed project.

## 1. INTRODUCTION

This Environmental Impact Assessment (EIA) has been prepared by the British Antarctic Survey (BAS) for the proposed wharf redevelopment project at King Edward Point (KEP) Research Station at South Georgia. The EIA covers the construction works and the operation of the new facilities.

The facilities at KEP are owned by the Government of South Georgia and South Sandwich Islands (GSGSSI) and are operated by BAS. Scientific research has been undertaken at KEP since 1924 with BAS leading on science since 1950.

The aim of the redevelopment is to upgrade the existing wharf facilities at KEP to allow for safe berthing of vessels, efficient transfer of cargo and to extend the design life of the wharf by 50 years. In addition, the facilities for launching and mooring small boats will also be improved.

The BAS construction partner appointed to the project delivery is BAM who is partnered with design consultants Sweco UK and Delta Marine Consultants (DMC). The technical adviser role is covered by the engineering consultancy Ramboll.

### 1.1. Background to Project

The Natural Environment Research Council (NERC) has commissioned the construction of a new polar research vessel, the RRS *Sir David Attenborough* (SDA), to replace the two existing British polar ships, the RRS *Ernest Shackleton* and the RRS *James Clark Ross*. Operated by the British Antarctic Survey (BAS), it is anticipated that the SDA will be ready for use in the 2020/21 season. Alongside the SDA, NERC has also commissioned the Antarctic Infrastructure Modernisation (AIM) programme to transform how BAS research stations enable and support science in the Southern Ocean.

At KEP, the AIM programme will upgrade the existing wharf and mooring facilities to ensure the continued logistical support of the station by the SDA.

### 1.2. Overview of Proposed Development

#### 1.2.1. KEP Wharf

Although, BAS is moving from a two vessel to a single vessel operation it is still required to support the same number of research stations, personnel and logistical activities and continue to provide high quality science. As such, the SDA has been designed as a much larger ship to provide cargo capacity similar to the combined capacity of the ES and JCR and to provide better science capability than the JCR currently offers. The larger SDA will have an impact on the requirements for marine infrastructure and cargo storage at all the BAS research stations in Antarctica and South Georgia. This means that the current wharf at KEP is not currently fit for purpose and needs to be upgraded as part of the AIM programme.

At KEP the SDA will require a greater depth of water at the quay side than is currently available in order to allow for safe operations. The mooring and berthing forces on the existing wharf from the SDA will also be much higher and therefore the structural elements of the wharf will need to be strengthened. The wharf needs to be upgraded and extended, widthways and lengthways into deeper water.

#### 1.2.2. KEP Slipway

The existing slipway is in deteriorating condition and currently only allows launching of boats in spring tides. An upgrade and extension of the slipway is required to secure the future of the KEP



small boat operation and to allow for easy retrieval of boats for maintenance works and launching as required.

### 1.2.3. Sourcing rock fill material

In order to provide the fill material required for the KEP wharf extension, it is proposed to quarry rock from King Edward Cove. Approximately, 10,412 tonnes (or 4,732 m<sup>3</sup>) needs to be excavated from King Edward Cove in order to produce the approximate required 5,727 tonnes (or 2,603 m<sup>3</sup>) of graded rock material for completion of the project.

### 1.3. Purpose and Scope of Document

The purpose of this EIA is to provide sufficient information on the KEP wharf redevelopment project to allow the GSGSSI to make an informed judgement on the possible environmental impacts of these activities on the South Georgia environment and whether or not they should proceed. The scope of this document covers the works required as part of KEP wharf redevelopment project and its directly associated logistics.

The document has been split into the following sections

- Section 1 provides an introduction
- Section 2 provides the approach to the environmental impact assessment
- Section 3 describes the proposed development of KEP wharf, the slipway, the dolphin and walkway and the mooring points. Detail is provided on the need, scope, location, design, construction methodology, materials, vehicles and plant and personnel involved in the project.
- Section 4 describes the proposed excavation to produce fill material for the wharf and associated structures. Detail is provided on the need, scope, location, design and methodology.
- Section 5 describes the non-construction operational procedures: fuel and waste management and biosecurity measures.
- Section 6 describes the supporting activities required for the project to be implemented.
- Section 7 outlines the overall construction programme
- Section 8 describes the current site and its existing operation
- Section 9 outlines the current baseline environmental information
- Section 10 identifies the potential environmental impacts and proposes mitigation measures
- Section 11 presents the impact assessment methodology and results
- Section 12 details the proposed monitoring and audit requirements
- Section 13 identifies gaps in information and uncertainties
- Section 14 sets out the conclusions of the assessment

A summary has been included at the beginning of this document to provide an overview of the EIA in a clear, concise and non-technical manner as well as to outline the conclusions reached.

## 2. APPROACH TO ENVIRONMENTAL ASSESSMENT

### 2.1. Statutory Requirements

South Georgia & the South Sandwich Islands (SGSSI) is a self-governing British Overseas Territory. Legislation is the responsibility of the Commissioner for SGSSI, who makes laws in the form of 'Ordinances' (primary legislation) and in the form of 'Orders and Regulations' (secondary legislation).

#### Wildlife and Protected Areas Ordinance Permits (WPA)

The WPA Ordinance is a GSGSSI law enacted in 2011 and provides a legal basis for the environmental policies. Under the Ordinance it is an offence to wilfully or carelessly introduce non-native species, to handle or harm any flora or fauna or conduct activities that are likely to result in damage to habitats. Permits issued under the WPA are required for any activity undertaken within the Territory that may cause damage to the biodiversity of the Territory.

#### Environmental Impact Assessment (EIA)

GSGSSI is committed, under the National Biodiversity Action Plan (NBAP), to ensure that environmental impact assessment is undertaken where necessary and for this to involve consultation with appropriate independent experts. The GSGSSI regulates all activities undertaken in the Territory through issuing Regulated Activity Permits (RAP) or visit permits for tourism activities. The RAP application incorporates the EIA process and it identifies the need for any additional permits to be issued under the WPA Ordinance.

There are three levels of RAP application. Which level is completed depends upon the complexity of the project and its likely impact on the environment:

- Category 1 and Category 2 projects are considered to have a low impact on species and habitats and are logistically simple to support. RAP Category 1 and 2 projects are required to complete a standard application form that is assessed by the GSGSSI Environment Officer. The majority of science, logistics and media projects undertaken in SGSSI fall under the definition of a Category 1 or 2 project.
- Category 3 projects fall outside the scope of Category 1 or Category 2, may be logistically more complex to support and may be considered to have a more significant and long-lasting impact on the environment. GSGSSI does not define a formal RAP process for Category 3 activities as each activity is assessed on a case by case basis.

The KEP wharf redevelopment falls under the definition of a Category 3 RAP project because the works are not permissible under Category 1 or 2. As such, the project requires a bespoke EIA in consultation with the GSGSSI. The EIA process for this project (as seen in the figure below) was agreed in consultation with GSGSSI in two stages involving an initial scoping document (already submitted and approved) and the final EIA submission which is represented by this document.

	Jun 18	Jul 18	Aug 18	Sep 18	Oct 18	Nov 18	Dec 18	Jan 19	Feb 19	Mar 19	Apr 19	May 19	Jun 19	Jul 19	Aug 19	Sep 19	Oct 19	
<b>Phase 1: EIA scoping document preparation</b>	■	■	■	■	■													
▪ Stakeholder comment and external review						■	■											
▪ BAS response to comment as needed							■	■										
▪ In principle permission agreed									■									
<b>Phase 2: Full EIA Preparation</b>									■	■	■	■	■					
▪ Stakeholder comment and external review														■	■			
▪ BAS response to comment as needed															■	■		
▪ Regulated Activity Permit Issued																■	■	
	■ BAS																	
	■ GSGSSI																	

Figure 1. EIA programme and timeline

## 2.2. EIA Methodology

The approach taken when compiling this EIA involved:

- i) Reviewing the initial scoping document and feedback from external reviewers to help shape the final EIA (represented by this document) and;
- ii) Following the Environmental Impact Assessment Guidelines (ATS, 2016) prepared by the Committee for Environmental Protection (CEP).

### Scoping Document

An EIA Scoping document was prepared by BAS in October 2018, circulated to external reviewers and a final version approved by GSGSSI in January 2019. The scoping document focussed on identifying and assessing the key potential environmental impacts as considered during the early stages of the project. A scoping checklist template was used based on the European Commission Guidance on EIA Scoping (EC, 2001) which posed a number of questions that helped to identify potential project activities and the ways in which they could interact with the environment therefore potentially causing an impact. The scoping checklist also helped to determine whether the interactions with the environment were likely to be significant and proposed potential alternatives or mitigation measures for each significant impact. The key significant impacts identified by the scoping exercise are summarised in Section 10.1.1 and are reassessed as part of the impact identification and assessment in this EIA (as detailed in Sections 10 and 11).

The Scoping document also helped determine the content and extent of the environmental baseline information required for inclusion in the EIA. The Scoping document also identified the following gaps in information which have been addressed as part of this EIA document:

- Environmental surveys to collect data on breeding bird locations, non-native species and aesthetic values
- Site investigation of the proposed quarry sites

- Site investigation of the proposed mooring points
- Site investigation to carry out geophysical survey of the wharf area
- Noise assessment for construction activities

### *ATS EIA Guidelines*

The ATS EIA Guidelines provide advice and recommendations on appropriate document structure as well as methodologies for identifying and evaluating impacts. These have been followed in preparing this document, wherever possible.

Other previously published EIAs for projects in South Georgia and Antarctica have also been used as sources of information on potential environmental impacts, methods of assessment and appropriate mitigation measures.

The purpose and need for the proposed project activities and a description of the design and construction of the KEP wharf and associated quarrying are described in Sections 3 and 4. Design and construction details have been provided by the Construction Partner BAM and the Technical Advisor, Ramboll.

Environmental baseline on KEP is described in Section 9 and was mainly sourced from existing published documentation and in consultation from scientific experts within BAS. Some additional data collection (as identified by the Scoping document) was also carried out at KEP during the 2018 – 2019 season.

Noise specialists *ABPmer* have provided the underwater noise assessment and BAM Environmental Manager, Neil Gouling, has provided the terrestrial noise assessment.

The predicted potential environmental impacts of the project have been identified through a three-step process that identifies: all project activities, their interaction with the environment and the potential for these interactions to cause an impact or change in the environmental value/resource. Section 10 describes this impact identification method in more detail and provides a breakdown of the identified impacts and suggested mitigation measures.

Section 11 assesses the significance of the impacts that have been identified by considering the following criteria for each impact: spatial extent, duration, likelihood and severity and by applying a risk value to each impact. Where negative impacts are predicted, measures to mitigate or to prevent those impacts are identified and discussed. The effectiveness of these mitigation measures is then reassessed by reconsidering the impact criteria and applying the risk value after the implementation of the mitigation. If the risk value has reduced then the mitigation is considered effective. This information is presented in an impact matrix format that allows for all the information to be presented concisely.

The impacts have been predicted on the basis of professional opinion and experience of individual BAS scientists and the BAS Environment Office.

A monitoring and audit plan has been developed to ensure that early warning of adverse effects can be identified quickly and modifications of activities can be made should they be necessary.

An overarching conclusion of the EIA process has been presented in Section 14.

### 2.3. Sustainability Strategy

A BAS overall Sustainability Strategy for the Antarctic infrastructure Modernisation Programme (AIMP) was agreed and issued in February 2019. The strategy aim is ‘to ensure that BAS infrastructure is designed, constructed and operated in accordance with best international sustainability practice’.

GSGSSI and BAS considered assessing the KEP Wharf Project formally under CEEQUAL<sup>1</sup> - an evidence based sustainability assessment for civil engineering and infrastructure projects – however, this was rejected on the basis that impact of the KEP design on sustainability would be considered by linking it to the overall AIMP Strategy. The strategy outlines eight aims with associated objectives some of which the KEP project is already compliant with as detailed in the table below. A KEP specific sustainability management plan is being developed to ensure the project is in compliance with good sustainability performance comparable to CEEQUAL standards.

*Table 1. BAS Sustainability Strategy Aims and evidence of KEP compliance (adapted from the KEP Sustainability Management Plan)*

No.	BAS AIMP Strategy Aims	Evidence of KEP project compliance with Strategy Aims
1.	Create and maintain healthy working areas	Appropriate Health & Safety training will be provided to construction staff including mental health and wellbeing awareness.  Recreational opportunities for construction staff will be considered.
2.	Maintain an efficient and sustainable water and wastewater regime	Comply with requirements of the EIA on water consumption.  Wet trades such as concrete mixing on site have been eliminated as part of the design.  Sea water to be used where possible e.g. dampening of dust producing activities.
3.	Create an efficient, reliable and sustainable sub-Antarctic energy network	Embedded carbon reduced where possible through careful design to minimise tonnage of steel required for project.
4.	Ensure resilient facilities through sustainable and appropriately innovative design	A sea level rise of 9.7mm per year is taken into account, which leads to a sea level rise of 0.49m over the design life of the structure.
5.	Develop and maintain inclusive, safe, resilient and sustainable BAS sub-Antarctic communities	The design has been developed in conjunction with the KEP community to ensure that there are no conflicts with any current or foreseeable operations or scientific research during the design life of the works.

<sup>1</sup> Civil Engineering Environmental Quality Assessment and Award Scheme managed by the BRE group

6.	Ensure responsible sourcing and efficient use of all resources through sustainable design and procurement	<p>Compliance with key principles of BAS Sustainable Procurement Policy.</p> <p>Reduction in embedded carbon of the project through design decisions which limit the quantity of precast concrete.</p> <p>Rock fill is required for the extended wharf and new slipway. Decision was made to source this locally and therefore a reduction in carbon is made by not importing additional material.</p> <p>Efficient design has reduced the steel required for the structural elements as much as practicable without compromising the robustness of the final solution.</p> <p>The generation of waste is limited through the maximisation of pre-made materials. Waste produced on site will be managed and removed as per the BAS Waste Management Handbook and will be guided via a specific Site Waste Management Plan.</p>
7.	Prioritise action to combat climate change and its impacts	<p>Future climate impacts have been designed for by considering a sea level rise of 9.7mm per year in design.</p> <p>Estimated whole life carbon footprint of project to be calculated.</p> <p>The use of chlorofluorocarbons and other hazardous materials listed in Annex A of the Montreal protocol, in any element of the Works is forbidden.</p>
8.	Interact sustainably with the sub-Antarctic environment	<p>The design is being developed to be sympathetic to the local natural environment and will comply with the legislative requirements of the Wildlife and Protected Areas Ordinance 2011 and the agreed mitigation of the Environmental Impact Assessment.</p> <p>The works shall comply with strict biosecurity protocols and will be managed via a dedicated Biosecurity Plan.</p> <p>The volume of local fill material required for the wharf and dolphin has been limited through careful design to reduce the extent of local excavations on site.</p> <p>The construction period shall avoid the key seal breeding season.</p> <p>Personnel will receive environmental and biosecurity training at pre-deployment, as part of their on-site</p>

		<p>induction and during their on-site briefings/toolbox talks.</p> <p>All environmental incidents reported to the BAS Environment Office.</p>
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#### 2.4. Consultation

In preparing this EIA, all consultation has been between BAS (and the construction project partners) and the GSGSSI as the statutory authority. Representatives from GSGSSI have been invited to all planning, decision and design meetings with BAS and the construction partner. The BAS Environment Office has also maintained direct consultation with the relevant officers within GSGSSI on specific matters of environmental impact.

An EIA Scoping document was submitted to GSGSSI in October 2018 and circulated to selected external reviewers for their feedback and an updated version finalised in January 2019. In addition, a draft EIA structure and methodology was also submitted to GSGSSI and selected external reviewers in February 2019. Feedback and comments from both these stages have been taken into account when preparing this EIA.

Once this EIA document is submitted to GSGSSI a final consultation stage will take place and appropriate external expert advice will be sought and coordinated by GSGSSI. A final revised version of this EIA will be re-submitted by BAS taking into consideration the feedback received. The final approval of the EIA remains the responsibility of the GSGSSI.

### 3. DESCRIPTION OF PROPOSED DEVELOPMENT 1 – KEP wharf and associated structures

#### 3.1. Purpose and Need

BAS is proposing to redevelop and extend the existing wharf at KEP Research Station in order to accommodate the SDA, which is due to replace the two existing BAS research ships in 2020, and in order to continue its support of the GSGSSI Fisheries Patrol Vessel (FPV) *Pharos* which berths at KEP for up 2-3 months throughout the year.

The existing wharf was constructed in 1987 by the Royal Engineers Military Construction Force and refurbished in 2000 and has been used annually by the JCR and ES for offload of cargo directly onto the wharf and for ship to shore refuelling. It is also used regularly by the *Pharos*, which supports the fisheries science and provides logistical support for the government and by HMS *Clyde*, a royal navy vessel. In its current state, the wharf is showing signs of degradation (see Appendix 1 - Wharf Structural Assessment Report, BAM, November 2018) and is not capable of supporting the berthing of the larger SDA. This would significantly impact and delay operations on site by forcing all operations to be carried out by tender. Therefore, it is necessary to make changes to the wharf that will allow the SDA to come alongside. The changes require a larger berthing face in deeper waters.

BAS is also proposing to redevelop the existing slipway at KEP in order to future proof the small boat operation of the station. KEP has five small boats which support the GSGSSI managed fishing and tourism industries, and the scientific research conducted on station. Namely, the five boats include two 10.5m jet drive harbour launches, two 5.5m Rigid Inflatable Boats (RIB) and one 2.5m RIB. The harbour launches are moored on the northern face of the wharf. The slipway on the southern side of the wharf is a key feature of the KEP boating operation, in that it allows the harbour launches and RIBs to be taken out of the water for regular maintenance and safety checks. There are some notable issues with the existing slipway: it is in a deteriorating condition and it only allows for launching and removal of boats during spring tides. The slipway is essential to the safety of the KEP boating operation, it needs to be repaired and extended in order to secure the future of the KEP boating operation and allow for boats to be launched and removed regardless of the state of the tide.



### 3.2. Location

The location of proposed wharf development is at King Edward Point in South Georgia (54°17' south, 36°30' west).



Figure 2. Location of KEP in South Georgia (MAGIC, BAS)



Figure 3. Existing KEP station and wharf (Alastair Wilson, BAS)

### 3.3. Site Investigations completed in 2018-19 season

Site investigations were carried out in in 2018/19 to collect data for the final design of the wharf and associated structures. The requirement for these investigations was identified in the EIA Scoping Document and the activities were approved by GSGSSI under separate Regulated Activity Permits prior to the completion of this EIA.

### 3.3.1. Trial pits

Visits in November 2018 and February 2019 involved digging trial pits in the existing wharf and at the proposed mooring points to investigate the ground conditions and to assess the structural condition of the existing wharf. See Appendix 2 – KEP Ground Investigation (Trial Pits) for detail of ground condition investigations. Ten trial pits in the wharf and at the proposed mooring points were excavated and all but one identified the presence of contaminants suspected to be hydrocarbon fuel from historic activities at KEP. Samples were returned to the UK for analysis in February 2019 and concluded that the ground within the wharf and at the location of the proposed mooring points is contaminated with hydrocarbon (identified as diesel) and other contaminants.

#### 3.3.1.1. Contamination Risk Assessment

A risk assessment (RA) specifically considering the risk to the marine environment before, during and after the construction of the new wharf, was undertaken by Sweco and, issued on the 31<sup>st</sup> May 2019 (see Appendix 3 – KEP Water Environment Risk Assessment). The RA identified that the pre-construction and post-construction risk to the water environment during normal use/maintenance of the wharf is low to moderate. However, it identified an increased risk of release of pollution from diesel, cadmium and aliphatic (C6 - C8) hydrocarbons during the construction phase as a result of either piling or excavation activities and recommended suitable mitigation measures.

Open excavation – is considered because at the time of commissioning the RA, the wharf design required open excavation in order to bury precast concrete mooring points and a precast concrete anchor wall in the wharf. The RA concluded that open excavation is likely to disrupt the static sub-surface environment and increase the risk that contaminated groundwater will migrate laterally and release to the water environment. In addition, excavation will involve removal of contaminated material and potentially require the removal of contaminated water from the excavation pits. Both the contaminated water and contaminated ground would need to be managed/treated appropriately either on site or removed for disposal outside the territory. Dewatering of the excavations could potentially generate significant volumes of contaminated water.

Piling - is considered because it is the selected method of driving metal wharf elements into the seabed in order to wrap around the existing wharf and to construct the dolphin and slipway. The RA concluded that piling is likely to disrupt the relatively static sub-surface environment and increase the risk that contaminated groundwater will migrate laterally and potentially contaminate the water environment. The existing wharf is thought to act as a barrier to some contaminant migration however, the action of the piling activities are likely to exacerbate any weakness or open joints resulting in additional release of contamination.

The risk assessment concluded that while any works to disturb ground may give rise to the mobilisation of contamination, works involving a driven pile solution are likely to be of a lower impact than works involving significant excavation and dewatering, and are less likely to generate significant quantities of contaminated soil and liquid waste requiring on-site management.

### 3.3.2. Bathymetry

A visit in February 2019 carried out a detailed bathymetric and topographical survey at KEP. See Appendix 5 - DEEP Offshore Survey Report. A sparkler sub-bottom profiler survey was carried out in the vicinity of the wharf. The sparkler did not categorically detect the top of the bedrock but it did locate the top of a denser layer which for the purposes of the design is being interpreted as the bedrock layer. In the area of the wharf this harder layer varied between 11 and 47 metres below the seabed.

### 3.4. Design Details & Scope of Preferred Option

The preferred wharf design involves retaining the existing wharf and expanding it with a wraparound structure (widened by approximately 1m on each side and lengthened by 3m) with two new mooring bollards on the wharf and three new shoreline mooring points. A dolphin (a standalone, man-made marine structure above the water level) with mooring bollard will also be built to the south of the wharf to provide a fixed structure which will extend the berthing and mooring capabilities of the design. In addition, a new extended slipway is also proposed.

The overall project is being undertaken in stages which aim to align with the Royal Institute of British Architects (RIBA) UK model for building, design and construction process (Plan of Work 2013 stages). The work stages are defined below:

Table 2. RIBA work stages

Work Stage	Definition	Explanation
WS 0	Strategic definition	Identify business case and strategic brief and other core project requirements
WS 1	Preparation and brief	Develop project objectives and undertake feasibility studies
WS 2	Concept design	Prepare concept design including outline proposals for structural design
WS 3	Developed design	Developed design includes coordinated and updated proposals for structural design, building services systems, outline specifications, cost information and project strategies in accordance with design programme.
WS 4	Technical design	Prepare technical design in accordance with design responsibility matrix and project strategies to include all architectural structural and building services information, specialist subcontractor design and specifications in accordance with design programme.
WS 5	Construction	Offsite manufacturing and onsite construction in accordance with construction programme and resolution of design queries from site as they arise.
WS 6	Handover and close out	Handover of structure and conclusion of construction contract
WS 7	In use	Undertake in use services
WS 8	Project completion	Handover to the end user

The majority of the design detailed in this section is at Work Stage 4 and represents the 65% design completion. However, (as described above) the recent discovery of the hydrocarbon contaminated ground in the wharf and mooring point area has required further investigations that resulted in a change to the design of the wharf anchor wall and mooring point design (agreed 20/05/2019) from buried precast concrete elements to driven sheet pile elements. This decision was made in order to eliminate or reduce the requirement for excavations in the area. At the time of writing this assessment, this element of the design is therefore only at WS3. Over the next few months, the

design will be refined and finalised at 100% and therefore some minor changes to the design represented in this EIA are expected. However, the overall environmental impacts identified in this assessment are not anticipated to change.

The RRS SDA is the principal vessel used in the design of the wharf because at 130m length it is the longest and largest vessel expected to moor alongside. However, other vessels that have been considered in the design of the wharf are: FPV *Pharos*, the BAS RRS JCR and Royal Navy vessels HMS *Protector* and HMS *Forth*. In addition, suitable bollards for the GSGSSI small boats will be provided on the north side of the wharf to allow for refuelling and connection to the existing electrical supply and refuelling cabinet.

The design life of the wharf and its associated structures has been agreed at 50 years as below.

Table 3. Design working life

Structure	Design working life	Period to first maintenance	Required maintenance
Wharf	50 years		
Dolphin	50 years		
Dolphin access walkway	50 years	15 years	Re-application of protective coating.
Mooring points	50 years		
Slipway	50 years		
Element	Design working life	Period to first maintenance	Required maintenance
Fenders	15 years	Refer to manufacturer's requirements.	
Fender chains and fixings	50 years	15 years	Re-application of protective coating. Repair of local damage from accidental berthing.
Bollards	50 years	15 years	Re-application of protective coating.

### 3.4.1. Wharf

The proposed new wharf involves constructing a new loading platform as a wrap-around structure around the existing KEP wharf. The existing wharf condition has been assessed by BAM and Delta Marine Consultants (KEP existing wharf loading assessment, 2018) and they concluded that the wharf is not capable of supporting additional loads, in its current state, due to insufficient space between the front and back wall. However, by installing a new sheet pile anchor/back wall to the wharf this would increase the capacity of the existing wharf structure and allow for the preferred wrap-around extension. The design of the new platform will provide safe and adequate mooring and berthing provisions for the vessels listed in section 3.4. The new wharf length at ~34m provides sufficient stability for the design vessels to be moored against the wharf fenders only, except for the SDA which due to its length will also need to use the mooring dolphin.

The wrap-around loading platform will consist of steel sheet piles<sup>2</sup> driven into the seabed and tied together by a waling beam<sup>3</sup> seaward of the existing wharf. The front wall, which will act as the new berthing face, is anchored to the existing wharf structure by tie-rods<sup>4</sup> attached to a new anchor sheet pile wall embedded within the wharf near the shoreline. The northern and southern side walls are also tied to each other across the wharf using tie-rods. The tie-rods and anchor wall are designed to contain the weight of the fill material and the tie-rods will all run above the existing structure's capping level. Waling beams will then be installed to act as structural steel beam to spread the load on the sheet piles and concentrate the load onto the tie rods. The cavity created by the wraparound structure will then be filled in with well graded granular material and the top level of the entire wharf will also be filled in to raise it 0.5m above the existing level to +2m chart datum (CD).

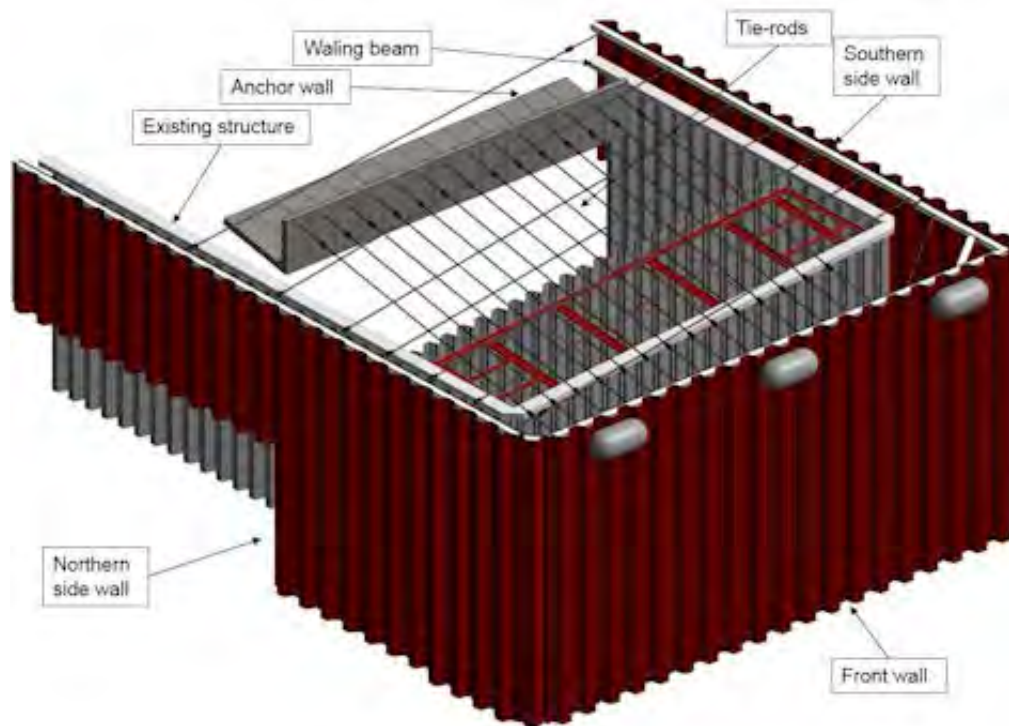


Figure 4. Wharf platform – Isometric view

Two 50t bollards (supported by the waling beams) will also be installed near the wharf front wall northern and southern corners to act as mooring points. Berthing provision will also be provided on the front wall (vessel berthing) and northern side wall (small boat berthing) in the form of mooring rings (design for these has not yet been finalised).

The seabed level (SBL) for the new wharf (~ 26m wide/34m long) varies along the front berthing wall from - 10m CD to -7m CD. Along the northern side wall, the SBL varies from -10m CD until it reaches surface level on the beach and along the southern wall, SBL varies from -7m CD again until it reaches surface level on the beach.

<sup>2</sup> Sheet piles are structural sections of steel which interlock to create a continuous wall

<sup>3</sup> A structural steel beam which helps to spread the load on the sheet pile and concentrate the load onto the tie rods

<sup>4</sup> Steel bars used to brace the structure

Table 4. Wharf structure and tidal levels

Description	Level metres Chart Datum (m CD)
New wharf capping beam	+2
Existing wharf capping beam	+1.4
New tie rods	+1.5
New wharf seabed level (SBL)	Varies from -7.0 at the south corner to -10.0 at the north corner

### 3.4.2. Dolphin & Walkway

The mooring dolphin will be positioned on the south side of the wharf and will be predominantly used to berth the SDA. In some temporary situations the FPV *Pharos* will also use the dolphin but this is only anticipated when it is using its crane operation on the wharf. The dolphin will also have a bollard for mooring of vessels and fenders at the front for berthing.

The structure of the dolphin will be made by driving sheet piles into the seabed to form a rectangular cofferdam with 10.8 m x 10.8 m dimensions, deck level +2.0m CD and a coping level of +2.2m CD. The sheet piles will be held together by a steel frame at the top of the cofferdam. The steel frame will be supported by four piles in each of the corners of the dolphin. These vertical corner piles are temporary to support the steel frame until the sheet piles are fully driven into the seabed and the top permanent frame has been bolted to the sheet piles.

The dolphin can be used for mooring of the SDA and *Pharos*. There will be no cargo operations on the dolphin.

As the dolphin is a standalone structure, the bollard on the dolphin will require safe access from the shore and therefore a steel frame walkway will be constructed which rests on the dolphin and the shoreline.

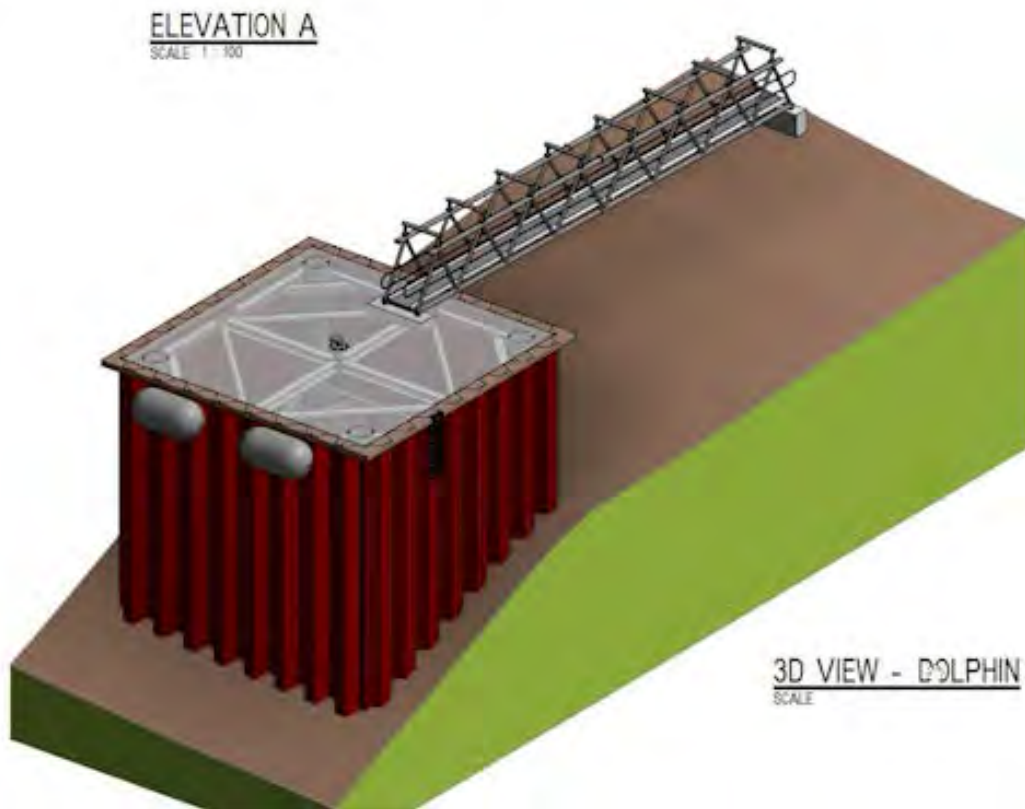


Figure 5. Dolphin and walkway – 3D view

### 3.4.3. Shoreline Moorings

Three shoreline moorings points (MP 1, MP2, and MP3 as shown in Figure 6 below) in the form of 50T bollards are proposed as part of the new wharf design. Two are required at the north and one at the south of the wharf. The mooring points will provide fastening of the breast and stern lines for the SDA and headlines for other vessels.

To ensure the prefabricated Teehead bollards offer appropriate resistance, to the SDA and other vessels, they will be anchored to the ground using a cofferdam structure made up of sheet piles in a square box shape. The cofferdam square (6m x 6m x 4.5m) will be a similar design to the dolphin and buried below ground level.

In addition, an additional mooring may be required for the SDA which cannot be placed onshore. For this a sinker anchor on the seabed is required.

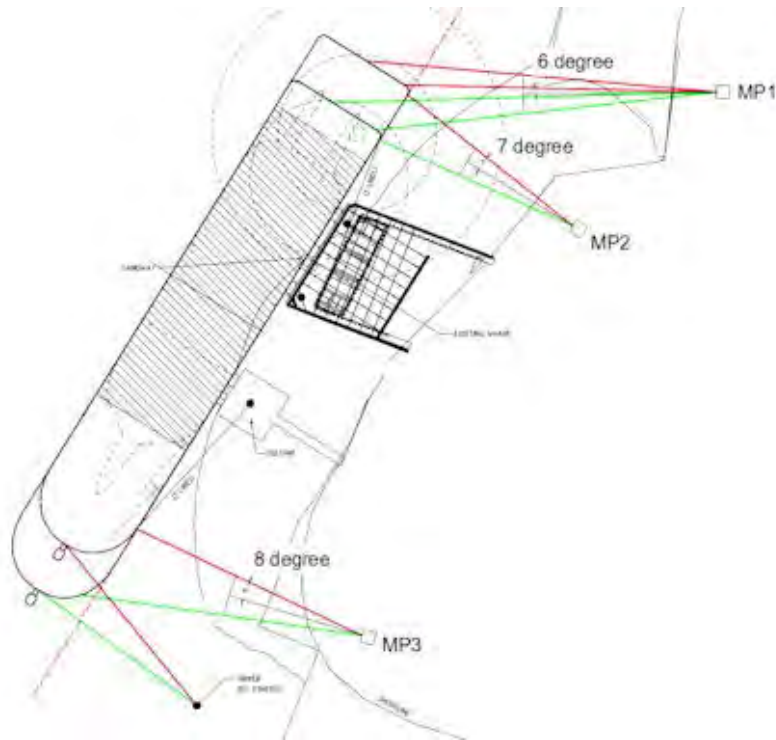


Figure 6. Mooring line angle

#### 3.4.4. Slipway

The existing KEP slipway is made up of a lower and upper section. The upper section is a wide concrete slab which sits immediately in front of the boatshed and is in good current condition and therefore is not considered in the scope of the slipway upgrade. The lower section however is a narrower slipway made up of several concrete slabs that sit between two beams and this extends ~ 1m below the water level. The lower section is in poor condition and is currently too short to allow for launching and retrieving of boats in states other than high tide.

The design for the new lower section requires that the slipway be replaced and extended to a depth of -1.60m CD at a length of ~22.5m and at a slope of 1:7.5 which will allow the safe winching of boats out of the water. The slipway will be made up of precast concrete slabs set adjacent to the south side wall of the wharf and anchored in place by sheet piles driven into the seabed at its front and exposed side.



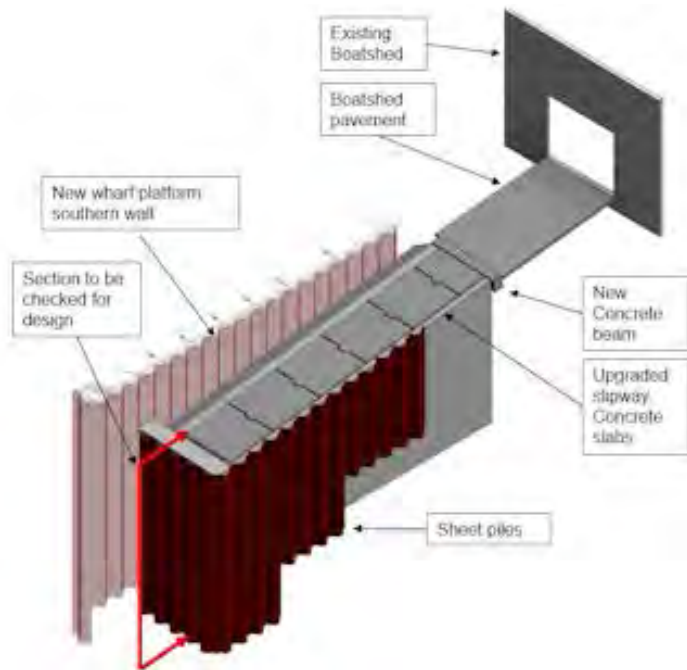


Figure 7. Upgraded slipway – Isometric view

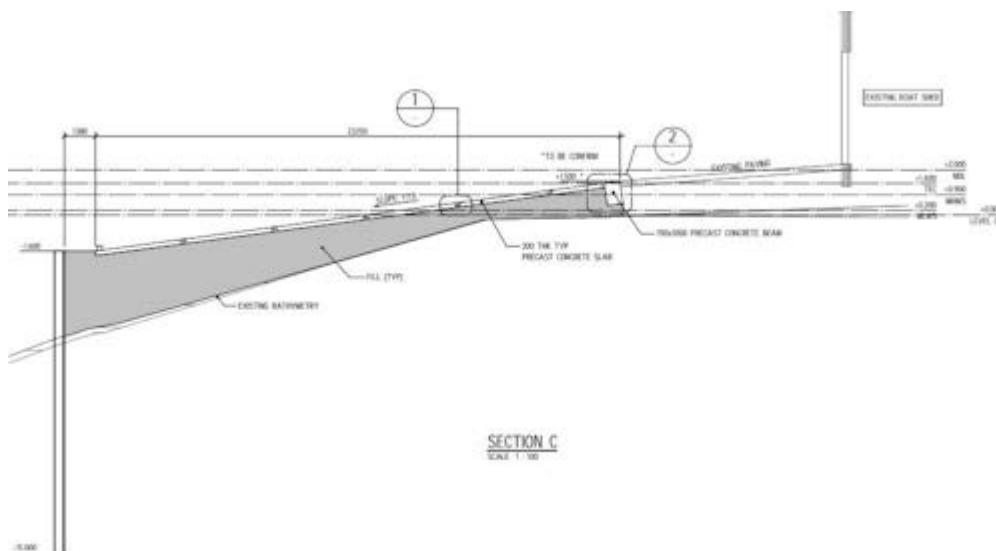


Figure 8. Upgraded slipway – drawing section

### 3.4.5. Scouring of seabed by vessel operation

There is no evidence of scouring<sup>5</sup> taking place at the existing wharf with the current vessel operations. However, once operational, the SDA (the largest vessel that the wharf is designed for) will berth alongside at a minimum of once a season. Therefore, as part of the design of the new wharf a scour analysis by design partner DMC was carried out to determine the scouring impact of the SDA during berthing and departing operations from the wharf.

<sup>5</sup> erosion of seabed sediment

A scour analysis study has been carried out to determine the scouring impact (and potential level of protection required) on the seabed in front of the wharf, dolphin and slipway from wash out when the SDA berths or leaves the quay.

The SDA has two main propellers and four thrusters (two at bow and two at stern). Areas of the seabed exposed to action of the propellers and thrusters could be impacted by significant scouring, with maximum effect being produced by the stern thrusters.

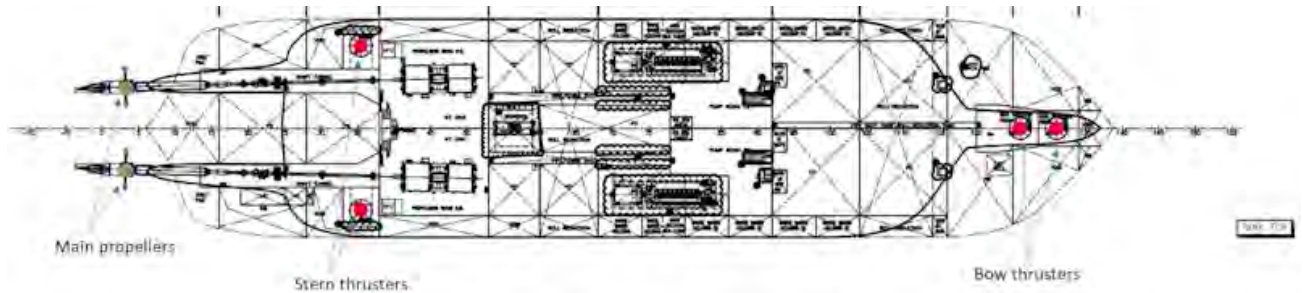


Figure 9. Location of SDA propellers and thrusters

The scouring study looked at the impact of scouring under a number of different scenarios. Based on the 'Guidelines for Protecting Berthing Structures from Scour Caused by Ships' (PIANC WG180, 2015) the operational power of the main propellers during berthing should be restricted to 5-15% of the vessels total installed power. As part of the scouring scenarios a maximum of 15% of propeller power was considered.

The SDA Master indicated that under normal operational conditions, no more than 25% of the thrusters full operational power would be used for berthing and departing operations. Between 25 – 50% of the thrusters full operational power would only be deployed in the case of extreme winds pushing the vessel against the berth. As such as part of the scouring scenarios a maximum of 50% thruster power was considered.

The key scenarios considered as part of the scouring analysis were:

Table 5. Scour analysis scenarios based on propeller and thruster power usage

	Main propellers (2x)	Thrusters (2x stern, 2x bow)
1. Normal operational power	15%	15%
2. Extreme operational power	15%	50%

The analysis indicated that under scenario 2, with 50% of the thruster power that the depth of scour hole developed could be up to 4.6m. This is considered an unacceptable scour and scour protection would be required. Under scenario 1, with normal berthing operations and 15% thruster the scour hole depth is estimated at 1.2m. This is considered an acceptable scour hole from a wharf stability point of view and no scour protection is required however strict vessel berthing operational procedures are required and ongoing monitoring of the scour.

It has been decided, as part of this proposed design, that scour protection will not be incorporated. Therefore, the SDA will operate under 15% propeller power and 15% thruster power during berthing

operations – this will be written into the vessels standard operating procedures. In addition, monitoring of the seabed level will take place by KEP station personnel after each departure of the SDA to monitor any potential scour development – this will be written into the station management procedures. If scour develops beyond acceptable limits then a repair would be necessary and further installation of scour protection

### 3.5. Alternatives considered

#### 3.5.1. Do nothing

The existing wharf at KEP is showing signs of degradation (see Appendix 1 - Wharf Structural Assessment Report, carried out by BAM in November 2018) and is not currently capable of supporting the berthing of the larger SDA. Additionally, the current wharf length is insufficient to secure the SDA safely and protect it against the force of westerly winds which could blow the ship onto the berth causing damage to the wharf fendering and to the ship's hull and mooring lines. There is also insufficient water depth to allow the vessel to berth in all states of the tide with a safe under keel clearance. BAS is already trying to reduce ship time at each station (due to moving to a single vessel operation) however by 'doing nothing', SDA operations would have to be carried out by cargo tender vessel therefore increasing (rather than reducing) time required on site and reducing SDA time allocated to science.

Therefore the 'do nothing option' and the continued use of existing berthing structures is not considered a viable option and is discounted.

#### 3.5.2. Do minimum

Repairs to the existing wharf could provide refurbishment to the aging structure and improve the berthing facilities for vessels that currently use the berth. However, repairs only would not allow the SDA to berth at the wharf and therefore SDA operations would have to be carried out by cargo tender vessel therefore increasing time required on site and reducing SDA time allocated to science.

In addition the extent of the repairs required is not known until further investigation and groundworks are carried out to assess the condition of the existing wharf. As the site is remote it may be difficult to make repairs to defects discovered without having the necessary equipment on site.

BAS is moving from a two vessel operation to a single vessel operation and therefore there is an operational requirement to be more efficient and reduce time spent on cargo relief and other logistical activities in order to safeguard ship time which is allocated to science. As such, the SDA will need to come alongside at KEP wharf in order to allow for quick and efficient cargo loading/offloading which would otherwise be significantly delayed if a cargo tender was used.

Repairing the existing wharf does not meet the requirements of the SDA and is therefore discounted.

#### 3.5.3. Demolish and rebuild the existing wharf

Demolishing the existing wharf offers opportunities for alternative design and construction methods which do not require the extension or encapsulation of the existing structure.

However, demolition would create large quantities of waste which would need to be removed for safe disposal or recycling. The existing wharf services would need to be removed and reinstated. It

would also mean that marine plant would be required for construction as the existing wharf platform would be removed and larger quantities of rock fill would be needed.

This option is discounted based on the additional costs required and the risks associated with the programme constraints.

#### 3.5.4. Rebuild the wharf at an alternative location

The existing location is the most suitable as it is sheltered from incoming winds and large icebergs. However, an alternative location could be used along the south-west coast of KEP (due south of the existing wharf).

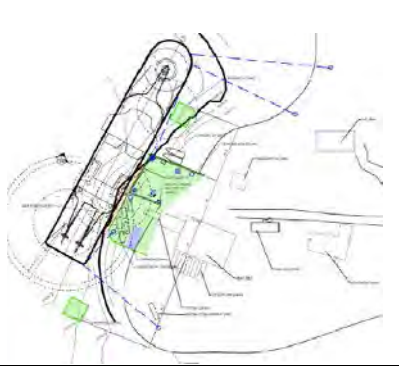

Constructing the wharf in a new location would have an impact on a previously undisturbed site. A wharf in a new location (e.g. due south of the existing wharf) would also be a considerably long distance from the station and cargo offloaded here would need to be transported along the coastal path to KEP station. This would increase traffic resulting in long-term disturbance of wildlife along the track, increased demands on station personnel and increased fuel consumption/costs.


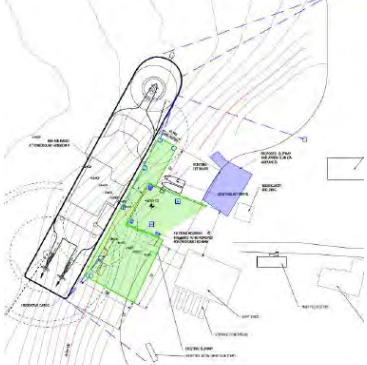
Therefore, the option of rebuilding the wharf at an alternative location is discounted as it would have a greater environmental impact than expanding the existing wharf.

### 3.5.5. Alternative designs




The below table describes all the design stages from Work Stage 1 to Work Stage 3 (Table 2. RIBA work stages) and identifies Option 2 from Work Stage 3 as the selected design which was taken forward to the current design stage of Work Stage 4. Larger versions of the alternative designs can be seen in Appendix 14 – Alternative wharf designs.

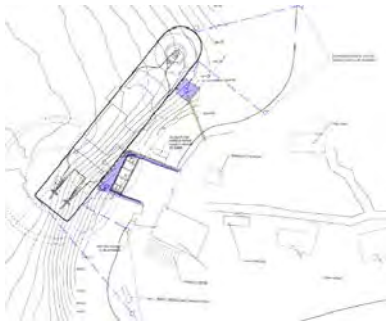

Table 6. KEP wharf – alternative designs

Design stage	Alternative Designs	Description	Design Drawing	Reason for discounting
Work Stage 2	Layout option 1	27m extension of existing wharf to the south-west only and the construction of two dolphins either side of the wharf to allow both port and starboard berthing of the SDA. This would require dredging of the existing bed in order to provide sufficient under keel clearance for the SDA.		Uncertainties surrounding dredging and whether existing wharf could withstand this. Additional piling would be required to stabilise the wharf with a deeper dredge level. Large area of seabed impacted and large quantities of rock fill required.
	Layout Option 2	A larger wharf extended from the existing wharf to the south-west and north-east. No dolphins or dredging required. The slipway would need to be relocated.		Higher cost than other options at WS2. Wharf is larger than required and therefore larger area of seabed impacted and larger amount of rock fill required. Likely requires two construction seasons.

<p>Layout Option 3 “Minimum Enhancement”</p>	<p>A 'T' shaped jetty, with 10m wide fingers to either side of the existing berth with the existing wharf forming part of the stem of the 'T'. The new berthing face would be in front of the existing quay. The slipway would need to be relocated.</p>		<p>Selected for further discussion and development at Work Stage 2 Value Engineering. This design was discounted as it later evolved into “Alternative Minimum Enhancement” at WS2VE.</p>
<p>Layout Option 3A “Moderate Enhancement”</p>	<p>As a way of moderately enhancing the design in option 3 - option 3A was proposed which includes an additional 10m berthing length to the south and an extension of the southern finger of the T-head jetty back to the existing land. This allows a greater cargo handling area and further limits vessel motion in bad wind and weather conditions.</p>		<p>Selected for further discussion and development at Work Stage 2 Value Engineering. This design was discounted as it later evolved into “Alternative Moderate Enhancement” at WS2VE.</p>

Work Stage 2 Value Engineering

<p>Wraparound existing wharf “Alternative Minimum Enhancement”</p>	<p>An alternative minimum enhancement design which involves a new wraparound structure that encapsulates the existing wharf with a 6m extension so that the new berthing face is in deeper water.</p>		<p>This option provides a robust wharf which allows all current vessels to berth. However, the SDA is not able to berth with this design and is required to carry out all operations using its tender vessel.</p>
<p>Wraparound wharf with port and starboard dolphins</p>	<p>A wraparound structure to the existing wharf with the addition of mooring dolphins to the north and south. The new berthing face is placed in front of the existing quay in deeper water.</p>		<p>The cost of two dolphins exceeds the budgets. It was also noted that dolphins are difficult to access over water and with two dolphins it could limit the operations of small boats.</p>
<p>Wraparound wharf with starboard mooring dolphin “Alternative Moderate Enhancement”</p>	<p>A wraparound structure to the existing wharf with the addition of a berthing dolphin to the north. The new berthing face is placed in front of the existing quay. This allows the SDA to berth starboard side only at the wharf. Access to the dolphin is given by a walkway which connects it to the shore.</p>		<p>This option best fulfilled the operational requirements of the berth and was progressed to Work Stage 3 to form the developed design as Option 2 and Option 3.</p>

<b>Work Stage 3 Developed Design</b>	<p>Option 2: Realigned Wraparound wharf with 10x10m starboard mooring dolphin</p>	<p>The layout is similar to the "alternative moderate enhancement" and includes a wraparound structure with a starboard mooring dolphin for the SDA. Alignment of the berth is optimised by following the contours of the bathymetry. A 10x10m dolphin is now situated in shallower water therefore reducing the volume of fill required in both the dolphin and the wharf extension. A mooring bollard is also situated on the breasting dolphin. A gangway connects the dolphin with the shoreline.</p>		<p>At the end of WS3, Options 2 and 3 were put forward as the preferred options at the South Georgia Stakeholder board meeting. This design (option 2) met all the requirements of the SDA and impacted on smallest amount of seabed and required less rock fill and the decision was made to progress it to the next stage of design at Work Stage 4. This design was the preferred design and was taken forward to WS4 for further development where the dolphin was moved to the south.</p>
	<p>Option 3: Realigned Wraparound wharf with 7.5x7.5m starboard breasting dolphin</p>	<p>This layout considered a reduction in the scope of the works of Option 2. The dolphin is reduced in size to 7.5x7.5m and the mooring point and gangway have been removed.</p>		<p>At the end of WS3, Options 2 and 3 were put forward as the preferred options at the South Georgia Stakeholder board meeting. This design (option 3) requires a slightly smaller quantity of rock fill. However, it does not have a mooring bollard or safe access for staff to shore and requires stricter navigational restrictions.</p> <p>This design was discounted at the board meeting as described above.</p>



### 3.6. Overview of Works

All works at KEP will be completed in a single season from early January 2020 to early June 2020. The charter vessel is scheduled to arrive at KEP in mid-January and cargo offload and biosecurity inspections will take 10-12 days to complete. Some early provisional electrical work will be carried out by the BAS Estates team in November. The construction site set up works will start in late January followed by the start of the demolition and construction works in the first week of February. It is anticipated that all construction activities will be completed in the first week of May with up to a month allowed in the programme for demobilisation in early June. The overall construction programme is in section 7.

The crawler crane will be one of the first pieces of equipment to be offloaded from the vessel and once assembled on site it will assist with transport of all offloaded cargo to its designated storage/usage location. KEP will be set up for areas of working and designated areas for storing equipment and materials will be defined. After the initial site establishment, the crawler crane will take up position at the mooring dolphin to begin the first piling works. At the same time, a second team will complete the site clearance at the existing wharf and prepare the crane platform for piling. Once the dolphin and wharf piling are complete the crane will move to the slipway and then install the mooring points for the final piling works.

### 3.7. Site Set Up Areas

The drawings below provide a description of the KEP site set up and material laydown areas.

Existing BAS containers (used for waste management, oil spill response and storage of hazardous materials) which are currently stored against the side wall of the boatshed will need to be relocated to make room for construction plant and equipment. It is proposed that these are moved to the far end of KEP station near Larsen House (building 22 seen in Figure 26). There is no planned ship to shore refuelling of KEP station planned in 2019/20 (the station was refuelled in 2018/19) and therefore there is no requirement for the spill kit to be positioned near the wharf. However, once construction works are complete, all BAS kit will be returned to its original locations.

All materials required in the construction of the wharf and associated structures need to be stored as close as possible to the wharf and within the reach of the crawler crane to avoid unnecessary vehicle movements in the area and double handling of materials.

The existing KEP buildings are shown with a red outline. Steel material for the piling activities is shown in blue stored on the beach in front of the existing biosecurity building and on the beach to the side of the existing boatshed. Precast concrete is stored to the side of the boatshed and is shown in green. The areas shown in pink represent plant and equipment (see section 3.10 for more detail on plant and equipment). The crawler crane is also shown in the two positions it will operate in for the duration of the works.

The local aggregate material (sourced from quarrying, as described in section 4) will be stored in a stockpile in an area of vegetation referred to as the 'village green'. This is shown in orange on the site layout below. The 'village green' is a managed area of bittercress which is an established non-native species which the GSGSSI is actively trying to eradicate. Biosecurity measures will be put in place to ensure that any aggregate stored here is managed appropriately to prevent further spread of the bittercress. Please refer to Appendix 6 – KEP Biosecurity Plan.

The construction site will be marked out with a simple rope barrier to restrict access of non-construction staff to the working areas (this is shown with an indicative blue line on the site map). A solid fence was not considered suitable as this could restrict movement of seals in the area.

However, in some areas of the site, specifically the area behind the crawler crane (between the boatshed and the biosecurity facility) the barrier will be a fixed fence to ensure that staff are safely separated from the crawler crane and all vehicle movements.

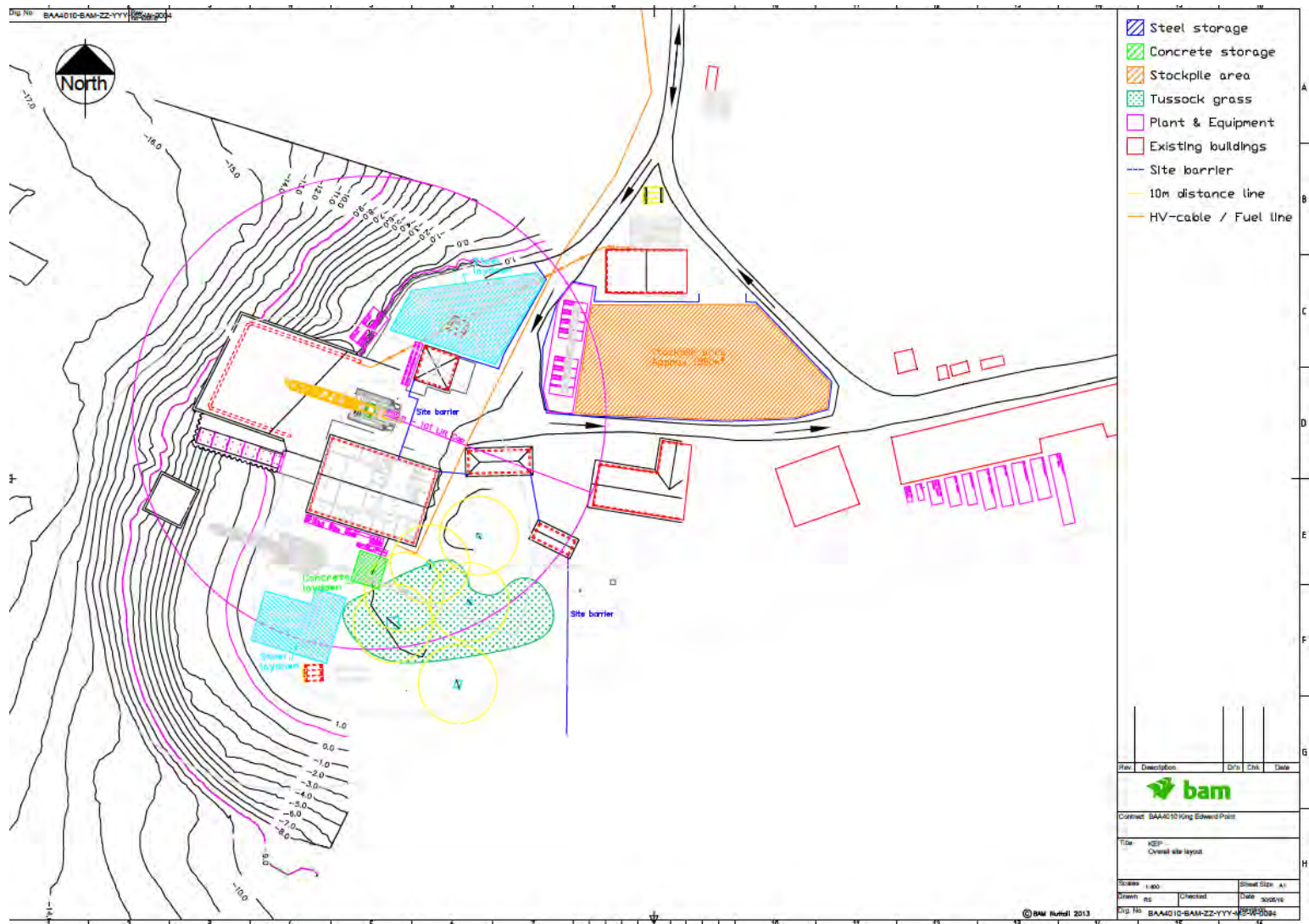


Figure 10. KEP Wharf site set up showing laydown areas of construction materials

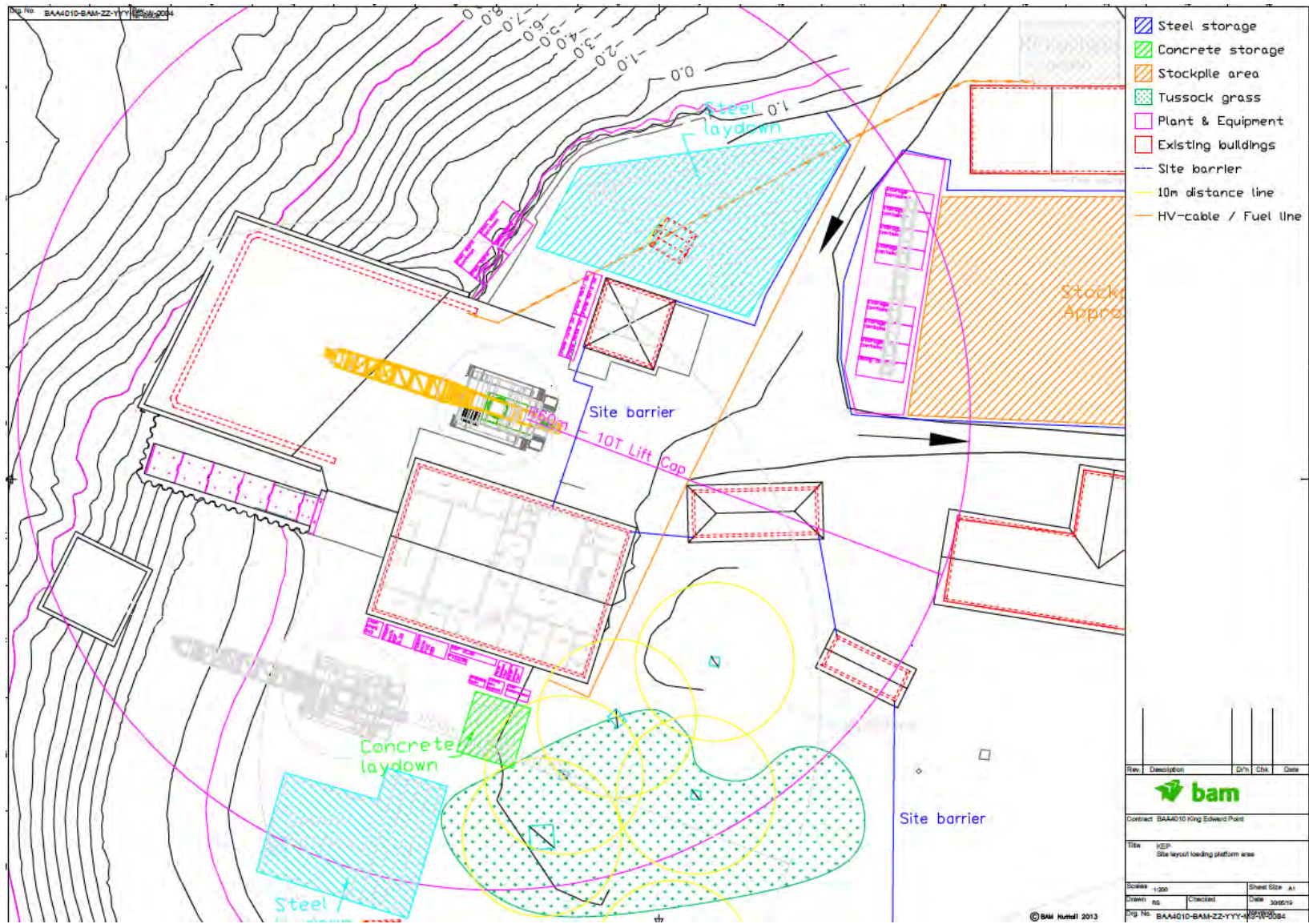


Figure 11. KEP wharf detailed site set up

## 3.8. Construction Methodology

### 3.8.1. Temporary Works

In order to successfully construct the wharf and associated structures a number of temporary works need to be set up to allow for the safe installation of the permanent project works. The following temporary works are required:

- Piling gate for the wharf loading platform and slipway
- Piling frame for the dolphin
- Access pontoons

#### **Temporary work platform on existing wharf loading platform**

The existing wharf may have issues supporting heavy equipment during the construction period as such a temporary strengthening structure is being investigated. This can potentially be solved by installing the new steel sheet pile anchor wall (which will support the extended wharf sheet piles) first and then spanning tie rods between the anchor and the sheet piles of the existing wharf.

The assumption is that this solution will not be required as the project is using a large crane (with a great enough reach to lift and move materials over the existing wharf) and building the wharf in such a way that it should not require additional strengthening. However, this method is included for consideration as a potential mitigation measure.

#### **Piling gate for the wharf loading platform and slipway**

In order to drive the sheet piles into the seabed for the wharf extension and slipway replacement, a piling gate will be used which will be temporarily installed to hold the sheet piles into position during driving. The gate is made up of two piles which support two horizontal beams at the top and two horizontal beams at the bottom. The gates have handrails to allow for safe access by staff.

#### **Piling gate for dolphin**

A piling gate will also be used in order to drive the sheet piles into the seabed for the dolphin construction. Two piling gates (top and bottom) will be supported by four temporary external spud piles<sup>6</sup> that allow the permanent sheet piles and waling frames to be installed.

#### **Access pontoons**

A floating pontoon will be used to provide access for installation of the temporary and permanent works. Two standard sized (3m x2.4m) pontoons will be used and six modular pontoon elements (0.6m x0.6m) will be available for smaller working areas.

### 3.8.2. Wharf Extension

#### **Existing services removal**

The existing services on the wharf will be disconnected and either protected or removed. The services include but are not limited to: fuel cabinet, low voltage cable, waste pipe from boatshed, tidal gauge, fenders and bollards. This work will be undertaken by BAS staff prior to the arrival of the construction team.

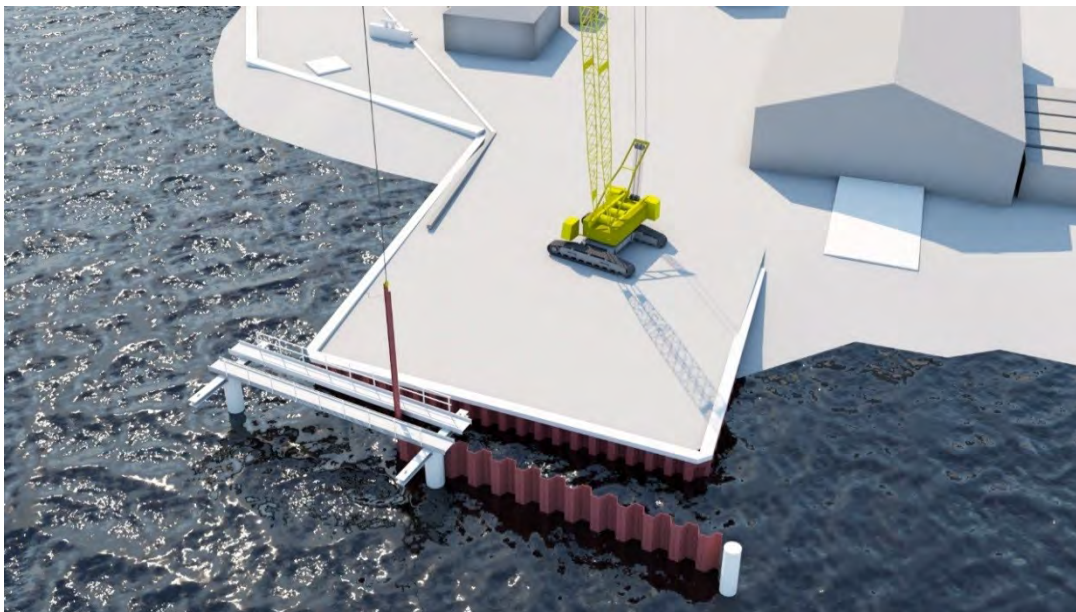
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<sup>6</sup> Strong, temporarily installed, beam to support permanent structure installation

## Sheet piles

All work will be carried out with the crawler crane which will be positioned behind the existing wharf loading platform (due to the reduced capacity of existing wharf. The area will be temporarily surfaced with crane mats<sup>7</sup> on which the crawler crane will operate. The crawler crane will be used to place the piling gate at the front wall to allow for the installation of the sheet piles starting at the norther corner and working counter clockwise to install all the sheets of the front and southern side wall. The northern wall sheet piles will then be installed.

The sheet piles will be installed with the support of a double piling gate. At the start of installation a spud pile will be installed to suit the sheet pile alignment and to support the top and bottom piling gates. The sheet piles will be picked up by the crane and positioned within the piling gate where they will be supported to allow them to be vibro driven into the seabed to just above the level of the top gate. Once driven in, the top gate will be removed and the sheet pile driven in further. The final part of the sheet pile may be required to be driven in with the use of an impact hammer. The piling gates allow for approximately 20 single sheet piles to be installed before they need to be repositioned again. Once all sheet piles are installed they will be trimmed to the appropriate level using oxy-propane burning gear.



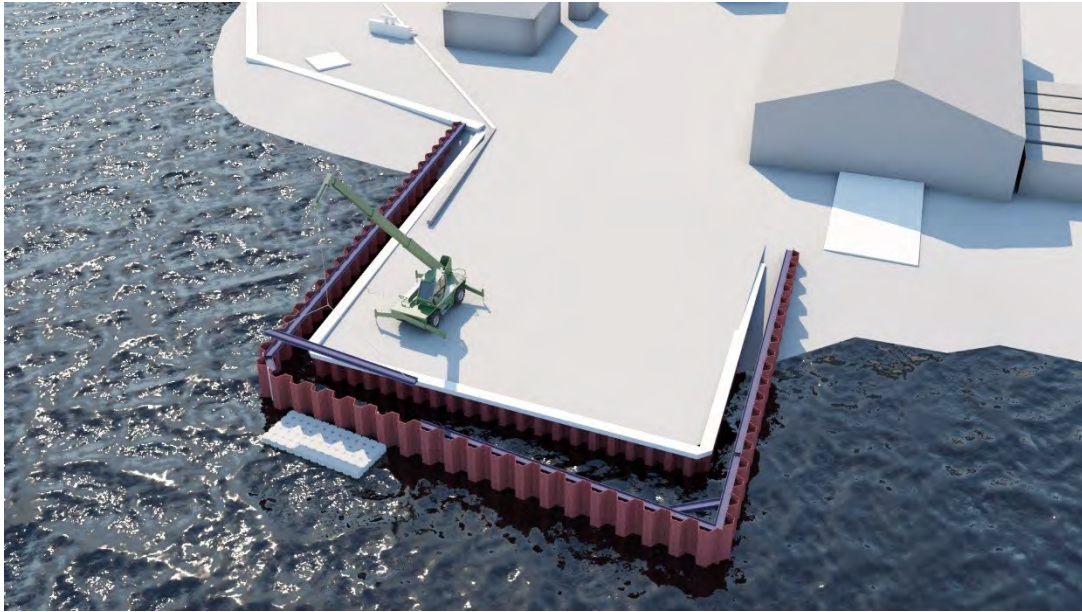
*Figure 12. Wharf sheet pile installation with piling gate supported by spud piles*

## Waling beams

Prior to the waling beam installation some backfilling will be completed between the new sheet piles and existing wharf to an expected depth of a third of the total required fill. Once the lower fill has been completed, access pontoons will be deployed to allow access to both the internal and external sides of the new sheet piles for bolt holes to be drilled in using a roto-broach magnetic drill. The waling beams will then be positioned into place by the telehandler and bolted into the holes. At this time, the capping beam will also be bolted to the top of the sheet piles and the prefabricated bollard frames will be attached directly onto the waling beams.

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<sup>7</sup> Timber sheets that provide access for tracked vehicles on difficult ground conditions and reduce damage to the surface area.

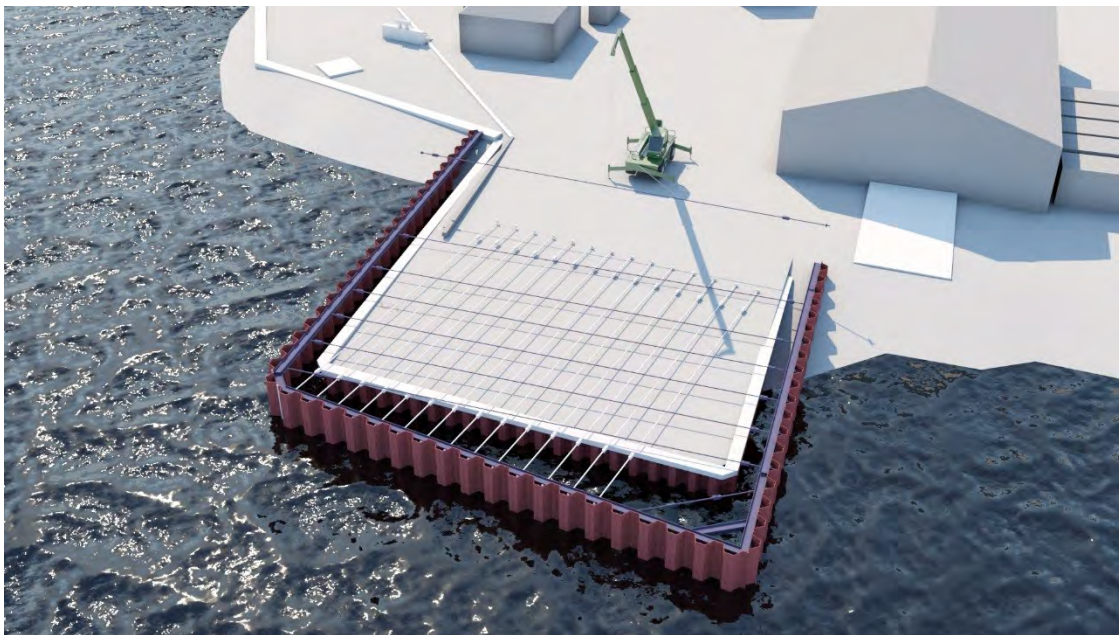


*Figure 13. Waling beam being installed*

### **Tie rods**

The new tie rods will be connected to the front wall of the loading platform first. The tie rods will be fixed to the waler using nuts and laid out on top of the existing wharf until they can be connected to the anchor wall of the loading platform first.

When the longitudinal tie rods are in position a layer of backfill will be placed over the tie rods to establish the level for lateral ties. Lateral ties will then be installed similarly but with a turnbuckle section at the centre of the prefabricated longer section thereby providing tolerance to tension the tie rod after all sections are connected.



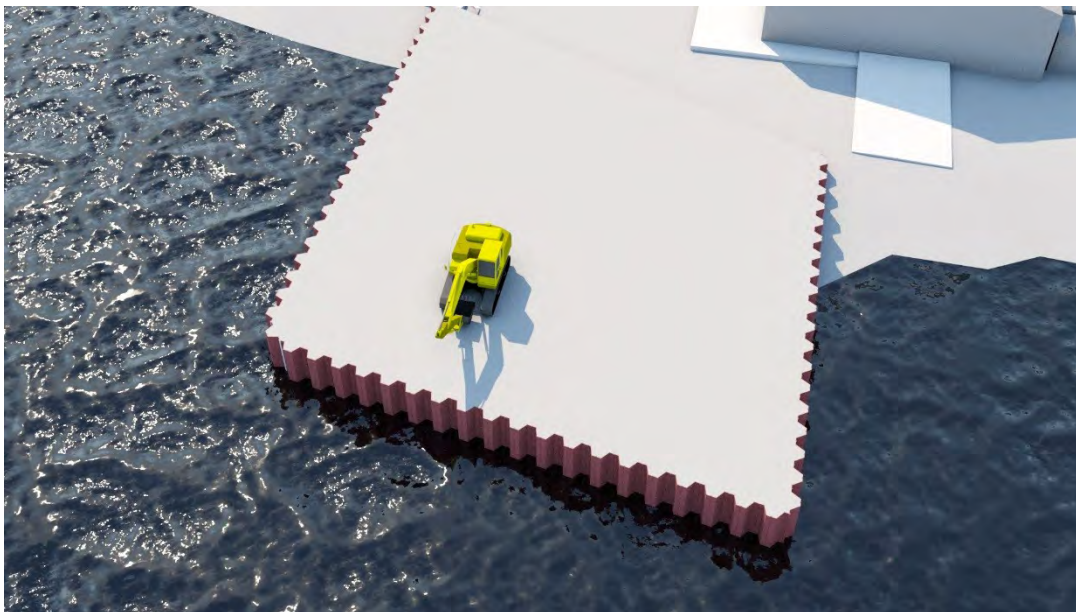
*Figure 14. Tie rod installation on loading platform*

### **Anchor wall**

The anchor wall design has recently changed from a buried precast concrete wall to a sheet pile driven wall. The anchor wall will be made up of one side of sheet piles (approximately 8m long) driven into the existing wharf using the same construction methods as the sheet piling for the wraparound wharf, dolphin and jetty. A waling beam will connect the sheets and provide the connections to the tie-rods (as described in the section above) therefore providing the anchor to the wraparound wharf.

### **Filling new loading platform**

Once the tie rods are completed and the anchor wall installed and backfilled (as described above) the remaining top surface backfill above the tie rods on the loading platform can go ahead. Material will be deposited by excavator and compacted using the vibrating plate compactor working from the anchor wall towards the berthing face. The void between the new and old sheet piles will also then be filled in layers. The fill below the water level will be compacted using an H-pile connected to the vibro hammer which will drive into the backfill. This vibration will consolidate the fill to prevent future settlement. The fill above the water will be compacted as normal using the vibrating plate compactor.



*Figure 15. The new loading platform being filled*

### **Capping plate and wharf bollards**

When the filling of the space between the existing platform and the new sheet piles is at +/- 1 meter below finish level, the capping beam profile will be installed on the sheet piles in line with design details, with the use of the telehandler. At the same time the telehandler will also assist with the installation of the bollards which will be connected to the waling beam of the front wall.

### **Quay furniture**

Finally the quay furniture will be installed on the loading platform. These are the fenders, bollards and the ladders.



### Re-installation of services

Reinstatement of the services will be carried out by BAS with associated civils work provided by the BAM team.

#### 3.8.3. Mooring Dolphin

##### Top waling frame

The dolphin structure is made up of a top prefabricated waling frame. The waling frame is anchored in place by four permanent spud piles at each corner. These permanent structures are installed with the assistance of four temporary spud piles on the outside footprint of the dolphin on top of which two temporary piling gates are placed. The permanent spud piles are then put in position within the piling gates and driven into the seabed. Once the spud piles are in position the piling gates are removed and the permanent top waling frame is then installed by crawler crane over the four permanent spud piles and welded to them.

##### Sheet piles

Sheet piles will be installed starting at the berthing side of the dolphin and working counter clockwise to complete the square dolphin.

The installed permanent waling frame will serve as the inner gate and the external gates will be formed by the temporary piling gates. The sheet piles will be positioned between the temporary piling gates and permanent waling frames and vibro driven into the seabed. When all sheet piles have been driven in the top external piling gate will be removed and the sheet piles driven to the finished level. If necessary, an impact hammer will be used to drive the sheet in to its final depth.

Once all sheet piles are driven all the temporary works (piling gates and temporary spud piles) will be removed. Floating pontoons and divers will then be used to gain access to the sheets to trim them to level using a gas axe and to bolt the sheet piles to the waling frame.

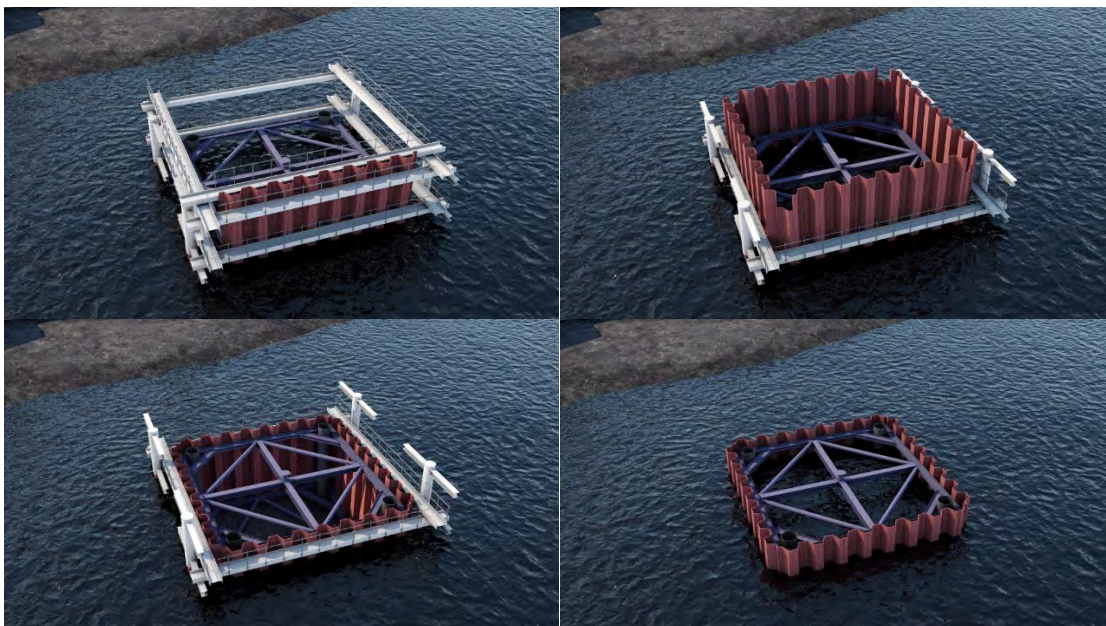


Figure 16. Installation of dolphin sheet piles including sheets being driven to finished level and temporary works removed.

## Filling

The dolphin cavity will be backfilled by a crawler crane using a clamshell bucket and the fill compacted using an H-beam suspended from the vibro hammer.

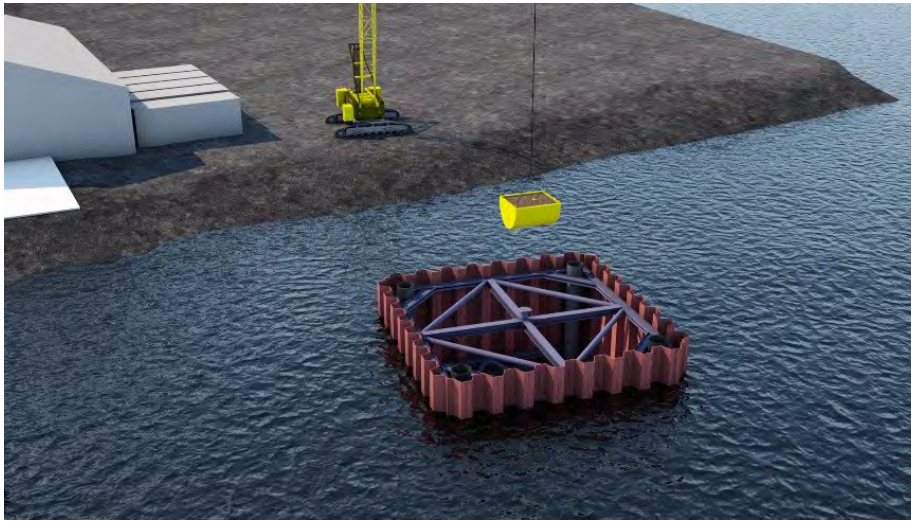


Figure 17. Backfilling the mooring dolphin

## Dolphin furniture

Landing platform - The landing platform for the walkway is a precast concrete block that will be placed on top of the back fill material. The concrete block will be picked up by the crane and placed on the fill. The mooring dolphin will then be further backfilled to the required level.

Fenders and bollard - The fenders, bollard, ladders and lifesaving equipment will be attached to the new structure. The crawler crane will install these items.

## Dolphin Walkway

Shore-side landing platform – This will consist of a precast concrete block and gabion baskets. The excavator will excavate the shingle shore to the required depth, place a layer of rock fill and level it out. The crawler crane will then place the concrete block on top and the excavator will back fill the area around it. Permanent gabions (filled with quarry rock) will be placed in front of the concrete platform to prevent washout.

Walkway assembly and installation – The walkway will be a prefabricated structure which can be assembled in parts on site and lifted as a single item directly into position once the foundations/platforms are prepared. Fixings for the fixed and free ends of the bridge will be determined in the later design stages.

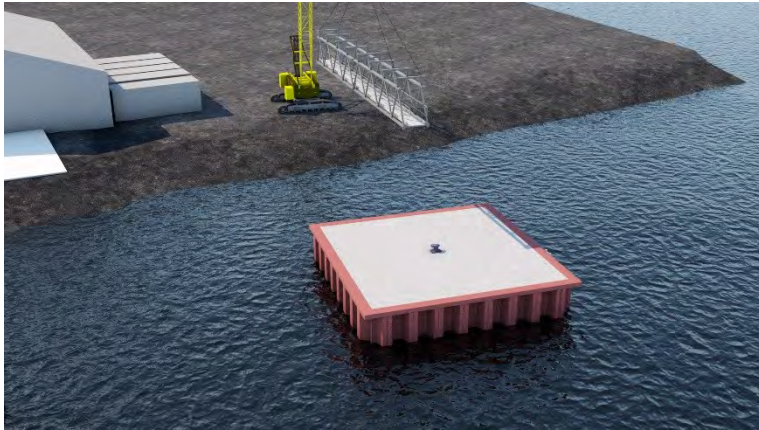


Figure 18. Installation of dolphin walkway

#### 3.8.4. Onshore Moorings

Three onshore moorings are required as part of the wharf redevelopment. They are made of sheet piles driven into the ground in a square to form a cofferdam.

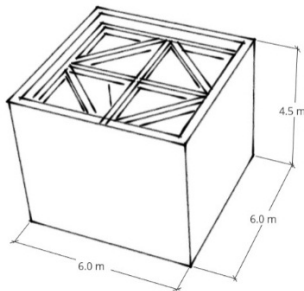


Figure 19. Mooring sheet pile cofferdam with waling frame installed

A temporary frame will be placed on the ground to align the sheets in place. All sheets will be driven into the ground using the crane and vibratory hammer to form a square of sheets. A permanent square waling frame will then be assembled and connected to the cofferdam. Finally, the bollard will be connected to the waling frame.

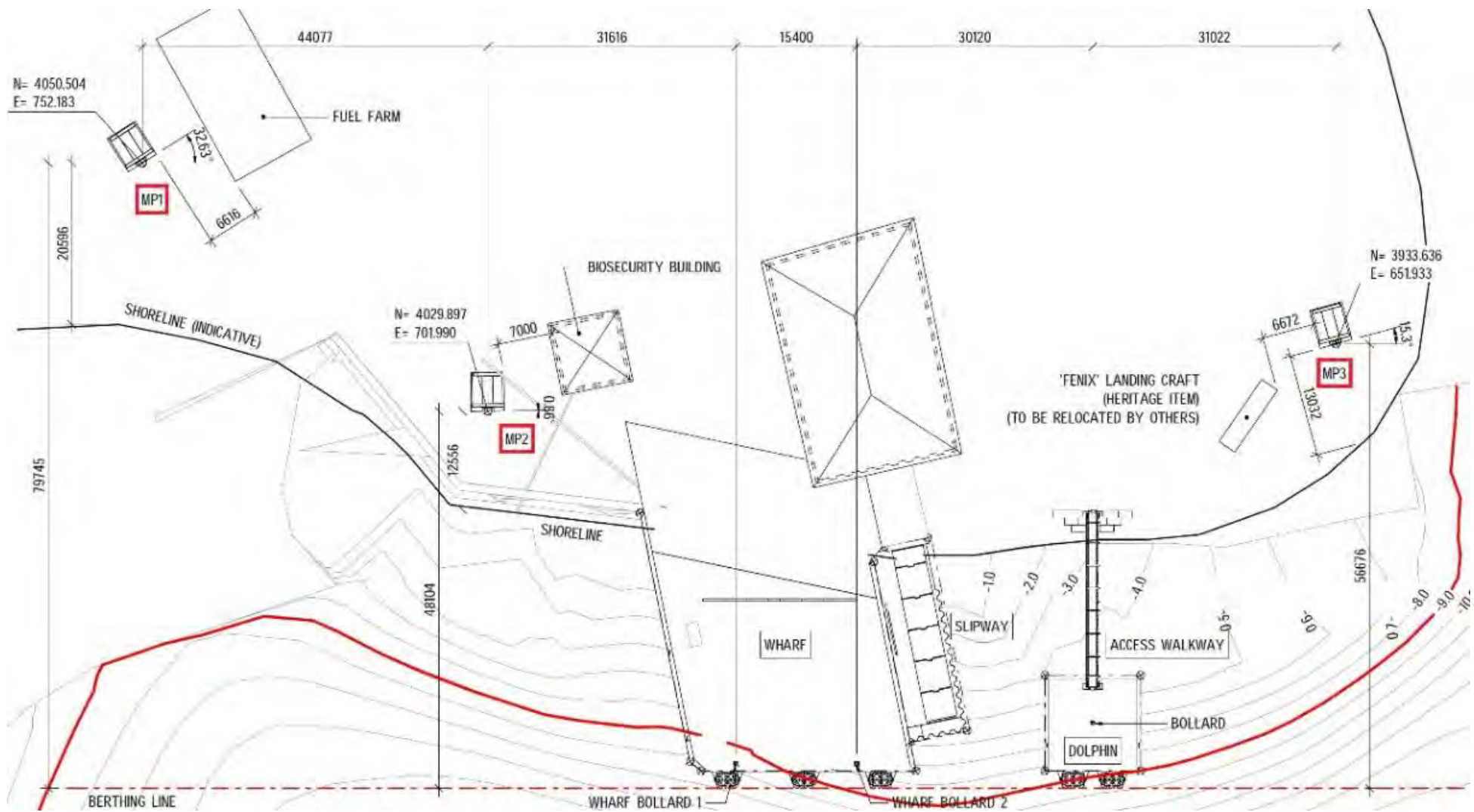


Figure 20. Mooring point locations on shoreline shown in red as MP1, MP2 and MP3

### 3.8.5. Slipway

#### **Existing lower slipway**

The lower part of the existing slipway will be demolished and removed to allow for the new slipway installation. To begin, a saw cut will be made with a concrete saw to create a straight connection between the existing 'paving' in front of the boat shed and the start of the new concrete slipway.

The existing concrete slabs will be demolished with a hydraulic hammer which will be attached to the excavator. The excavator will then remove the concrete rubble and put this aside for later use as fill.

#### **Sheet piles**

The first sheet piles will be driven at the bottom of the slipway working around to the shoreline. The installation will be supported by a temporary spud pile supporting a piling gate. The sheet piles will be positioned against the piling gate after which they will be vibrated into the seabed. The last part of the sheet pile may be driven with the use of an impact hammer.

Due to the limited space at the top of the slipway in front of the boatshed, the crawler crane will have to be positioned behind the loading platform or at the same position as it is placed during the works on the dolphin to drive the end wall. After the sheet piles have been installed the divers will trim the sheet piles to match the slope of the new slipway. The crawler crane or telehandler will assist when trimming the sheet piles.

#### **Filling**

Two 310 steel beams will be fixed on top of the fill material at the sloped position of the underside of the concrete slabs. The area between the steel beams will be further filled to the top of the steel beams. In addition to the quarried fill material, concrete rubble from the old slipway may also be used as fill material. A third steel beam will then be slid over the two steel beams to remove any fill material above the designed slope.

#### **Precast concrete slabs**

Precast concrete slabs will be installed and connected to a precast concrete beam at the top of the existing paving. The concrete slabs will be placed from the top and connected to each other by a hook. Large quarried stones will be placed between the sheet piles and the concrete slabs to act as rip-rap.

### 3.9. Construction Materials

The following key materials are anticipated for the construction of the wharf and associated structures.

- Sheet piles ~ 601 tonnes
- Tie rods ~ 12 tonnes
- Steel waling and capping beams ~ 80 tonnes
- Steel walkway ~ 13 tonnes
- Precast concrete ~ 28 m<sup>3</sup>

Many of the materials will be prefabricated in order to shorten the time required for installation on site. Detailed breakdown of materials is included in Appendix 7 – Construction Materials.

### 3.10. Equipment & Vehicles

The final size of the plant and equipment required to carry out the wharf and associated structures works will be determined by the capacity of the transportation vessel (cargo hold space and crane lifting capability) and the conditions on site. A full list of plant and equipment is detailed in Appendix 8 – Equipment and Plant, but the key equipment is summarised below:

- 300T Crawler crane
- Two Tractor 165hp
- 30T Excavator with hydraulic breaker
- 45T Excavator
- 24T Trailer
- Two 18T Rock tipping trailers
- Two Vibro Hammers (52M)
- Impact Hammer (S70)
- MEWP / Cherrypicker
- Two Plate compactors
- Two boats
- Two small work pontoons (and six small modular pontoon elements)

### 3.11. Personnel

Construction staff will be on site at KEP from January to June 2020. The footprint on site at KEP both for working and living is restricted and as such the construction team is being kept purposely small with appropriate skills required to deliver the works. Approximately 18 multi-skilled personnel will be deployed to KEP:

- 1 x Project Manager
- 1 x Construction Manager /Marine Mammal Observer (MMO)/ Diver
- 1 x Works Manager
- 1 x Sites Engineer
- 4 x Divers
- 1 x General Operator / Banksman
- 1 x Crane Operator
- 1 x Fitter
- 1 x Welder
- 2 x Machine Operator – 30 T excavator
- 1 x Machine Operator – Telehandler and Tractor
- 1 x Subagent - Plant Operator for quarry
- 1 x Machine Operator – Loading shovel and ADT
- 1 x Works Manager / Plant Certifier

The BAS KEP Doctor will provide any necessary medical services required by the BAM construction team. In addition, the BAM Construction Manager and BAS Project Manager will also be qualified advanced first aiders.

In addition to the key BAM construction personnel, the project will also have other support staff on site for either short periods or the duration of the construction. The key support staff currently identified are:

- 1 x BAS KEP Project Manager – the role will be split between three members of the project team who will provide cover throughout the season and provide project management supervision of all BAM works.
- 2 x BAS Chefs – responsible for preparing all meals for both KEP and BAM staff throughout project.
- 2 x BAS Medical Unit (BASMU) Doctors. The BASMU KEP Doctor will be on station as usual but will also be supported by another doctor for the duration of the construction works to ensure that the appropriate medical support is available for the BAM construction team and station personnel. In addition, the BAM Construction Manager will also be a qualified advanced first aider.
- 1 x General Station Assistant – responsible for supporting with cooking, cleaning, waste management and general support tasks for the project.
- 2 x Environmental Support – responsible for cargo biosecurity inspections and early implementation of EIA mitigation measures in January and early February.
- 1 x Ramboll support – the role will be split between two Ramboll staff who will provide cover throughout the season and provide technical assurance. As a secondary role they will also support with project management, environmental management support and station liaison support.

Roles and responsibilities of the construction staff are summarised below:

#### **BAM Project Manager**

The BAM Project Manager will oversee all contractual responsibilities and have overall responsibility for the BAM construction site and works. This will involve: Health, Safety, Environmental and Security, Site Activities, Staff, Administration, Quality Assurance and Control on site. They will also be the direct point of contact between the Contractor and the Employer. The temporary works will also fall under their responsibility.

#### **BAM Construction Manager**

The BAM construction manager will manage the construction activities and have line management responsibility for all the construction team.

#### **BAM General Foreman**

The General Foreman has the overall responsibility over the foremen and crews and will relay any problems and engineering issues back to the Construction/Project Manager.

#### **BAS Project Manager/Site Supervisor**

The BAS Onsite Supervisor/Project Manager is responsible for day to day stakeholder communication between BAS (including onsite communication to Station Leader) and BAM, as well as overseeing progress and BAS onsite contract administration.

### 3.12. Predicted Lifespan

The design life for the new wharf, slipway and dolphin is 50 years.

### 3.13. Plans for Decommissioning

If the wharf, slipway and dolphin were to be decommissioned in future then the reverse of the construction methodology, as described above, will be followed. The structures have been designed to allow for future systematic deconstruction. In short, the sequence would follow:

- Remove quay furniture
- Remove backfill material
- Cut the tie rods connecting to the anchor wall
- Remove outer sheet piles

The plan for decommissioning does not currently include the removal of the existing wharf where hydrocarbon contamination has been discovered. A detailed risk assessment and methodology would need to be considered to allow for the removal the existing structures that currently contain the contaminated material.



## 4. DESCRIPTION OF PROPOSED DEVELOPMENT 2 – Quarrying

### 4.1. Purpose and Need

The extension of the wharf and associated structures requires the use of fill material in the form of aggregate.

Backfill material is required to fill between the new and existing walls of the wharf and to provide fill for the mooring dolphin and slipway extension. A further fill layer is required over the entire footprint of the wharf to raise the platform level from the existing level of about +1.2 – +1.3mCD to +2.0mCD.

It is proposed that the material can be sourced locally by establishing a quarry site<sup>8</sup> to extract suitable rock talus / scree or a glacial moraine deposit, which will be free from dirt, soil, peat, loam, clay or organic matter. A total quantity of 2603m<sup>3</sup> of fill material is required (see table below).

Table 7. Volume of fill material required

Location	Volume required (m <sup>3</sup> ) / tonnes
Wharf wrap-around	1595 m <sup>3</sup> / 3509 tonnes
Slipway extension	143 m <sup>3</sup> / 315 tonnes
Dolphin	965 m <sup>3</sup> / 1903 tonnes
Total anticipated volume	2603 m <sup>3</sup> / 5727 tonnes

The material will need to be screened to select the appropriate sizes of rock particles and therefore it is expected that a larger quantity (than is required for fill) will need to be extracted in order to produce the required amount of graded fill. Two different grades of fill material are required i) to provide backfill for structure and ii) to provide a surface material for the wharf suitable for pedestrian and vehicular access. The surface material will comprise approximately the top 0.5m of the fill on the wharf.

The grading criteria for the fill material is defined below.

Table 8. Grading of rock/fill material

Description	Grading (mm/kg)
Backfill material	10 mm – 250 mm +
Surface topping	10 mm – 20 mm

### 4.2. Site Investigations completed in 2018/19

The requirement for a quarry site investigation was identified in the EIA Scoping document and the GSGSSI approved a site visit in November 2018 under a separate Regulated Activity Permit that was issued prior to completion of this EIA. The site investigation looked at eight possible locations and initially identified Q1 and Q6 as the preferred locations based on their estimated yield/volume and

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<sup>8</sup> Quarrying will be achieved by excavation only – no blasting is required.

ease of access. Sites Q3 and Q5b were the preferred back-up options at the time. See Appendix 10 - KEP Quarry Site Investigation Report.

Further investigation of these four sites were carried out in January, February and March of 2019 to determine the impact on sensitive ecological receptors and to determine the impact of quarrying activities on the aesthetic values of each site. Details of these investigations are in Section 9.1.1.1 of the EIA. Quarry 6 and other locations in the Grytviken area are home to a number of well-established non-native and invasive plants (see 9.1.7.1), none of which are currently established on the KEP track or at KEP station itself.

As such, quarrying locations will be restricted to areas on the KEP track only, with Q1 chosen as the preferred location and Q2 as the back-up option.



Figure 21. Quarry site investigations with Q1 as preferred and Q2 as back up quarry site.

### 4.3. Location

The site investigation concluded that Q1 and Q2 are the preferred quarry locations due to the following factors:

- suitability of the material
- ease of access
- short haulage distance
- lack of established non-native plants
- limited interference to wildlife
- limited interference to visitors to Grytviken

Samples taken from Q1 confirm that material from this area is suitable as a fill material and that the potential yield is relatively high and should be adequate to satisfy the requirements of the construction. Samples were not taken from Q2 during the site investigations however, this site has been quarried previously and there is confidence that the material will also be suitable as a back-up option for a very small quantity of fill material. Therefore, Q1 is the first choice for the extraction of the majority of the material.

#### 4.4. Alternatives considered

##### 4.4.1. Importing rock fill

The importation of aggregate from areas outside SGSSI poses a biosecurity risk due to the potential for it to include biological material such as soil, seeds, invertebrates and other propagules. In order to reduce the risk of introduction of terrestrial non-native species aggregate should either be dredged from a marine environment or sourced from a quarry of known provenance and be guaranteed to be free of topsoil. Preventative measures during transport and once on site are also required to prevent further contamination. These would include aggregate being stored in sealed bags within a sealed container, only the minimum amount required being shipped to South Georgia and being used as quickly as possible once on site to reduce the risk of any non-native species present becoming established in their introduced environment.

The cost of sourcing and transporting appropriately clean aggregate in the quantities required is prohibitively high and the risk of introducing new non-native species to South Georgia is considered too high to accept.

##### 4.4.2. Sourcing rock at other local areas

Alternative local quarrying options were considered as described in section 4.2 and as detailed in Appendix 10 - KEP Quarry Site Investigation Report, and section 9.1.7.1. The alternative locations were rejected primarily due to the risk of spreading already established non-native plants from the Grytviken area to the KEP area and vice versa. In addition, the alternate sites were also rejected due to insufficient yield and/or greater haulage distance and/or difficulty in accessing. The overall environmental impact of using these alternate sites was considered higher than the selected sites at Q1 and Q2.

#### 4.5. Overview of works

Quarrying works will begin early in the construction project programme (see section 7 for overall programme) and are expected to be completed in late March over a 9 week work period.

Table 9. Quarrying activities programme

Quarrying Activities	Start Date	End Date
- Quarry site set up	27/01/20	12/02/20
- Quarrying activities and material haulage to KEP	13/02/20	25/03/20

The quarrying activities will involve safe excavation using a 30T excavator with a rock bucket attached. The extracted material will be passed through a mobile screener to filter out the grades of material required. It may also be necessary to crush some larger pieces of rock, prior to screening, using a hydraulic hammer attached to the excavator. The processed material will be loaded by excavator into a rock trailer (pulled by a tractor) for transport to the construction site. Any remaining by-product from the quarrying will be stockpiled at the site for later reinstatement.

A total quantity of 2,603 m<sup>3</sup> (or 5,727 tonnes) of graded material above 10mm is required for the wharf construction project. Approximately, 4,732 m<sup>3</sup> (or 10,412 tonnes) of material will need to be excavated from the quarry in order to achieve the required volume of graded material.

#### 4.5.1. Quarry 1 (main site)

The area will need to be prepared for excavation works. There are two small areas of tussock grass that provide suitable nesting habitat for pipits and which will need to be removed as part of the quarrying works.

Pipits can raise up to three broods in a single season with each brood taking approximately 6 weeks from laying to fledging. There is a possibility that birds could be sitting on nests in the tussock when the construction work is due to begin. In order to avoid birds nesting in the area from late January onwards various options have been considered:

- The preferred option would be to remove the tussock grass in early September prior to the start of the project to remove the habitat and ensure that no birds are nesting in the area when the construction work begins. However, this option cannot be supported by BAS or GSGSSI as the appropriate staff and plant will not be on site at this time to carry out the removal of the tussock.
- Netting the tussock grass to prevent nesting was considered but this has the potential to cause bird entanglements and injuries and also runs the risk of being destroyed by seals leading to waste netting in the environment.
- The most practical and proposed solution is to monitor the area for nesting birds starting in early September. Any eggs found in the tussock grass prior to mid-December will likely fledge before the construction works are due to begin and can be left undisturbed. Any new eggs laid in the tussock from early January onwards are likely to delay the start of construction works by up to 2 weeks until the chicks fledge. In this situation, it is proposed that the nests are removed from the tussock and placed in a new location prior to hatching.

When the quarrying works begin in late January, the tussock grass will be removed (along with a layer of topsoil) and placed (tussock facing up) to one side. Further preparation works will also be carried out including removal of snow cover, creating access to the KEP track and preparing a location for processing of the extracted material. An HV cable that provides power to KEP traverses Quarry 1 and this will need to be located, exposed and protected prior to any excavation works.



Figure 22. Location of quarry 1 as seen from Grytviken

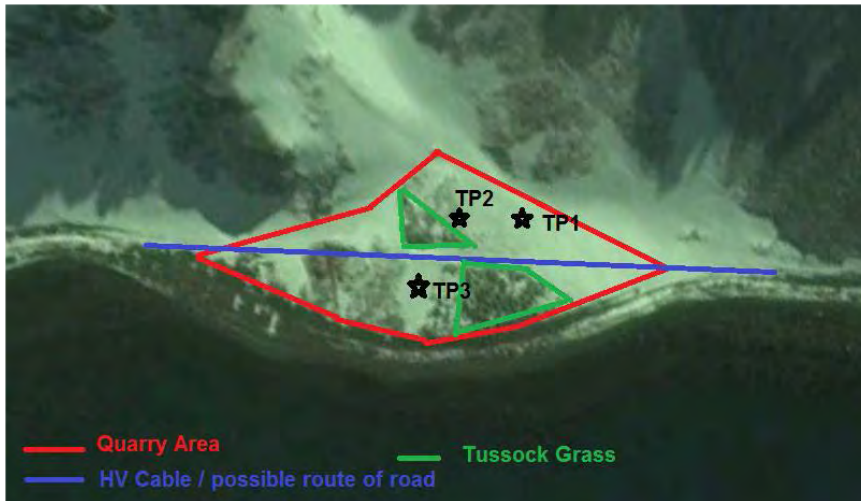


Figure 23. Quarry 1 area +/- 130mL and 55mW (adapted from GoogleEarth)

A topographical survey of Quarry 1 indicates that it is capable of an estimated yield of 3200m<sup>3</sup> of final graded material which is greater than the amount required (2603m<sup>3</sup>) for the completion of the wharf construction works. The rock extraction will take place in two stages. The area between the HV cable and the track/road first followed by the area between the HV cable and the cliff face.

#### Stage one – preparation of site

- Strip topsoil and vegetation and stockpile (tussock facing up) separately along the track and against the cliff face.
- Locate, expose and protect HV cable
- Level the ground in the processing area.
- Prepare the track/road for transport. The track is already level and 3.5 – 4.0m wide however, some filling of potholes and placement of fill over drainage pipes may be required.
- Carry out additional trial pits and particle size distribution to confirm the ground conditions are suitable (as per site visit in November 2018)

#### Stage two – extraction and processing

- Begin excavation works between the HV cable and the KEP track/road starting from the corner closest to Grytviken and working towards KEP.
- Initially, a small area of the quarry will be flattened out for the screener to operate but as the works progress the screener will be set up in a prepared area at the bottom half of the quarry. The excavated material will be screened as it is removed with the required product (> 10mm) loaded in the rock trailer and the by product stockpiled against the slopes in the worked out areas.
- The upper part of the quarry area will be processed only after the first half has been finished.
- Additional trial pits and testing of the material will be carried out as required.

#### Stage three – Reinstatement and landscaping

- Once excavation and processing is complete, the unused by-product will be used to fill the excavation areas making sure that the HV cable is well covered and protected.
- The by-product will be positioned to form a lower platform or berm at the base of the excavated areas to create additional stability to the excavated slopes.

- The topsoil and vegetation will be returned to the site.
- An accurate assessment of the final landscaped profile has not yet been made as this depends on how much product needs to be quarried to achieve the required quantity of graded material. The final profile assessment will be made on site.

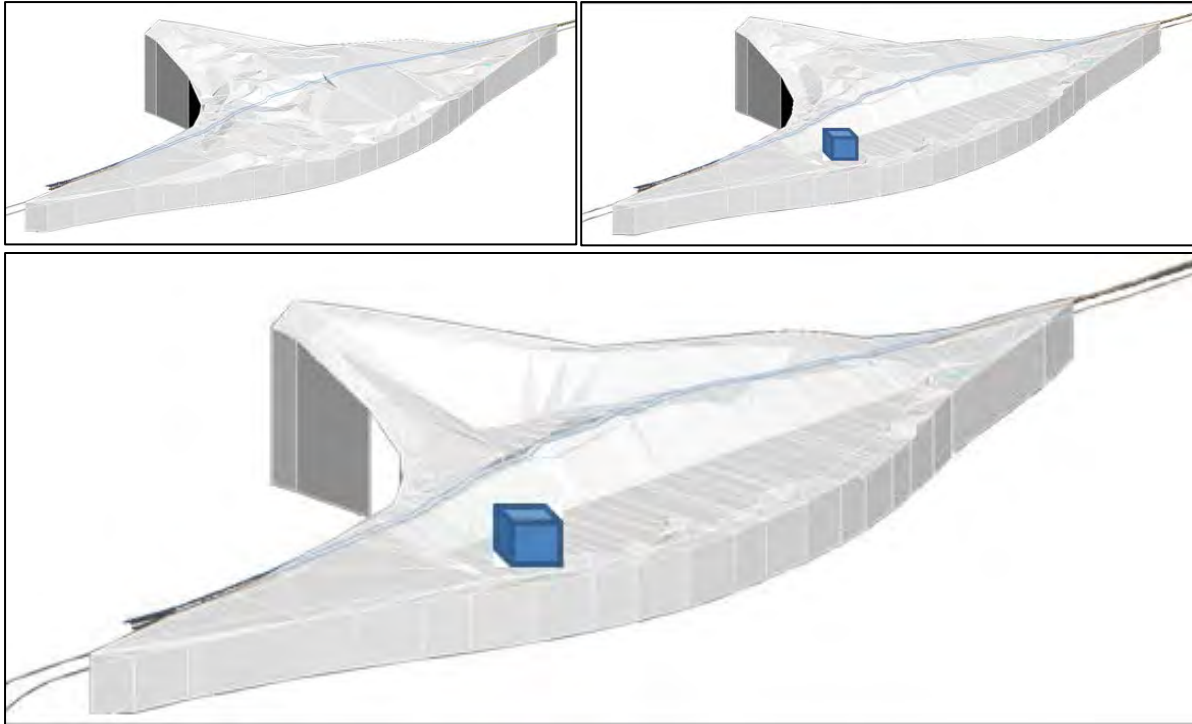


Figure 24. Left to right: Quarry 1 i) prior to excavation process; ii) after extraction of bottom part; iii) after all extraction (HV cable shown as blue line and screener as blue cube)

#### 4.5.2. Quarry 2 (back-up site)

Quarry 1 is expected to produce all the required fill material for the construction of the wharf. However, in the event that Quarry 1 is insufficient then Quarry 2 will also need to be worked to produce an additional small quantity of fill material. The process for extraction at Quarry 2 will be similar to those described above for Quarry 1.



Figure 25. Quarry 2 location, proposed excavated area in red

#### 4.6. Personnel and equipment & vehicles

The quarry works will be managed by a site supervisor and three operators assisted by the following vehicles and equipment:

- 1 x 30T Excavator with hydraulic breaker
- 1 x Mobile screener
- 2 x tractor with trailer

#### 4.7. Transport of material

Processed aggregate will be transported using the existing track from the quarry location to KEP for i) stockpiling at the village green (see 3.7) or ii) direct depositing in the area of final use.

Two 25T tractors with trailers will drive the 1.5km round trip. Each trip will involve loading, tipping and waiting and is expected to take 20 minutes. Therefore, assuming a 15% delay time, approximately 20 trips in each 8-hour working day are anticipated, capable of transporting 400 tonnes a day. A total of 286 round trips are required to transport the total amount of fill material for the wharf construction works.

The existing track will be used as both the haulage road and BAS, GSGSSI, museum and BAM pedestrian access. The track will be closed to other visitors such as tourists. The track is also frequently used, or crossed, by seals and birds. Vehicles will maintain a maximum speed limit of 10mph to ensure minimal disturbance to pedestrians and animals and to allow animals to safely move away from the track. A project specific Traffic Management Plan has been prepared, that describes measures to ensure safe movement of construction traffic:

- All vehicles have all round visibility achieved with mirrors and cameras.
- All operators will have VHF radio communication with a dedicated project channel
- 10mph speed limit
- There is a clear line of sight between KEP and the quarry sight and therefore there are no blind spots on the track.
- Overtaking is not permitted
- The track between the quarry and KEP will be closed to non-construction activity during the full duration of the quarry works. If during this period, transport on the track is required for BAS or GSGSSI operations this will be coordinated and managed on site.
- On-site training, inductions, signs and traffic controllers/banksmen will ensure safe use of the track.
- Vehicle marshals will be used for difficult manoeuvres only.
- Appropriate warning signs will be placed along the track and near vehicle operations to increase awareness.

## 5. DESCRIPTION OF OPERATIONAL PROCEDURES

### 5.1. Fuel management and oil spill response

The project will use approximately 100,000L of MGO fuel supplied by the stations' own fuel tanks. See 8.3.7 for details of the KEP fuel storage. KEP was refuelled by BAS in 2018/19 using the standard ship to shore refuelling procedure and therefore no further refuelling is anticipated during the construction season.

Small quantities of other fuels and hazardous substances will be supplied by the project as below.

Table 10. Construction fuel and hazardous substances (excluding MGO)

Fuel/hazardous substance	Storage	Volume/Size
Petrol	2 x 205L drums	410L
Oxygen	Cage	16 cylinders size W
Propane	Cage	4 cylinders size E
Galvafruid	COSHH store	5L
Line Marker	COSHH store	12 x 750ml cans
Engine oil	COSHH store	TBC
Hydraulic oil	COSHH store	TBC
Cutting compound	COSHH store	TBC

#### 5.1.1. BAM Refuelling Procedure

Daily refuelling of the majority of BAM project plant and vehicles will take place at the KEP fuel farm that is equipped with a hose and trigger nozzle assembly. Refuelling will only be carried out by BAM designated and trained personnel in accordance with the standard BAS refuelling procedures and following the BAM standard refuelling procedure as detailed below.

#### **BAS Fuel Farm Refuelling Procedure**

- Fuel for vehicles is taken from the hose and trigger nozzle assembly inside the fuel farm structure door.
- Refer to the 'Diagram of draw Off Valves' (on display in fuel farm). Select the tank to supply the fuel and open the appropriate valve in the range DO1 to DO6. Write "IN USE" on the tank in chalk.
- Open the valves DO7, DO8, DO9 and DO17. All other DO valves are shut.
- Open the electrical supply cupboard and select breaker S2 to hand.
- Switch on the power supply for fuel pump two. Zero the fuel meter and use the trigger nozzle to fill the vehicle, inform the generator mechanic of fuel drawn on completion.
- On completion of filling stop the pump, isolate the electrical supplies and close all the DO valves in the pump enclosure. Stow the hose trigger nozzle catching any residual fuel in a suitable container, which is inside the bund.



## **BAM Standard Refuelling Procedure**

- Only trained nominated personnel to carry out refuelling operations

### Prior to refuelling, ensure:

- You are in a safe position (i.e. no moving plant with free access to refuelling point)
- A suitable spill kit is available
- Check condition of hoses, nozzle for defects
- Deploy plant nappy at refuelling point

### During refuelling, ensure:

- Correct refuelling cap is removed (i.e. not a water tank)
- Funnels to be used at all times when refuelling containers
- Refuelling operations are supervised at all times
- Due care and attention is paid to prevent drips and spills
- Return fuel hose to its hook and that lids/caps are replaced on fuel containers/plant
- Fuel tanks are secured after use and drums are stored upright in an area where they will not be knocked over or damaged

#### *5.1.1.1. Procedure for refuelling with towable bowser*

Some plant and equipment, which is too difficult to move to the fuel farm (i.e. the screener that needs to be towed and the crane which is very large) will be refuelled on location using a towable bunded steel diesel bowser pulled by a tractor or similar plant item. Refuelling is only to be carried out by nominated and trained BAM refuellers.

### **Filling the Towable Bowser from the Fuel Farm.**

#### Before Filling the Bowser

- Ensure that spill kits are available and within easy reach of the refuelling location.
- Ensure that a suitable fire extinguisher (CO<sub>2</sub>, dry powder or foam) is available and within easy reach of the refuelling location
- Make sure the bowser is as close to the refuelling point as possible but allows access to the bowser hoses.
- Switch off all item of plant in the vicinity and remove the keys.
- Ensure no other sources of ignition are present.
- This is a two person job
- Both operators must be in radio contact during the procedure, carry out radio check before starting work

#### Filling the Bowser

- Put on PVC gloves
- Undo the diesel cap from the bowser
- Take an absorbent pad from the spill kit or use a plant nappy to catch any drips from the fuel hose.
- Follow the BAS standard operating procedure (as above) for refuelling from the Fuel Farm.
- Do not overfill the bowser. This will also help prevent spillage when on uneven ground.
- Filling of fuel tanks must be attended at all times, under no circumstances must tanks be left to 'fill themselves'

### After Filling the Bowser

- Place fuel cap back on the bowser.
- Place any diesel contaminated PPE or spill kit material in the oil contaminated waste drum.

### **Refuelling Plant and Fuel Tanks from the Towable Bowser.**

#### Before Refuelling

- Ensure that spill kits are available and within easy reach of the refuelling location.
- Ensure that a suitable fire extinguisher (CO<sub>2</sub>, dry powder or foam) is available and within easy reach of the refuelling location
- Make sure the bowser is as close to the item to be refuelled as possible but allows access to the bowser hoses.
- Switch off item of plant to be refuelled and remove the keys.
- Ensure no other sources of ignition are present.

#### Refuelling

- Put on PVC gloves
- Unlock the bowser
- Undo the diesel cap from the item of plant
- Use a plant nappy to catch any drips from the fuel hose.
- Place the fuel hose into the diesel refilling point on the item of plant.
- Start the diesel delivery pump.
- Do not use the latch on the delivery hose and walk away from the refuelling operation.
- Do not fill the diesel tank to the brim; allow a little room to prevent spillage on uneven ground

#### After Refuelling

- Place the diesel delivery hose back into the compartment within the bowser tank, ensuring any drips are collected by the absorbent pad or plant nappy.
- Relock the bowser tank
- Place fuel cap back on the item of plant refuelled.
- Place any diesel contaminated PPE or spill kit material in the oil contaminated waste drum.

### 5.1.2. BAM Emergency Oil Spill Contingency

The purpose of this contingency plan is to describe the procedures that will be used by BAM when working for BAS at KEP Research Station.

- BAM will be directly responsible for dealing with small volumes of spilt fuel and oil that do not pose a risk to the health and safety of staff and or wildlife.
- For larger oil spills (>205 litres), or small spills that pose a risk to the health and safety of staff and/or wildlife, the KEP Station Leader must be informed immediately. The response procedure will then be determined and coordinated by the KEP Station Leader. In such a circumstance, the KEP Oil Spill Contingency Plan will supersede any instruction provided below.

**Fuel and chemical spills within BAS are classified as follows:**

<b>Tier 1</b>	Small spills which can be dealt with immediately by one person or a dedicated station response team
<b>Tier 2</b>	Medium spills that require the full resources of the station and assistance from BAS Cambridge
<b>Tier 3</b>	Large spills which exceed the resources of the station and BAS Cambridge and require outside assistance

**In the event of a fuel, oil or chemical spill the following procedure should be followed:**

1	Stop work immediately	
2	If spillage is flammable, extinguish all possible ignition sources.	
3	Identify the source of the pollution and prevent further leakage. <ul style="list-style-type: none"> <li>• Plug leaking drums</li> <li>• Right upturned containers</li> <li>• Switch off machinery with leaking hydraulic hoses</li> </ul>	
4	Quickly assess the spill. Determine: <ul style="list-style-type: none"> <li>• The risk of fire or harm to human health</li> <li>• Time and location of spill</li> <li>• Type of spilt material and quantity</li> </ul> <p>All spills on water will be tier 2 or 3</p>	
	<b><u>For Tier 1 Spills</u></b>	<b><u>For Tier 2 or 3 Spills</u></b>
	Put on suitable PPE, including waterproof gloves	Immediately inform the Station Leader who will take responsibility for co-ordinating the spill response.
	Prevent further spread of spill using absorbent socks.	Put on suitable PPE, including waterproof gloves
	Attention to be taken to prevent oil from entering the sea, watercourses or drainage systems.	Follow the Station Leader's or Response Team's instructions.
	Inform the Station Leader	
	Recover spilt material using absorbent pads or skimmers.	
	Dispose of waste fuel, contaminated spill kit materials and PPE in 205ltr drums. The Station Leader will identify the correct drums for disposal.	

<b>For All Spills</b>
All personnel who may have come into contact with the spill are to receive a medical check up
BAM personnel and their subcontractors are to assist the Station Leader in preparing a detailed spill report.

### 5.1.3. BAM Spill Response Equipment

All items of plant over 20 tonnes will carry a spill response kit containing:

- 25 x 50cm x 40cm 'Superior' oil-only pad
- 4 x 7.5cm x 1.2m Superior Sock Oil
- 5 x 30cm black cable tie
- 5 x 46cm x 90cm 200 gauge blue plastic disposal bag
- 1 x Spill Kit instruction sheet
- 2 x Pairs Goggles
- 2 x Pairs PVC Gloves
- Contained in a 61cm x 48cm x 15cm Vinyl holdall

All other mechanical plant will carry a spill response kit containing:

- 18 x 50cm x 40cm 'Superior' oil-only pad
- 24 x 7.5cm x 1.2m Superior Sock Oil
- 3 x 30cm black cable tie
- 3 x 46cm x 90cm 200 gauge blue plastic disposal bag
- 1 x Spill Kit instruction sheet

## 5.2. Waste management (refer to SWMP)

Domestic waste produced by the project staff will be managed by BAS, in accordance with the Waste Management Handbook.

Construction waste will be managed by BAM in accordance with Appendix 9 – Site Waste Management Plan (SWMP). The SWMP includes a list of the predicted waste types, quantities and disposal options. Construction waste will be packed for shipping by BAM and removed from KEP by BAM using their chartered vessel. BAM will also be responsible for the subsequent waste disposal according to the waste hierarchy.

Before unused construction materials are defined as waste they will be offered to the BAS Station Leader and the Facilities Manager for re-use within the Research Station and approved by the BAS Environment Office.

The anticipated tonnage and volumes of waste from the KEP Wharf redevelopment activities are listed below.

Table 11. Excavation Waste

Type of Waste	Estimated Quantity by management method – Tonnes/(m <sup>3</sup> )			
	Total	Re-Use (on-site)	Recycle	Dispose
Crushed Stone	4,685 (2,129)	4,685 (2,129). Re-use as fill in the quarry		

Table 12. Construction Waste

Type of Waste	Estimated Quantity by management method – Tonnes/(m <sup>3</sup> )			
	Total	Re-Use (on-site)	Recycle	Dispose
Steel	500 (0.06)		500 (0.06)	
Alkaline Batteries	0.5 (<0.01)		0.5 (<0.01)	
Clothing/textiles	5 (≈0.1)		5 (≈0.1)	
Cardboard	40 (0.06)		40 (0.06)	
Paper	5 (0.03)		5 (0.03)	
Timber	200 (0.4)	100 (0.2)	100 (0.2)	
Plastic	10 (0.01)		10 (0.01)	
Oil	500 (0.5)			500 (0.5)
Oil filters	5 (0.01)			5 (0.01)
Oil contaminated rags	10 (0.04)			10 (0.04)
Aerosols	10 (0.1)			10 (0.1)

Table 13. Demolition Waste

Type of Waste	Estimated Quantity by management method – Tonnes/(m <sup>3</sup> )			
	Total	Re-Use (on-site)	Recycle	Dispose
Concrete	9.2 (4.0)	9.2 (4.0)		
Steel	2.5		2.5	

### 5.3. Biosecurity

The redevelopment project at KEP will involve the movement of personnel and transfer of cargo, equipment and plant between locations of distinct biological diversity. This increased activity at KEP has the potential to increase the risk of non-native species introductions into the local environment.

SGSSI Wildlife and Protected Areas Ordinance (2011) legislates to minimise the risk of non-native species introductions to the islands, and BAS and BAM are obliged to conform to this legislation. It is essential that all necessary precautions are taken to prevent the introduction of non-native species to KEP from other locations. A specific Biosecurity Plan (see Appendix 6 – KEP Biosecurity Plan) has been prepared detailing the guidance and measures that will be taken along the material supply chain as well as for activities taking place at KEP.

## 6. DESCRIPTION OF SUPPORT ACTIVITIES

### 6.1. Shipping – cargo

A vessel will be chartered to transport the bulk of the project cargo, materials and vehicles during a single trip from either a UK or EU port to KEP. The shipping contractor has not yet been selected but the decision will consider the total cargo (volumes and weights), capability of the vessel to offload materials at KEP, the draft of the vessel and its compliance with environmental regulations and the capacity of the KEP wharf to support the vessel coming alongside.

All cargo items will be biosecurity checked prior to loading onto the chartered vessel and the necessary checklists completed (Appendix 6 – KEP Biosecurity Plan) by the Charter Operator under the supervision of the BAM Environmental Lead. The vessel is expected to be loaded in the UK or EU in early December 2019 and sailing to KEP should take approximately 25 days without any stops.

A small quantity of cargo (approximately one 10ft container) and all the food provisions for the project will be delivered by the JCR during the vessels' first call to KEP in November. All cargo transported by BAS will meet the standard BAS Biosecurity Regulations.

Additional cargo (approximately 4 x 10ft containers) currently stored in the Falkland Islands will also be transported to KEP on the *Pharos*. Provisions will be made in the Falkland Islands to biosecurity check the cargo as per the EIA Biosecurity Plan.

### 6.2. Transport – personnel

All construction personnel will be input to KEP in early January by BAS vessel or FPV *Pharos*. Personnel will fly from the UK to the Falkland Islands where they will join the vessel for onwards transport to KEP. Other project support personnel may also be input throughout the season.

### 6.3. Accommodation

The construction project staff and project support staff will be hosted in Larsen House and Everson House. A total of 26 beds are available in these houses which is adequate to support the full site team and any potential temporary supporting staff. Both houses have a kitchen and communal area. The BAS KEP team normally lives in Everson House but will relocate to Discovery House for the duration of the project which also has its own kitchen and communal area. Two chefs and a general team assistant will manage all construction team and KEP staff catering and all meals will be prepared and served in Everson House.



Figure 26. KEP buildings layout with Everson House and Larsen House circled.

#### 6.4. Energy use

The project will use energy supplied by the existing KEP infrastructure. See section 8.3.8 for details of the stations power generation and usage.

#### 6.5. Water

The station water supply will support the additional fresh water needs of the project. See section 8.3.9.

#### 6.6. Unexploded Ordnance (UXO)

King Edward Cove was subject to military activity during the South Atlantic conflict and was under military operation from 1982 to 2001 (see Section 8.2.2 ). The risk of finding UXO on South Georgia during the construction project period has been considered and the project commissioned and completed an Explosive Ordnance Desktop Threat Assessment in August 2017 to assess the potential risks to the proposed works. The assessment was based on research of historical evidence.

The assessment concluded that KEP is a Low Risk site for ordnance but that the risk of encountering UXO during the proposed works could not be completely ruled out. The following risk mitigation measures will be implemented on site:

- The GSGSSI Government Officers will provide a UXO safety and awareness training session as part of the induction to KEP.
- All personnel will be instructed to take the following steps if they encounter UXO or suspect items during works on site:
  - DO NOT TOUCH!
  - Note its position and place a marker nearby; a GPS plot is ideal.
  - Make a note of its size, shape, colour, markings, condition and quantity; if possible
  - Take a digital photo.
  - Inform the Government Officer as soon as possible.
- GSGSSI will coordinate any emergency response to UXO found on site. Works in the area will cease until the site is declared safe.

## 7. CONSTRUCTION PROGRAMME

Construction activities at KEP will take place from January to early June 2020 over a 6 month period. The main key dates are as such:

- |  |                |
|--|----------------|
| ▪ Gathering of cargo, packing and biosecurity in EU/UK warehouse | Nov/Dec 2019   |
| ▪ Charter vessel with cargo departure from EU/UK                 | Dec 2019       |
| ▪ Staff arrival at KEP   | 10 Jan 2020    |
| ▪ Cargo vessel arrival at KEP                                    | 15 Jan 2020    |
| ▪ Cargo offload and Site Set Up                                  | Jan 2020       |
| ▪ Quarrying activities   | Feb – Mar 2020 |
| ▪ Construction activities  | Feb – May 2020 |
| ▪ Demobilisation:  | Late May 2020  |
| ▪ Final departure from KEP                                       | 06 Jun 2020    |

The detailed construction programme at the time of writing this EIA is shown below indicating specific construction activities and their timeframes based on the most recent information. The schedule is revised on a monthly basis and the detailed construction programme is expected to be finalised in August 2019.

Table 14. KEP Construction Programme

Construction Programme Activity	Start Date	End Date
Construction team training in UK	Oct. 2019	
<b>Mobilisation</b>		
- Pre-departure cargo consolidation including biosecurity inspections	21/11/19	13/12/19
- Charter vessel loading at UK/EU port and departure	13/12/19	21/12/19
- Construction team input to KEP (by BAS vessel or FPV <i>Pharos</i> TBC)	10/01/20	
- Charter vessel arrival, offload at KEP and departure	15/01/20	25/01/20
KEP construction site set up	27/01/20	08/02/20
Demolition works (removal of quay furniture, bollards and concrete slipway)	07/02/20	14/02/20
<b>Quarrying</b>		
- Quarry site set up	27/01/20	12/02/20
- Quarrying activities and material haulage to KEP	13/02/20	25/03/20
<b>Dolphin</b>		
- Dolphin piling	07/02/20	24/02/20
- Dolphin backfilling	25/02/20	03/03/20
- Dolphin quay furniture installation	25/03/20	30/03/20
- Walkway installation	31/03/20	06/04/20



<b>Wharf</b>		
- Wharf extension piling	03/03/20	18/03/20
- Wharf waling and tie rods	16/03/20	03/04/20
- Wharf anchor wall	04/04/20	14/04/20
- Wharf extension backfilling	16/03/20	30/04/20
- Wharf capping plate and quay furniture	22/04/20	04/05/20
<b>Slipway</b>		
- Slipway piling	19/03/20	24/03/20
- Slipway backfilling and precast panels	25/03/20	17/04/20
<b>Mooring</b>		
- North onshore mooring	21/04/20	27/04/20
- Mid onshore mooring	24/04/20	30/04/20
- South onshore mooring	28/04/20	04/05/20
<b>Reinstating services</b>	01/05/20	06/05/20
<b>Demobilisation</b>		
- Preparing plant, material, equipment	01/04/20	06/06/20
- Charter ship arrives, loading of ship and departure	27/05/20	04/06/20
- Construction staff departure 1 (quarry and welding team) – by BAS vessel	01/04/20	03/04/20
- Construction staff departure 2 (final personnel) – by BAS vessel	04/06/20	06/06/20

## 8. DESCRIPTION OF THE SITE

### 8.1. Location

King Edward Point is a research centre for applied fisheries research and the GSGSSI administrative centre which is owned by GSGSSI and operated by BAS. BAS staff provide logistic and boating support for the GSGSSI as well as delivering an agreed science plan which provides critical research to support sustainable fishing in the SGSSI Maritime Zone.

KEP Station (54°17' South, 36°30' West) lies at the entrance to King Edward Cove, a small sheltered bay within Cumberland East Bay. It's an area of flat land at the head of the cove surrounded by rising mountains and cliffs on all sides. KEP is located midway along the island of South Georgia in the Southern Atlantic Ocean about 1400 km south-east of the Falkland Islands. The island of South Georgia is around 170 km long and between 2 km and 40 km wide and its highest point is at Mount Paget (2,960 m) on the Allardyce Range.

Other infrastructure in the cove includes Grytviken, a historic whaling station and its associated structures, which is managed by the GSGSSI under the South Georgia Heritage Policy and Strategy and is a popular visitor site.

### 8.2. History of Site

Captain Cook claimed South Georgia for the UK in 1775. The islands have been under UK administration since 1908. South Georgia and the South Sandwich Islands were declared a British Dependent Territory by the South Georgia and South Sandwich Islands Order (1985). Today South Georgia and the South Sandwich Islands are a separate Dependent Territory or Overseas Territory. The Governor of the Falkland Islands is currently the Commissioner for South Georgia and the South Sandwich Islands.

South Georgia was first sighted by London merchant Antoine de la Roche in 1675 and was later claimed for Great Britain by James Cook in 1775. In his book about the voyage, Cook, made special mention of the abundance of seals, whales and seabirds, which encouraged sealers from the United States and the UK to venture south. Sealers hunted fur seals almost to extinction by the end of the 19th century. In 1904 the Norwegian Carl Anton Larsen established a whaling station at Grytviken, the first of several on South Georgia, which operated until 1965.

The first buildings were built at King Edward Point in 1912 to provide the administrative post for the Government Magistrate who had responsibility for the supervision of the whaling industry and issuing of whaling permits. The last formal Magistrate remained on site at King Edward Point until 1969 (almost 4 years after the closure of the last whaling station at SG).

The first government science presence at King Edward Point was made by the *Discovery Investigations* by establishing a scientific laboratory and accommodation (Discovery House) for some of their scientists in 1925.

The British Antarctic Survey took over the buildings at King Edward Point in 1969 and the Station Leader (then known as the Base Commander) was also appointed GSGSSI Magistrate. Since this time, the BAS Station Leader at KEP has continued to perform both functions of the station management on behalf of the BAS Director and any necessary duties for the Commissioner for South Georgia and the South Sandwich Islands.

BAS managed the research station at KEP from 1969 until the outbreak of the South Atlantic Conflict when the island was invaded by Argentine troops in 1982. A British Military garrison occupied King Edward Point from then until 2001 when it was again handed back to BAS for scientific operation.

### 8.2.1. Past Developments

#### **Buildings**

##### Pre-1930s

King Edward Point has been occupied since 1912 when the first permanent buildings were established for the Government Magistrate. The only building which remains from this era is the Customs gaol which was built in 1911 and which was renovated in 2009/11 and now acts as a storage for government supplies.

The second oldest building, Discovery House, built in 1925 was the first government science structure to be erected at KEP by the Discovery Investigations. The building still stands at KEP and was recently renovated and converted to self-contained accommodation block in 2012/13.

##### Post-1990s

Larsen House, named after Captain Carl A Larsen, Norwegian whaler and explorer, was built in 1992 (upgraded in 2001/02) and provides additional accommodation during the summer months.

In 2000/01 four new station buildings were erected at KEP research station. The James Cook biological laboratory, named after Captain James Cook who claimed South Georgia for Britain. Everson House, a new accommodation building named in honour of Inigo Everson, BAS marine biologist who worked for BAS between 1964 - 2002. Shackleton Villa, a self-contained apartment attached to Everson House was provided for the Government Marine Officer and is now used for additional Government accommodation. The other buildings were a food store and generator/boat shed.

In 2006 a new building was erected for the Government Officer, and named Carse House after Duncan Carse, who led the South Georgia Surveys of the 1950s.

During the 2000/01 major station construction works a number of older buildings were also demolished including Shackleton House, built in 1962/63 as a hospital and accommodation, the Customs House, Coleman's (the former residence of the last Magistrate) and Quigley's (the former residence of the last government engineer).

#### **Wharf**

##### 1925 or 1926 - original jetty

The first jetty was built at the end of King Edward Point in 1926 and was formed by filling a shallow (timber boat), that was discovered on the shore as early as 1902, with aggregate and sinking it in place. It consisted of a timber deck suspended on timber piles.

##### 1980/81 – original jetty repairs

The original timber jetty was renovated and two mooring dolphins were installed to the south side of the berth. The sunken shallow may have remained in place during these renovation works but photographic evidence from the time suggests that it was removed.

In 1985 the wooden jetty was damaged beyond repair when the ship that was moored alongside it broke away from its mooring in strong winds and impacted the berth whilst trying to re-berth.

#### 1986/87 - existing wharf construction

The old wooden jetty was replaced in 1986/87 by the Royal Engineers Military Construction Force with a Larsen sheet pile construction, which was backfilled with locally sourced scree and beach aggregate. The front wall of the jetty was tied to the back wall and a reinforced concrete capping beam was installed to secure the northern, southern and western walls. Four small bollards were also installed on the wharf, two near the berthing face and two set further back along the northern and southern walls.

#### 1999/00 - existing wharf repaired

In the late 1980s and early 1990s the wharf was inspected several times due to the capping beam failing leading to deformation of the wharf front wall. The damage was likely caused by poor compaction of the fill material and poor construction of the capping beam. Further refurbishment works were carried out by the Military Works Force from October 1999 to April 2000. They replaced the capping beam, mooring points on the quayside and installed off-quay bollards along the shoreline. The works were designed to a Design Working Life of 10 years.

#### 8.2.2. Past Military Activity - Unexploded Ordnance (UXO)

KEP and Grytviken were subject to military activity during the South Atlantic conflict and the invasion of Grytviken by Argentina and subsequent recapture by Britain in 1982. A British military garrison was held at Grytviken and KEP from 1982 until 2001.

GSGSSI has a UXO policy and management plan in place. The following advice is provided to people who may find an item of UXO or suspect item:

- DO NOT TOUCH!
- Note its position and place a marker nearby; a GPS plot is ideal.
- Make a note of its size, shape, colour, markings, condition and quantity; if possible
- Take a digital photo.
- Inform the Government Officer as soon as possible.

#### 8.3. Current use of site

KEP is owned by GSGSSI but is operated by BAS as a facility for applied fisheries research. The resident community at KEP and Grytviken is made up of personnel from BAS, GSGSSI and the South Georgia Heritage Trust (SGHT).

BAS staff are the largest resident group and they live, work and operate the facilities at KEP station. A total of eight BAS staff live at KEP year round with numbers increasing in the summer due to short-term summer science and project visitors.

GSGSSI employ 3 Government Officers (GO) on rotation and usually have 2 GOs living at KEP throughout the year. GSGSSI also employ a Deputy Postmaster who manages the post office and lives at KEP.

SGHT employ a museum director and up to 5 other staff on shorter contracts. They live and work at nearby Grytviken where they manage the museum and shop.

### 8.3.1. Domestic

A range of buildings are located at KEP some of which are used for BAS research purposes and some of which are used for government administration.

Accommodation for up to 38 people is distributed between three buildings: Everson House (main accommodation), Larsen House (short-term accommodation for summer visitors) and Discovery House (visiting science accommodation).

Table 15. KEP buildings and their use (adapted from KEP Station Management Handbook, 2016)

KEP Building	Description
Everson House	Constructed 2001. Accommodation and living facilities primarily for BAS staff. Sleeps up to 18 staff.
James Cook Laboratory	Constructed 2001. Laboratories and offices for BAS team, Government Officer and Government Post Office.
Temperature Controlled Facility	Constructed 2001. Provides holding tanks for Marine science.
Larsen House & Macklin Medical Centre	Larsen House was constructed in 1992. It is an ex MOD building which was renovated in 2002 and expanded to include the medical centre at one end of the building. Larsen, provides self-contained accommodation for 12 people and is primarily use for summer visitors and external projects.
Food Store	Constructed in 2001 as storage for dry, cool and frozen provisions.
Boatshed	Constructed in 2001 and houses workshops, boatshed, generator shed, general storage.
Hydro-electric turbine House (located at Grytviken)	Constructed in 2008 at Grytviken, it provides electricity to KEP and the museum at Grytviken.
Fuel Farm	Constructed in 2001, it contains 6 banded fuel tanks with a roof.
Discovery House	Historic building dating from 1925. It was renovated in 2012/13 as self-contained accommodation.
Biosecurity Building	Constructed in 2009 it provides containment for incoming cargo, fresh provisions and travel equipment.
Carse House	Constructed in 2005. Self-contained 3 bedroom house, accommodation for the Government Officer and GSGSSI visitors.
Shackleton Villa	Constructed 2001. A self-contained two bedroom apartment attached to Everson House. Government Officer accommodation.
JCUFI store	This is a row of small brick built coal sheds/stores which were converted to storage rooms in 2013/14.
Gaol	Constructed in 1911 and renovated in 2009/11 for storage of government supplies.

KEP station follows a 08:30-17:30 working day Monday-Friday. However, personnel are expected to work hours outside of this period as necessary to achieve the agreed workload.

There is no chef employed at KEP for the BAS team and cooking duties are split out amongst the team using a rota system.

### 8.3.2. Recreation

There is plenty to keep people fit and active on station. The boat shed hosts a small gym with the usual gym equipment. The boat shed is also used for table tennis and when the boats are removed can also be used as a badminton court. Recreational walking, scrambling and running is popular around King Edward Cove and further afield. Other sports activities include skiing, snowboarding and snow-shoeing in the winter months, recreational boating (supported by the boatperson) and football on the old football pitch at Grytviken. There are also daily opportunities for wildlife watching and photography with opportunity to travel further afield to the many penguin colonies on nearby beaches. On station staff have access to a library, numerous board games and puzzles, regular film nights and musical instruments.

### 8.3.3. Science

King Edward Point Research Station is a centre for research into the sustainable management of commercial fisheries around the island of South Georgia. Research is carried out by BAS scientists on behalf of the GSGSSI.

Scientists carry out strategic research on the biology and ecology of the commercially fished species, Patagonian toothfish (*Dissostichus eleginoides*) and mackerel icefish (*Champscephalus gunnari*) as well as on a number of dependent and by-catch species. The research is varied and involves the analysis of specimens and data obtained from a range of sources such as trawl surveys, fishery samples (provided by the scientific fishery observer programme operating at South Georgia) and plankton trawls carried out in association with the GSGSSI Fisheries Patrol Vessel. Major areas of research include the development of growth models for the exploited species, assessing the response of populations to changing environmental conditions and examining ecosystem relationships of the exploited species and more recently, providing data to assist with marine spatial planning at South Georgia. In addition, this research also complements areas of the core BAS 'Ecosystems' research programme, conducted by BAS scientists in the Southern Ocean.

In addition, to fisheries research, since 2008 a Zoological Field Assistant has carried out field research in support of a higher predator monitoring programme at South Georgia. Predator reproductive performance and diet are monitored providing data underpinning the Conservation of Antarctic Marine Living Resources (CCAMLR) Ecosystem Monitoring Programme site at Maiviken. The results of the research are provided to CCAMLR and are used to assist with the stock assessments and population modelling of target species undertaken by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) on behalf of the GSGSSI [KEP Research Station Management Handbook, 2006].

In 2015, a new meteor radar was installed at King Edward Point to discover more about how small mountainous islands in large oceans impact global atmospheric circulation through gravity wave propagation. One of the radar antennas is located behind the boatshed at KEP.

A BAS Automatic Weather Station is also located behind the boatshed and it provides pressure, temperature, and wind speed and direction data for long-term monitoring.

A tide gauge owned by the National Oceanographic Centre (NOC) is positioned on the existing wharf and provides sea level changes data.

Part of the South Georgia Wave Experiment (SG-WEX) run by the University of Bath, BAS, the Met Office and the University of Leeds, the radar works by detecting meteors or shooting stars as they enter the Earth atmosphere. By tracking the speed and direction of meteor trails, the radar provides information on the wind in that part of the atmosphere.

In 2011, the British Geological Survey (BGS) re-established the King Edward Point magnetic observatory, extending observations made by BAS from 1975 to 1982. The observatory plugs a significant gap in the global network of magnetic observatories, allowing better monitoring of the South Atlantic Anomaly and changes occurring deep within the Earth [BAS website, KEP science].

#### 8.3.4. Tourism

The GSGSSI allows regulated tourism visits to South Georgia by commercial cruise ships or yachts. Vessel operators are mostly all members of the International Association of Antarctica Tour Operators (IAATO) and they are granted access to a total of 49 approved visitor sites of which Grytviken is the most visited site. All visiting vessels to South Georgia are required to call at Grytviken as part of the customs and tourism clearance process managed by the GSGSSI Government Officers. In 2017-18 a total of 82 cruise ship visits and 14 yacht visits were made to South Georgia with a total of 10,227 passengers landed ashore during the season which lasts from approximately late October to middle of March.

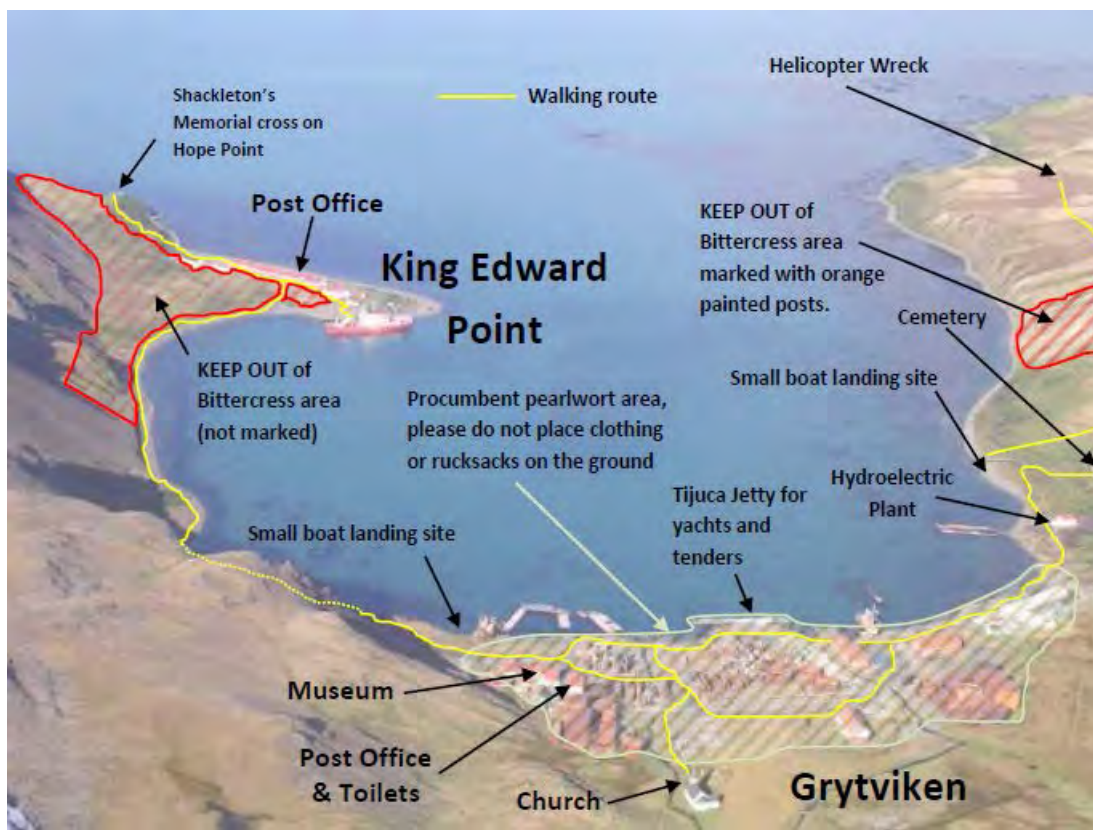


Figure 27. GSGSSI visitor map indicating the route (in yellow) that visitors are permitted to walk on and the location of KEP, Grytviken and the whaler's cemetery.

### 8.3.5. Vehicle operations

KEP has one JCB 531 Loadall which is managed by the BAS Mechanical Services technician. However, at least half of the KEP personnel are trained to operate it for everyday work.

### 8.3.6. Boating operation

The Senior Boating Officer is responsible for the safe operation of boats, crew training, boat maintenance and record keeping. All boat trips must have a boat operator and one crew as minimum. The following boats are used at KEP:

- 2 x 10.5m Harbour Launches Mustang Marine Ribworker - General purpose boats to support Marine Officer duties;
- 2 x 5.5m RIB Humber 'Defender' - General purpose boats, personnel transfer ship to shore, recreation support and beach landings;
- 1 x 2.5m 'SOLAS' RIB tender - Ship to shore personnel transfers or operations within King Edward Cove.

### 8.3.7. Fuel Storage

The bulk of KEP fuel is held in the fuel farm which is capable of holding 300,000 litres of Marine Gas Oil (MGO). If the station is reliant purely on these stocks for power supply then this represents approximately 18 months of fuel supply. However, since the introduction of the hydroelectric power plant in 2008, MGO fuel consumption has reduced to approximately 45,000 litres annually.

Location	Capacity of tanks (litres)	Contingency Containment
Fuel Farm	6 x 50,000 ltrs (Total = 300,000)	Bund can contain over 100% of tanks capacity
Generator shed	2 x 2,700 ltrs	Double skinned tank
Boiler	1 x 1,800 ltrs	Double skinned tank
Disco house coal shed	1 x 2,500 ltrs	Double skinned tank

Figure 28. KEP fuel storage

### 8.3.8. Power Generation

The main source of power is provided by the Hydro Electric turbine house at Grytviken which is powered by water from the Gull Lake dam. Electrical power is generated and transferred to Grytviken and KEP 24hrs per day.

The generator shed in the boatshed also holds two diesel engines which can power generators to provide electricity in the event the hydroelectric plant fails or during its maintenance shutdown.

### 8.3.9. Water Supply

Due to South Georgia's abundant precipitation there is no shortage of water. Water from a stream in Bore Valley is directed, via a dam, through pipework to Grytviken and KEP and then through a process of filtration and UV sterilisation to holding tanks which supply the station.

### 8.3.10. Waste Management

Waste management at KEP follows the BAS Waste Management Policy and the guidance provided in the BAS Waste Management Handbook.

The BAS Waste Management Policy is to:



- Minimise waste in the first instance;
- Reuse and recycle at source where possible; and
- Remove all wastes other than sewage, grey water or food waste for reuse, recycling or final disposal.

At KEP, waste is separated at source, compacted and packaged within the waste management room of the boatshed. Segregated waste is stored in a designated 20ft ISO container behind the boatshed during the year to await collection once or twice each season by BAS vessels. All recyclables and hazardous wastes are returned to the UK for recycling or safe disposal and all general (non-hazardous) wastes that cannot be recycled are sent to the MOD managed landfill site in the Falkland Islands. BAS currently has an 81% average recycling rate across all its stations with KEP achieving a 91% recycling rate during the 2016/17 season.

The only wastes produced at KEP that are disposed of in the local environment are waste food, sewage and grey water. Sewage and urine and grey water are macerated and discharged directly to sea. Waste food is pressure cooked and macerated before being discharged to sea. The exception is foods that decompose slowly, such as fats and orange peels which are incinerated in batches on site by the Government Officers in the GSGSSI drum incinerator.

## 9. DESCRIPTION OF THE ENVIRONMENT

The objective of this section is to provide baseline environmental data for the area around King Edward Point Research Station and the potential quarry sites in the local vicinity, to inform the EIA for the redevelopment of the wharf and the removal of rock for its construction

South Georgia teems with wildlife, including large populations of seals, penguins and flying birds. The local seas are rich in fish and krill and whales can be seen in the local waters. The northern coast contains many deep fjords and bays, which provide protected anchorage. Most of the gentler slopes below about 100 m are covered with tussock grass, but in places relatively level swards of shorter grass and other plants occur. These are dotted with small pools and tarns. Above about 100 m are areas of sparsely vegetated gravels and cryptogam-dominated scree and rock faces.

Rats and mice were introduced to South Georgia by sealers and the Norwegian whalers introduced reindeer as a source of fresh meat. However, the rats caused dramatic negative effects on the island's bird populations, while the reindeer damaged local plant populations. Following island-wide eradication efforts, in May 2018 the island was declared free of invasive mammals.

King Edward Point lies on a spit of low lying land within Cumberland East Bay on the northern coast of South Georgia at Lat. 54° 17G S, Long. 36° 30G W. The former whaling station at Grytviolen lies about 750 m to the west of the site. To the north of the site the land rises steeply to an altitude of about 500 m.

The following sections describe the flora and fauna found in the areas around King Edward Cove.

### 9.1. Ecology

#### 9.1.1. Terrestrial Flora

The vegetation surrounding King Edward Cove is similar to that of other areas of mainland South Georgia. The dominant plant is tussock grass, *Poa flabellatae*, that wherever it is influenced by fur seals or seabird colonies is a deep green colour (see figure below), presumably due to the availability of nutrients; elsewhere it is distinctly yellowish-green. This robust grass grows in clumps or tussocks, up to a metre in diameter and 1 to 1.5 metres high, the shoots radiating from a peaty stool composed of the dead and dying leaf bases with mineral inclusions. The density of the tussock vegetation is largely determined by water availability, with dense vegetation forming in wet areas, and more open tussock on drier ground. On seaward slopes up to about 100 m above sea level the tussock grass forms an almost pure continuous stand, the dense shade provided by the overhanging shoots preventing the growth of any other vascular plants between the clumps.



Figure 29. Fine scale habitat map of King Edward Cove showing NDVI vegetation (satellite data from <https://www.sggis.gov.gq>)<sup>9</sup>



Figure 30. Elephant seals in tussock near KEP station

Over some areas of low altitude grassland around South Georgia, including around King Edward Cove, there has been damage by fur seals, resulting in the crowns of individual tussocks being killed leaving a fringe of flattened living tillers. At the most severely affected sites seal erosion has left areas of bare hummocky ground. Clearings in tussock grassland may be occupied by more or less extensive swards or by banks of mosses, with variable amounts of the grass *Deschampsia antarctica*, *Callitriche antarctica*, the burnets *Acaena magellanica* and *A. tenera* or the pearlwort, *Colobanthus quitensis*. In nitrogen-enriched situations the foliose alga *Prasiola crispa* may occur.

Further inland, and particularly near the whaling station, larger areas of flatter wet ground are dominated by extensive swards of Antarctic hair-grass (*Deschampsia antarctica*) and wet habitat mosses. On scree and boulder fields and on cliffs and rocks near the coast, lichen and moss communities can be found. However, these are not dominant in the areas around the research

<sup>9</sup> Normalized Difference Vegetation Index (NDVI) quantifies vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs). NDVI always ranges from -1 to +1. For example, when you have negative values, it's highly likely that it's water. On the other hand, if you have a NDVI value close to +1, there's a high possibility that it's dense green vegetation.

station. The table below provides a list of native plant species found in the vicinity of King Edward Cove.

Table 16. Native plants in the vicinity of King Edward Point

Name	Common Name	Abundance
<i>Acaena magellanica</i>	Greater Burnet	common
<i>Acaena magellanica</i> x <i>A.tenera</i>	Hybrid Burnet	uncommon
<i>Acaena tenera</i>	Lesser Burnet	common
<i>Callitriche antarctica</i>	Antarctic Starwort	uncommon
<i>Colobanthus quitensis</i>	Antarctic Pearlwort	common
<i>Colobanthus subulatus</i>	Lesser Pearlwort	uncommon
<i>Cystopteris fragilis</i>	Brittle Bladder-fern	uncommon
<i>Deschampsia antarctica</i>	Antarctic Hair-grass	common
<i>Festuca contracta</i>	Tufted Fescue	common
<i>Galium antarcticum</i>	Antarctic Bedstraw	common
<i>Grammitis poeppigiana</i>	Strap Fern	rare
<i>Hymenophyllum falklandicum</i>	Filmy-fern	uncommon
<i>Juncus inconspicuus</i>	Lesser Rush	uncommon
<i>Juncus scheuchzerioides</i>	Greater Native Rush	common
<i>Lycopodium magellanicum</i>	Magellanic Clubmoss	common
<i>Montia fontana</i>	Water Blinks	uncommon
<i>Ophioglossum crotalophoroides</i>	Adder's-tongue	uncommon
<i>Phleum alpinum</i>	Alpine Cat's-tail	common
<i>Poa flabellata</i>	Tussock Grass	common
<i>Polystichum mohrioides</i>	Shield fern	common
<i>Ranunculus biternatus</i>	Antarctic Buttercup	common
<i>Rostkovia magellanica</i>	Brown Rush	common
<i>Uncinia macrolepis</i>	Smith's Sedge	uncommon

#### 9.1.1.1. Vegetation surveys at proposed quarry sites

To ascertain the impact of any activities on local vegetation, photographic surveys were undertaken in Jan/Feb 2019 at each of the originally proposed quarry sites (Q1, Q3, Q5b and Q6) as described in section 4.2.

Photographs showing the typical habitat at each of the proposed quarry location are shown below. A blue 35 litre rucksack has been used for scale in each image.

At quarry site 1 the dominant vegetation was the introduced plant *Poa annua*, which covered up to 80% of the ground in some areas. Other plants with surface coverage up to 15% included *Acaena magellanica*, *Deschampsia antarctica*, *Festuca contracta* and *Poa flabellata*. Vegetation cover at quarry sites 3b and 5b were much sparser with up to 90% of the ground free of vegetation. Plants present at site 3b included *Acaena magellanica* and *Festuca contracta*, which site 5b also contained *Acaena tenera*, *Deschampsia antarctica* and *Phleum alpinum*. Quarry site 6 had a generally high level of vegetation cover, with *Festuca contracta* covering up to 70% of the surface but with other plants, including *Acaena tenera*, *Blechnum penna marina*, *Deschampsia antarctica* and *Rostkovia magellanica*, common with up to 20% surface coverage.

**Quarry site 1: road between KEP and Grytviken**

54°16.770 S, 36°30.137 W	54°16.782 S, 36°30.098 W
	
54°16.769 S, 36°30.062 W	
	
54°16.786 S, 36°30.045 W	



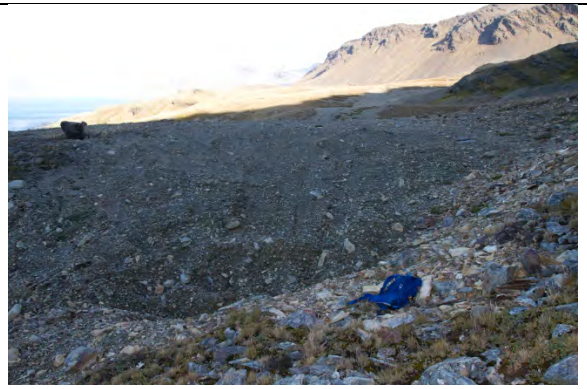
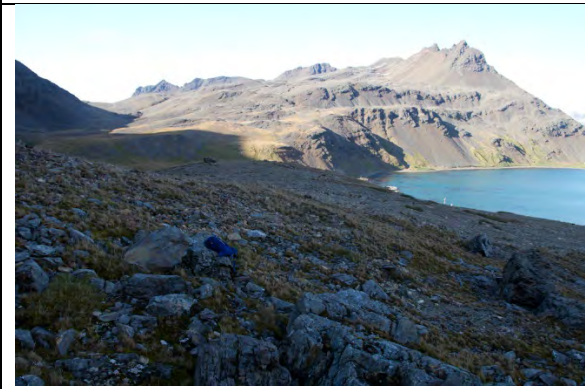
54°16.798 S, 36°30.025 W



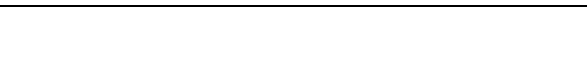
**Quarry Site 3**

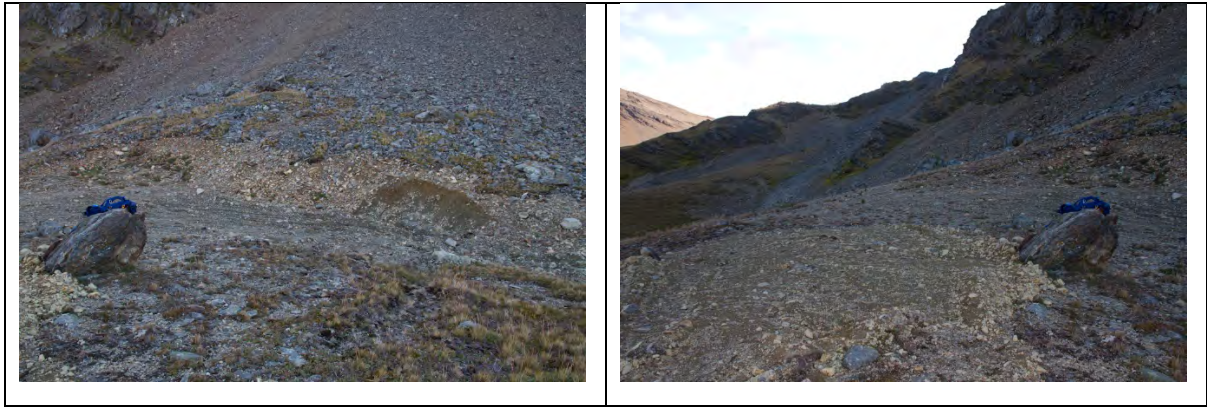
54°17.011 S, 36°30.931 W

54°16.988 S, 36°30.897 W

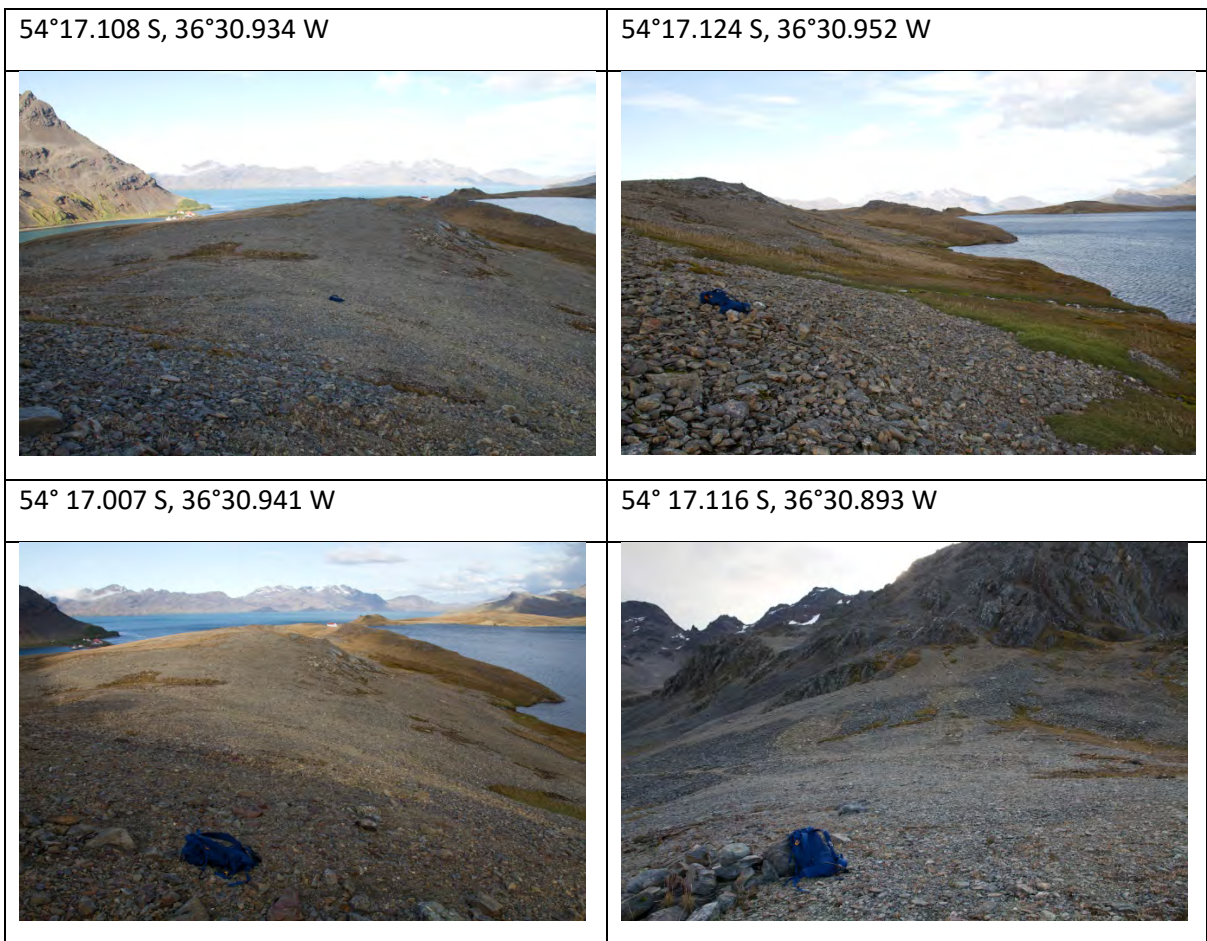


54° 17.011 S, 36°30.951 W

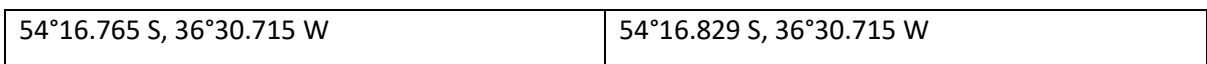




**Quarry Site 5b**



**Quarry Site 6**





### 9.1.2. Terrestrial Fauna

No native or non-native terrestrial mammals, other than humans, are now found on South Georgia. Neither does the island have any reptiles or amphibians. Invertebrate fauna around King Edward Point is similar to that of the rest of mainland South Georgia where over 200 species are found. The most obvious macroscopic forms include enchytraeid worms, an oligochaete (*Microscolex georgianus*), numerous mites, springtails, the spider *Notiomaso australis*, beetles, and several flies including a large helcomyid kelp fly (*Paractora trichosterna*) found along the shore. The freshwater pools and streams in the vicinity do not appear to support an extensive invertebrate fauna, apart from larvae of the chironomid *Parochlus steineri* in the streams.



Table 17. Common native invertebrate species found at Grytviken whaling station

Order	Family	Species
Coleoptera	Perimylopidae	<i>Hydromedion sparsutum</i>
	Lathridiidae	<i>Aridius malouinensi</i>
Diptera	Heleomyzidae	<i>Prosopantrum austrinu</i>
	Sphaeroceridae	<i>Archiborborus albican</i>
	Heleomyzidae	<i>Paractora trichostem</i>
	Palloppteridae	<i>Heloparia ekeloefi</i>
	Chironomidae	<i>Parochlus steinei</i>
	Mycetophilidae	<i>Mycoma bifida</i>
Araneae	Micryphantidae	<i>Notiomaso australi</i>

### 9.1.3. Marine Benthic Communities

South Georgia is a highly isolated island with its marine life influenced by the circumpolar currents. The nearshore benthic marine communities have been researched sporadically over the last two centuries with most species collections and records documented for a limited number of sites within easy access. Limited shallow marine survey work has been undertaken but that which has been carried out indicates that South Georgia's subtidal assemblage consists of species characteristic of South American, Falkland Islands, Antarctic, or circumpolar distributions. Marine communities generally show high species diversity and abundance with the exception of the littoral zone where ice abrasion and glacial inputs mean lower density and diversity. Permanent communities occur in the intertidal zone, especially in rock pools, and these are dominated by algae, hydroids, littorinid and polyplacophoran molluscs, amphipod crustacea and polychaete annelids. The tidal range is normally less than two metres and so zonation patterns are not especially obvious. In deeper waters, common fauna includes *Parborlasia corrugatus* (Nemertea), nereid and polynoid polychaets, *Glyptonotus antarcticus* (Amphipoda), *Serolis sp.* (Crustacea), sea spiders (Pycnogonidae), the nudibranchs *Austrodoris kerguelensis* and *Flabellina sp.*, the gastropods *Nacella concinna*, *Margarella sp.*, *Trophon sp.*, the echinoderms *Odontaster validus*, *Diplasterias brucei*, ophiuroids, stalked jellyfish (*Haliclystus antarcticus*), and many varieties of ascidians, sponges, and anemones.

#### 9.1.3.1. Seaweed

Despite the harsh conditions of the shallow marine environment of South Georgia a unique and diverse array of algal flora has become well established resulting in a high level of endemism. Generally, seaweeds show the strongest zonation throughout the intertidal zone, where the most diverse assemblages were at or near low tide areas. A report by E. Wells et al., (2011) suggests that there are at least 127 species of seaweed around South Georgia, with species observed around KEP listed below.

Table 18. Seaweed found in the vicinity of KEP

Group	Species name
Brown algae	<i>Desmarestia menziesii</i>
	<i>Geminocarpus germinatus</i>
	<i>Macrocystis pyrifera</i>
Red algae	<i>Callophyllis atrosanguinea</i>
	<i>Callophyllis variegata</i>
	<i>ErythroGLOSSUM undulatissimum</i>
	<i>Gymnogongrus turquetii</i>
	<i>Iridaea cordata</i>
	<i>Myriogramme smithii</i>
	<i>Piconiella plumosa</i>

N.B: No green algae were found at KEP

#### 9.1.3.2. KEP wharf marine biodiversity survey

A survey of the benthic environment adjacent to KEP wharf was undertaken by BAS researchers in May 2018 to describe the benthic life present in front of the wharf and on the structure itself and describe the seafloor substrate. A Deep Trekker G2 ROV (Remotely Operated Vehicle), modified with additional lighting, was deployed from a rigid-hulled Inflatable Boat (obtained from the RRS *Ernest Shackleton*) at seven points shown in Figure 31. Video transects were run perpendicular to the wharf and started approximately 50 m away from the front waterside edge of the wharf. The ROV followed a straight line towards the wharf remaining 50 cm above from the seafloor. Two vertical surveys took place on the wharf face (labelled with crosses in the figure), with the ROV remaining approximately 20 cm away from the wharf and drifting up at a rate of 10 m min<sup>-1</sup>. At all times the ROV camera was kept angled towards the seafloor or wharf front with variation only made to check obstruction and direction. Large numbers of kelp clumps and anthropogenic debris, such as scaffolding poles and fishing line caused the most significant obstacles, which necessitated detours to prevent entanglement of both the ROV umbilical cord and ROV itself.

#### Seafloor substrate

The seafloor substrate consisted mainly of soft sediment near the start of the video surveys (c. 50 m away from the wharf). As the ROV approached within 20-30 m of the wharf the soft sediment gave way to poorly sorted sediment consisting of cobbles, pebbles and sand. Occasional large rocks or anthropogenic structures were found in the soft sediment and tended to be colonised by kelp.






Figure 31. KEP wharf showing 5 (1-5 red lines) video survey tracks and 2 (1&2 black crosses) vertical wharf surveys

### Benthic and wharf survey

The benthic survey used a modified SACFOR scale (see <http://jncc.defra.gov.uk/page-2684>) the results of which can be found in Table 21. For the purposes of this assessment, the area in front of the wharf was treated as a single survey site. However, the majority of life was found in the latter 25 m of the surveys (towards the wharf), which coincided with the presence of poorly sorted substrate, so there was variation within each survey. Between surveys, however, variation remained relatively low with the largest range in SACFOR Key Score being 2, showing that biodiversity was reasonably consistent along the length of the wharf. The wharf transects showed a large abundance of many taxa in a relatively small sample area. All species were treated as morphotypes (i.e. animals with similar morphological characteristics) as species identification was impossible without detailed imagery and collection. The tables below present:

- Example images of the morphotypes observed during the survey;
- The SACFOR key, which provides details on the frequency or density of individual morphotypes; and
- The results of the survey for the horizontal and two vertical transects.

Table 19. Morphotypes observed at KEP wharf

Images of morphotypes found at KEP	
001: kelp	
002: feather worm – solitary sabellidae	
003: colonial pink-mouthed hydroid	

004: yellow seastar



005: red algae



006: foliose bryozoan



007: yellow fronds



008: cushion seastar



009: limpet



010: brittle star



011: orange sponge



012: stalked ascidian



Table 20. SACFOR Key (modified from <http://jncc.defra.gov.uk/page-2684>)

Score	SACFOR	Description
P	Present	Could not quantify abundance but present
0	Absent	Did not appear during survey
1	Rare	Only one or two representatives
2	Occasional	One or two representative found rarely
3	Frequent	Found regularly throughout the survey
4	Common	Three or more representative found regularly
5	Abundant	Representatives rarely not seen
6	Super-Abundant	Representatives are covering a large majority or all of the seafloor

Table 21. Results of survey showing SACFOR diversity across horizontal and vertical transects

Morphotype	Seafloor horizontal transect number					Sum	Mean Score	Range	Wharf vertical transect number	
	1	2	3	4	5				x-1	x-2
001	2	2	2	2	3	11	2.2	1	4	4
002	1	1	0	0	0	2	0.4	1	0	0
003	2	0	1	0	2	5	1	2	2	0
004	3	4	5	5	5	22	4.4	2	5	5
005	2	1	2	2	2	9	1.8	1	3	5
006	1	2	1	0	0	4	0.8	1	2	5
007	0	2	1	1	1	5	1	1	6	6
008	0	1	1	0	0	2	0.4	1	0	0
009	0	0	0	0	0	0	0	0	0	P
010	0	1	0	0	0	0	0	0	0	1
011	0	0	0	0	0	0	0	0	0	2
012	0	0	0	0	1	1	0.2	1	0	0



#### 9.1.4. Avifauna

Several species of birds breed in the general area around Grytviken and KEP, and it is likely both that numbers of individuals will increase and new colonies will become established now that rats have been eradicated (see Figure 32). Breeding species include light-mantled albatrosses (not present every year) and white-chinned petrels, which breed mainly in small groups of nests or burrows in high ground away from the buildings. There were few of the smaller burrowing petrels breeding in the area prior to the rat eradication; they may be increasing but will also be breeding mainly or entirely on the high ground. Most of those species prefers tussock slopes except for Wilson’s storm petrels which typically breed in crevices in boulder scree and South Georgia diving petrels which breed in burrows dug in fine scree. There are small numbers of scattered nests of South Georgia pintails in the area, again mostly in higher ground near fresh water ponds, and within a few days of hatching, female ducks can be seen closer to the shore with broods of ducklings. South Georgia pipits have been recorded nesting in the tussock and a few fledglings were seen in 2018/19. A small number of territories of brown skuas are present east of Grytviken, and Antarctic terns breed around Gull Lake and behind the church at Grytviken. There is considerable seasonal variation in the presence of nonbreeding birds, but king penguins (which moult in the area), kelp gull, Antarctic terns, South Georgia shags, South Georgia pipits and South Georgia pintails are frequently seen foraging in shallow water or on the shoreline, and often rest on the beaches.

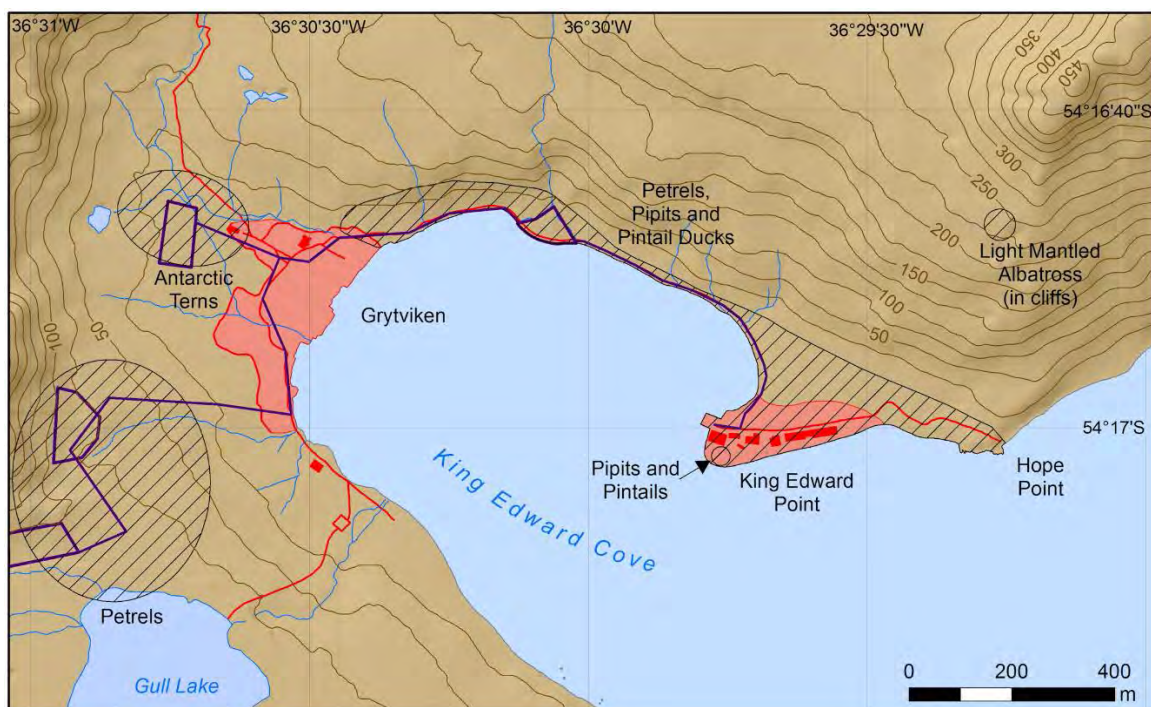


Figure 32. Approximate distribution of breeding birds around King Edward Cove (breeding areas by species shown in grey lined areas).

Table 22. Laying and fledging dates for birds that breed in vicinity of King Edward Cove

	Breeding Species	Laying	Fledging
1	light-mantled albatross	October	June
2	Wilson’s storm petrel	December	March

3	white-chinned petrel	November	April
4	South Georgia pintail	November	March
5	South Georgia pipit	November	February
6	Antarctic tern	November	March
7	brown skua	November	February

#### 9.1.5. Fish assemblages

Several species of fish are known to inhabit the waters of King Edward Cove. Sampling was undertaken between 2002 and 2006 using trammel nets to sample the fish assemblage throughout winter and summer. Focussing on the sites closest to the wharf, in waters between 25 and 45 meters depth the most commonly encountered fish were rock cod such as the marbled rock cod (*Notothenia rossii*), humped rock cod (*Gobionotothen gibberifrons*) and the black rock cod (*Notothenia coriiceps*). Low numbers of other species such as Antarctic dragonfish (*Parachaenichthys georgianus*) and blackfin icefish (*Chaenocephalus aceratus*) were also present. *Notothenia rossii*, *N. coriiceps* and *P. georgianus* were present throughout the year with samples being taken in January, March, April, May, July and October.

A long-term sampling effort of larval fish abundance has taken place in Cumberland Bay since 2002. From this dataset it is clear that larvae of several of these fish species are present throughout the year, and peak between September and November (Table 23). This indicates that the spawning seasons (for *G. gibberifrons*, *P. georgianus* and *C. aceratus*) occur in late winter and spring (Belchier & Lawson, 2013), this is a pattern which has been described in detail in previous work (North, 2001) and similar to other sub-Antarctic regions (Koubbi et al., 2009).

Table 23. Temporal variability in larvae of fish species known to inhabit King Edward Cove. Larval samples were averaged from Cumberland Bay as a whole. Only 7 and 8 samples of *N. rossii* and *N. coriiceps* respectively were found over the sampling period (January 2002 – October 2008, Belchier & Lawson, 2013).

	<i>N. rossii</i>	<i>G. gibberifrons</i>	<i>N. coriiceps</i>	<i>P. georgianus</i>	<i>C. aceratus</i>
<b>Months present in larval assemblage</b>	n/a	All year	n/a	August - November	August - February
<b>Peak month</b>	n/a	November	n/a	September	November

These results suggest that whilst fish will be present throughout the construction period, due to the timing and localised nature of the proposed works at KEP, the mobility of fish species and the timing of their spawning cycle, it is unlikely the construction work will have a noticeable impact upon the fish assemblage. Therefore, any impacts of the KEP wharf construction on the fish assemblage in King Edward Cove are likely to be centred on the noise produced during piling and building activities. Anthropogenic noise may cause disruption to several aspects of fish ecology being influenced by noise such as predator prey interactions, communication and distribution of species (Slabbekoorn et al., 2010).

## 9.1.6. Marine Mammals

### 9.1.6.1. Seals

The immediate vicinity of the wharf area at KEP is home to two species of seal, elephant seals (*Mirounga leonina*) and Antarctic fur seals (*Arctocephalus gazella*). Elephant seals breed on the flat grassy area on the seaward side of the KEP buildings, east of the wharf, from late August to November. After suckling weaned pups remain for another 4-6 weeks becoming increasingly mobile and often gathering on or swimming around the wharf itself. Juvenile animals return to the area to moult from November/December followed by adult females Dec/Jan and Bulls later in the summer. All elephant seals have typically left the area by mid-March – April.

Antarctic fur seals also occur around KEP and Grytviken during the spring and summer months (November-April) in low numbers (100s) although these are typically juvenile and sub-adult males that come ashore to rest and play. Individual females may, during December, pup near to the wharf. However, the main breeding areas are usually along the southern side of the cove and around the coast at Maiviken. Fur seal pups enter the water during January and gradually expand their exploratory range until weaning in April so that their interaction with the wharf area will increase as the summer progresses.

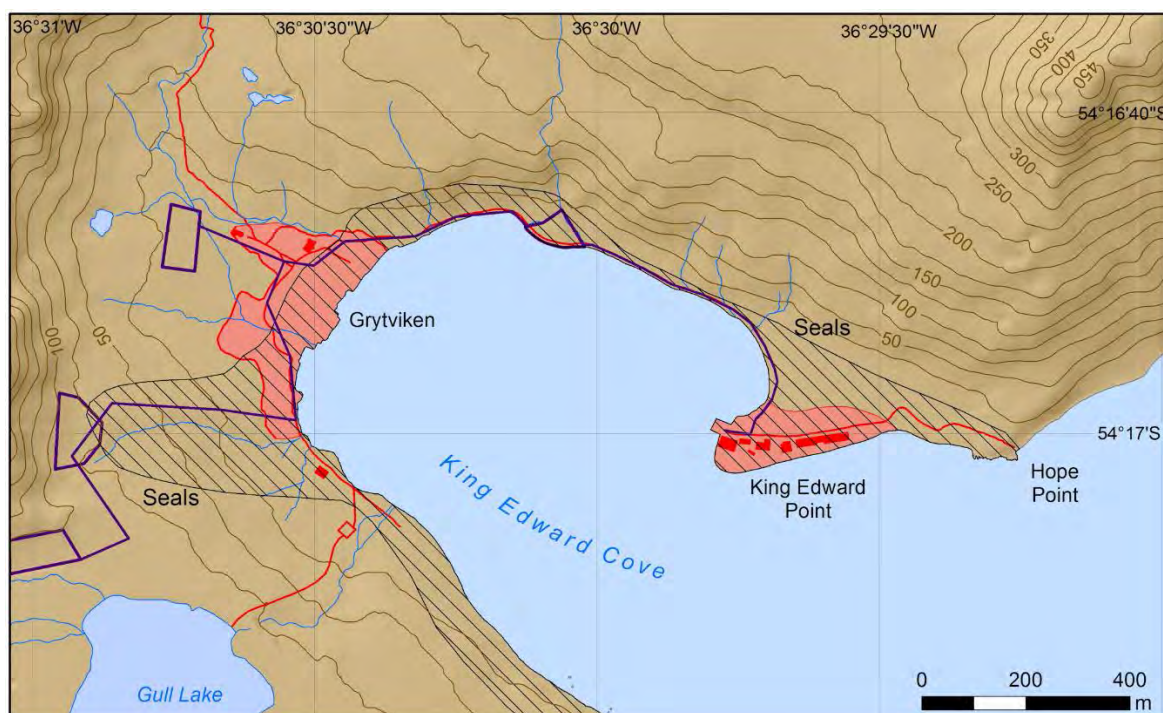


Figure 33. Approximate distribution of transient elephant and fur seals around King Edward Cove. Elephant seals breed on KEP itself, while fur seals breed in low numbers in the band of coastal tussock east of Gull Lake.

### 9.1.6.2. Whales

Whales are rarely seen in King Edward Cove, but southern right whales, *Eubalaena glacialis*, and humpback whales, *Megaptera novaeangliae*, are sometimes seen feeding in Cumberland East Bay, mainly between December and March, occasionally as late as early June. Minke whales, *Balaenoptera acutorostrata* and killer whales, *Orcinus orca*, are recorded from time to time.

### 9.1.7. Non-native species

Rat and mice eradication operations throughout South Georgia mean the risk of rat, mouse or reindeer impacts to the area around King Edward Point, and South Georgia as a whole, have been greatly reduced, if not eliminated, and the native species are recovering their earlier distribution ranges. Strict biosecurity measures are in place to reduce the risk of reintroductions of rodents.

#### 9.1.7.1. Non-native plants

The small and fragile vegetated ecosystems of South Georgia cover approximately 30,000 hectares (8% of the total area of the island). There are 25 species of native vascular plants on South Georgia and 41 non-native plant species, which have been introduced through human activities, including originally by sealers and shore-based whaling operations. The only invasive alien widely distributed on South Georgia is *Poa annua*, although five others (*Cerastium fontanum*, *Rumex acetosella*, *Taraxacum officinale*, *Deschampsia caespitosa* and *Poa pratensis*) grow up to at least 1 km from former whaling stations. After reindeer were removed from South Georgia (although there were no reindeer on the Thatcher Peninsula where KEP is located), non-native plant species were released from grazing pressure and, as a consequence, have been able to grow, flower and set seed unhindered. The GSGSSI have put in place a non-native plant management programme and it is estimated that 33 non-native plant species can be managed to zero density or eradicated by 2020 given adequate resourcing. Figure 34 shows the distribution of the non-native plants in the vicinity of King Edward Cove. It should be noted that bittercress (*Cardamine glacialis*) and smooth meadow grass (*Poa pratensis*) are the dominant non-native plants around KEP, but a wider diversity of non-native species are found in the vicinity of Grytviken. In particular, the 'Village Green' area of KEP, located near the jetty and between the fuel farm, biosecurity shed and Discovery House, contains soil with a persistent seed bank of bittercress. Monitoring and eradication of emerging plant is ongoing (Indigena, 2019).

It can be seen from the figure below that bittercress is the dominant non-native plant in the vicinity of KEP, yet it has not managed to establish at the proposed quarry sites. Proposed quarry sites, 1, 3b and 5b seem to contain no non-native species that are currently subject to management control, while quarry site 6 contains a widespread population of common bent (*Agrostis capillaris*) and also some sheeps sorrel (*Rumex acetosella*).

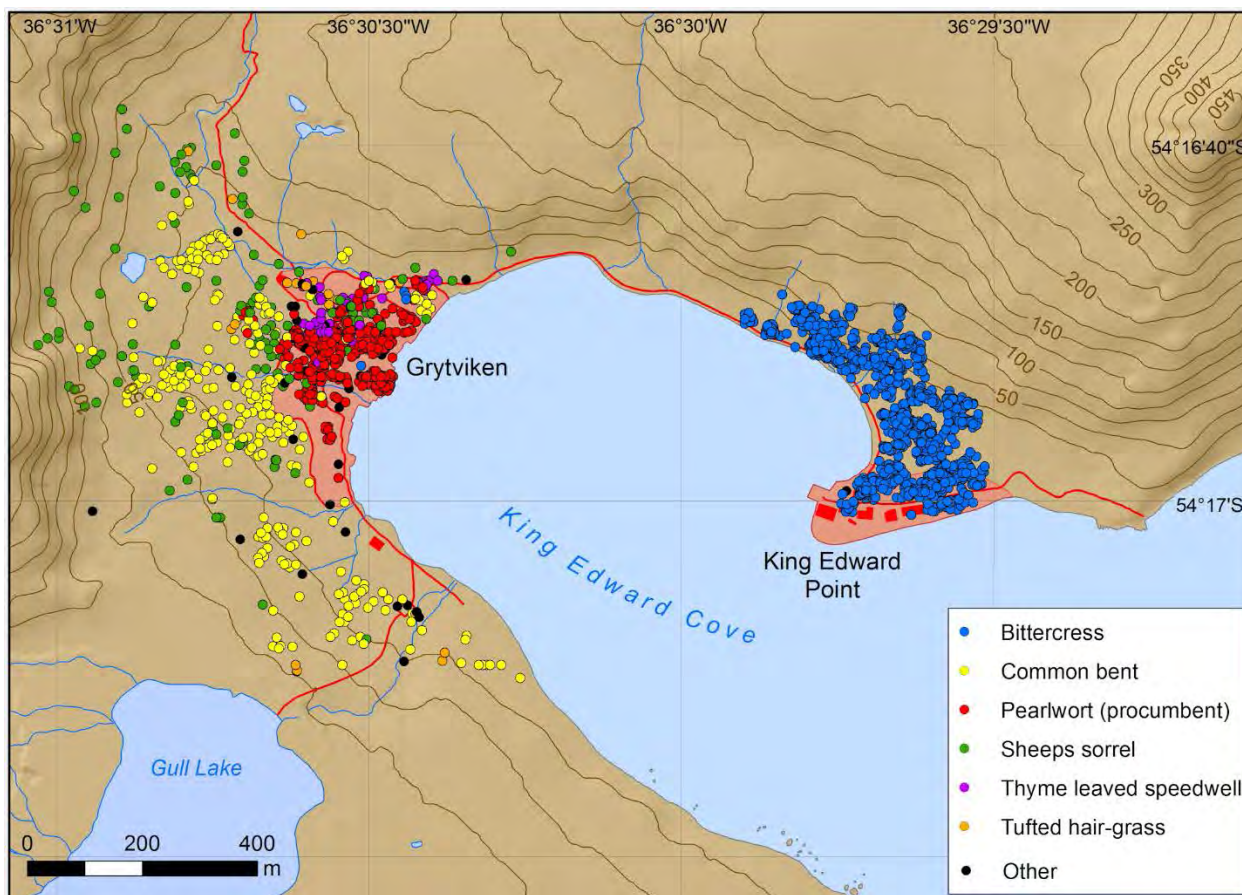


Figure 34. Distribution of non-native plants currently under management control (i.e. spraying, removal) in the King Edward Cove area. Other very widespread non-species present in the area (e.g. *Poa annua*) but are not shown, as they are likely beyond control.

#### 9.1.7.2. Non-native invertebrates

Due to the long period of human activity in the vicinity of King Edward Cove, the majority of which time, no biosecurity practices were in place, several non-native invertebrates have been introduced. The number of non-native invertebrates in the vicinity of KEP is not accurately known, but is likely to be a sub-set of the species found across South Georgia (see Table 24). The origin of many of these species is thought to be Europe, South America or the Falkland Islands, with some being transported through the activities of sealers and whalers. The hoverfly *Eristalis croceimaculata* and blow fly *Calliphora vicina* provide a new ecological role as pollinators on the island, which may impact upon the establishment of non-native plants reliant on insect pollinators for successful seed-set and dispersal. The introduction of predatory beetles, such as *Trechisibus antarcticus*, may also have negative impacts upon native invertebrate populations.

Table 24. Terrestrial non-native invertebrates in South Georgia, Vogel et al., (1983)

Order	Family	Species
Coleoptera	Ptiniidae	<i>Ptinus lectu</i>
	Sciaridae	<i>Lycoriella caesar</i>
	Trichoceridae	<i>Trichocera regelationis</i>
	Psychodidae	<i>Psychoda parthenogenetica</i>

	Trechidae	<i>Trechisibus antarcticus</i>
	Trechidae	<i>Merizodus soledadinus</i>
Diptera	Scatopsidae	<i>Scatopse notata</i>
	Syrphidae	<i>Eristalis croceimaculata</i>
	Calliphoridae	<i>Calliphora vicina</i>
Siphonaptera	Psyllidae	<i>Nosopsyllus fasciatus</i>
Arthropleona	Hypogastruridae	<i>Hypogastrura viatica</i>
		<i>Hypogastrura purpurescens</i>
		<i>Ceratophysella denticulata</i>
Symphypleona	Bourletiellidae	<i>Bourletiella hortensis</i>
	Katiannidae	<i>Sminthurinus elegans</i>

Eradication measures are unlikely to be practicable or effective for most if not all of the species described here, given the practical difficulties of locating all individuals and life stages of an established and/or spreading invertebrate, as well as their existing distributions on the island and the apparent abundance of potential habitat and food sources (Frenot et al., 2005).

## 9.2. Physical Characteristics

### 9.2.1. Meteorological Conditions

Lying well to the south of the Polar Front, the climate of South Georgia shares characteristics of the sub-Antarctic and maritime Antarctic, i.e. predominantly cold, wet and windy conditions. However, the weather is very changeable. The climate is characterised by deep depressions tracking eastward between the Antarctic Peninsula and South America. The Allardyce and Salvesen mountain ranges cut across the predominantly westerly winds, giving some shelter to the north-east coast of South Georgia, including the vicinity of KEP. The mountains also act as a barrier to clouds and consequently, sites on the north-eastern coast are sunny, relative to other parts of the island, with an average of 75 hours of sunshine per month (maximum average of 160 hours in January). Temperature measurements from Grytviken and KEP show monthly means ranging from +5.4 °C in February to -1.6 °C in August, while mean monthly precipitation ranges from 95 to 145 mm throughout the year with a notably drier period from October to January. Snow occurs in all months of the year but although late snow patches may persist until January, there is no permanent snow or ice in the immediate vicinity of the station at sea level.

### 9.2.2. Air Quality

Given the location of King Edward Point far from other areas of human habitation, the level of air pollution is almost certainly very low with the only sources likely to be from the station's generators station plant and vehicles (telehandler, excavator, quadbike, land rover, jetboats and RIBs) and the exhaust fumes of visiting vessels. Therefore, any pollution would be very localised and rapidly dispersed. Air quality may be impacted by natural sources, in particular, the large amounts of faecal material produced on the beach near the station by the resident wildlife population.

### 9.2.3. Geology

South Georgia is the easternmost extension of the mostly submerged North Scotia Ridge, which extends from the tip of South America towards the South Sandwich Islands in the east. The North Scotia Ridge developed approximately 40 million years ago and is a chain of continental blocks that have been displaced as sea floor spreading led to the development of the Scotia plate and ultimately the opening of Drake Passage. The continental blocks of the North Scotia Ridge, including South Georgia, are likely to have their origins in the Fuegian Andes of South America.

South Georgia is not of direct volcanic origin; the majority of South Georgia's sediments are derived from the eroded rocks of a volcanic arc. Geologically, South Georgia is dominated by a sequence of sandstones and shales, up to 8 km thick called the Cumberland Bay Formation, which were laid down in an Early Cretaceous sedimentary basin around 130 million years ago. The entire sequence is moderately deformed into large scale folds with an associated tectonic foliation. The turbidite sedimentology of the strata indicates a volcanoclastic composition associated with a low-grade metamorphic facies.

The geology of King Edward Point and Grytviken is also dominated by the Cumberland Bay Formation and is characterised by weakly deformed and folded metasedimentary turbiditic sediments. Rare fossils have been identified from Grytviken that indicate an Aptian age (125 – 113 million years) for the volcanoclastic/sedimentary rocks.

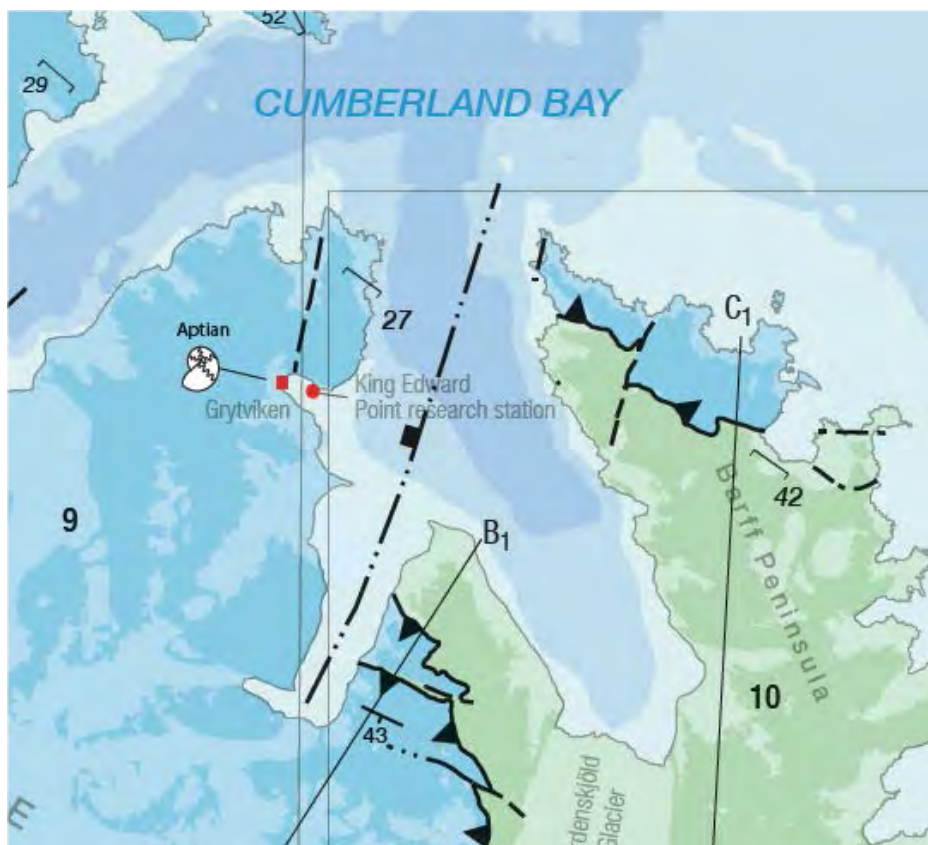


Figure 35. Cumberland Bay geology, dominated by the Cretaceous-age Cumberland Bay Formation (shown in blue). The green coloured unit is the Cretaceous age Sandebugten Formation, which is a more quartz-rich sandstone succession and probably represents a time equivalent of the Cumberland Bay Formation.

### 9.2.4. Geomorphology

KEP station is built upon a raised beach on a promontory at the head of King Edward Cove. Steep ground to the rear of the station makes access to the rest of the island difficult.

#### 9.2.4.1. Soils

Areas of tussock, some of which is eroded and damaged by fur seals, are present behind the station which may lie over accumulated peat. On much of the beach area, organic material may consist of fur seal faecal material, hairs and bones while sediments may also be added from stream run-off.

#### 9.2.4.2. KEP historic ground contamination

Preliminary soil investigations, undertaken during the 2018/19 season (3.3.1), provide evidence of substantial contamination of ground (including by hydrocarbons) near the wharf. A risk assessment undertaken by Sweco (Appendix 3 – KEP Water Environment Risk Assessment) considered the risk of contamination of the water environment as a result of the construction works and is discussed in more detail in section 3.3.1.1. The risk assessment also reviewed available data and information to determine the possible cause and extent of the contamination in the area. A British Military garrison occupied King Edward Point from 1982 until 2001 and two pollution incidents, which are thought to have occurred prior to 1985, are reported in a British Military report:

- Pre-1985 (unknown date) - Seawater entered the fuel feeder lines which then froze and burst the pipes resulting in fuel spilt in the ground to the rear of Shackleton House (now demolished).
- Pre-1985 (unknown date) - Overflow pipes from the generators fuel header tanks near the generator shed (now demolished) were discharging directly to the ground.

Additionally, in the past, oil drums are known to have been buried in the area around the existing fuel farm which could also be a potential source of past fuel spills. Anecdotal evidence also indicates that a former diesel tank near the shoreline had a long-term history of leakage.

The figure shown in Appendix 4 - Extent of ground contamination, produced as part of the Sweco Risk Assessment provides an indication of the known extent of diesel contamination, as a result of the trial pits and sampling, and also the potential extent of contamination based on historical information as presented here.

#### 9.2.4.3. KEP historic asbestos

Asbestos within the historic buildings at Grytviken is recorded and managed by GSGSSI. Some asbestos is encapsulated and buried at Grytviken and in smaller quantities at KEP also.



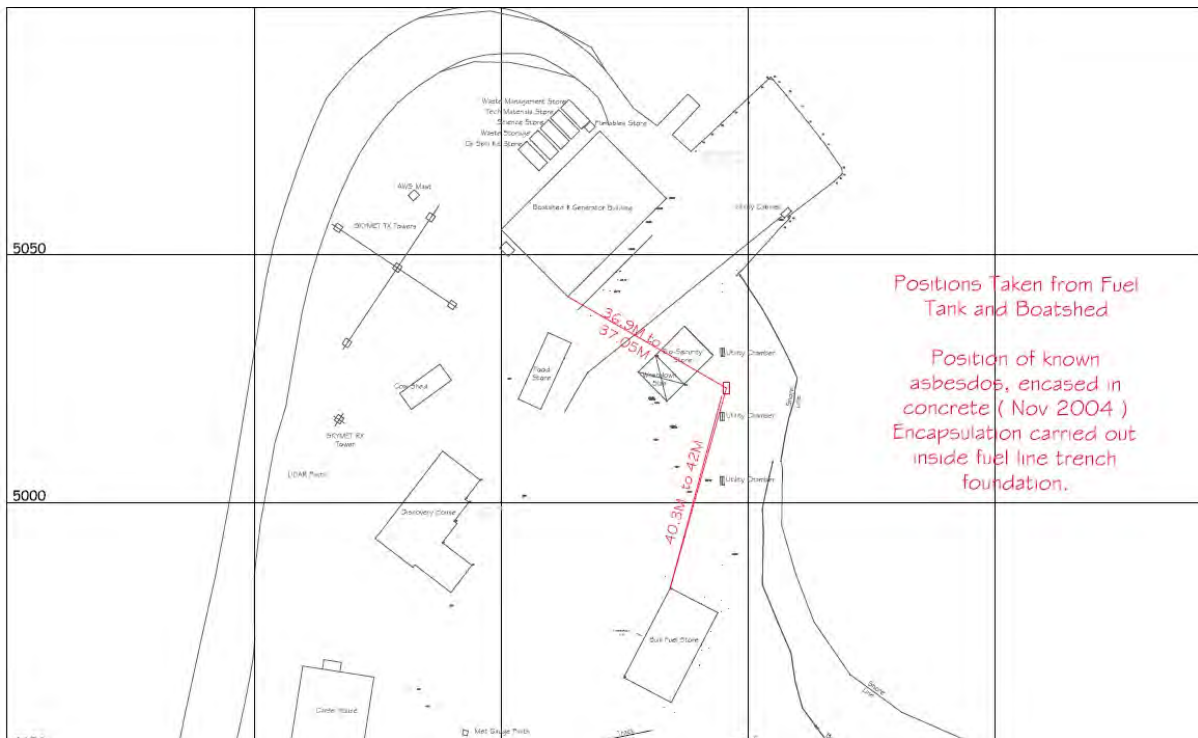


Figure 36. Location of buried and encapsulated asbestos at KEP shown in red (also shown in red is the distance of the asbestos from the boatshed and fuel tank).

#### 9.2.5. Bathymetry and marine conditions

The Admiralty Chart shows that the seabed drops relatively quickly to general depths of around 15-20m depth in the vicinity of the existing wharf.

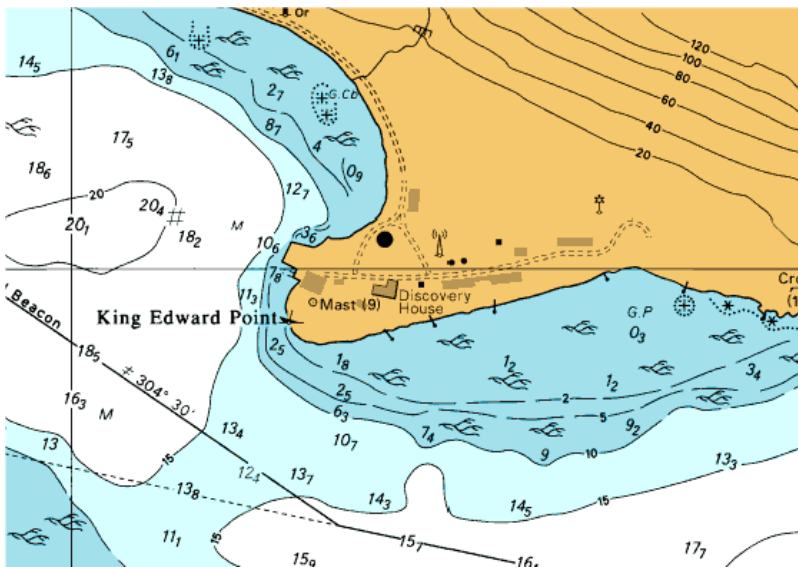


Figure 37. Admiralty chart showing bathymetry of waters around KEP.

A commissioned multibeam survey of the local bathymetry, undertaken in Feb/Mar 2019 using a Norbit iWBMS, provided more detailed information on the bathymetry in the immediate vicinity of the wharf and which largely matched the information in the Admiralty chart, albeit at greater spatial resolution.

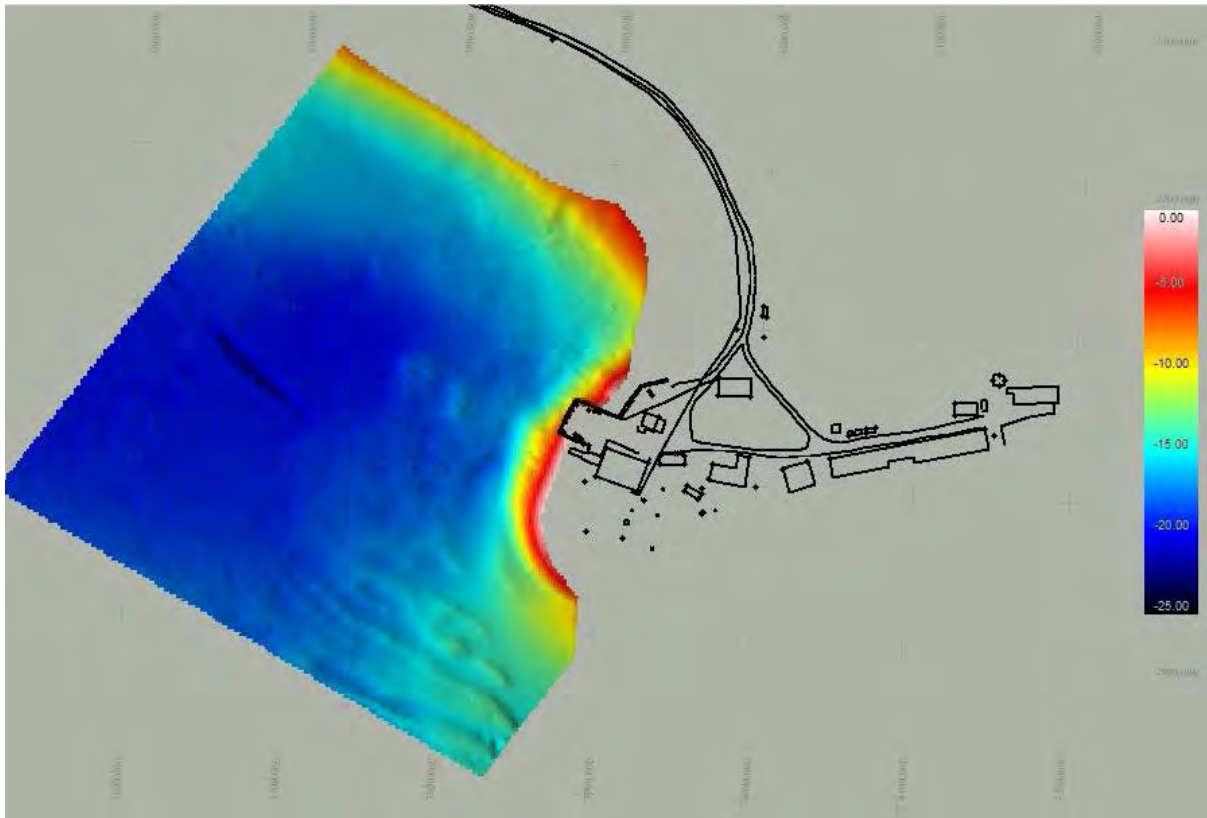


Figure 38. Bathymetry data around KEP wharf showing increasing depth from red to blue

#### 9.2.5.1. Tides

Tidal ranges are small, generally less than 1 m. Due to the position of King Edward Point at the head of King Edward Cove and within Cumberland East Bay, the nearshore sea conditions are generally calm relative to other more exposed areas of the island. During winter months, brash ice can accumulate in the cove. The seabed is understood to be rock with shingle over it. The depth of shingle is not known but in February 2019 geophysical surveys, commissioned by BAM, detected denser layers between 11 and 47 meters below seabed. The tides at KEP are mixed semidiurnal (i.e. two high tides and two low tides of different size each day). Astronomical tidal levels for KEP are given on Admiralty chart 3595 as follows:

- Mean High Water Springs (MHWS) +0.9 mCD
- Mean High Water Neaps (MHWN) +0.7 mCD
- Mean Low Water Neaps (MLWN) +0.4 mCD
- Mean Low Water Springs (MLWS) +0.2 mCD

The above measurements relate to Chart Datum.

#### 9.2.5.2. Anthropogenic debris near the wharf

The multibeam survey undertaken in Feb/Mar 2019 also provided information on objects on the seabed. These consisted mainly of some loose cables in the shallows north of the existing wharf, some debris close to the wharf and a group of tires around 15 m from the wharf.

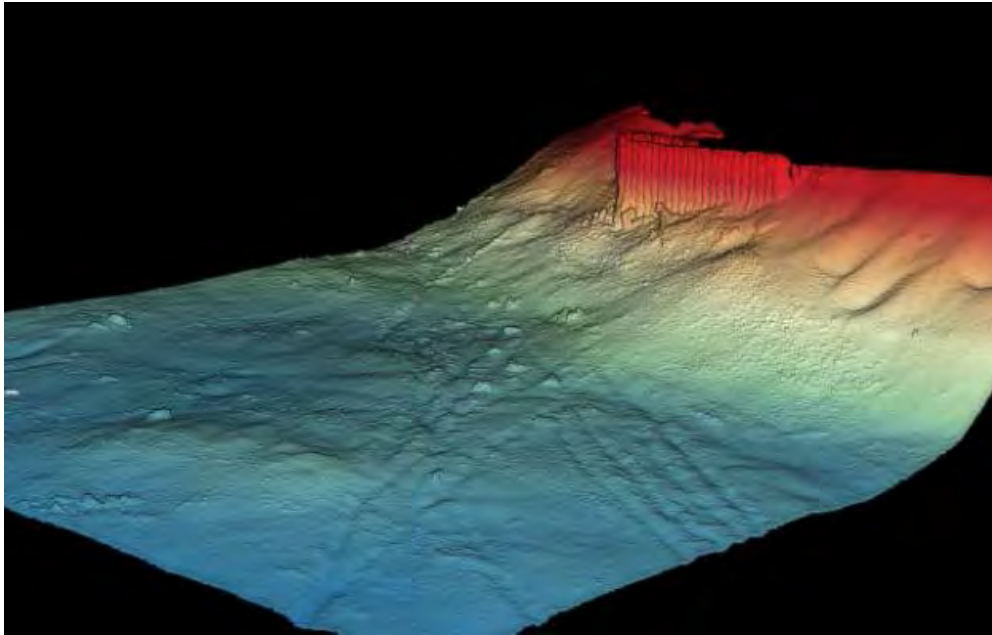


Figure 39. Multibeam survey of the seabed in the immediate vicinity of the wharf. Debris is visible near the wharf and the tracks on the seabed represent where anchors have dragged in the soft sediment.

During the earlier survey of the wharf using the ROV, large and obstructive structures were found scattered over the survey area. The figure below provides the approximate position of any anthropogenic material observed. Any structures that could cause issues to further work in the area were recorded. It should be noted that many anthropogenic structures provided hard substrate surfaces for marine organisms to grow upon, including the wharf itself. As all positions were derived from timing and directional information from the ROV, their positions should not be considered as fully accurate, but do demonstrate the amount of anthropogenic material within the sample area.

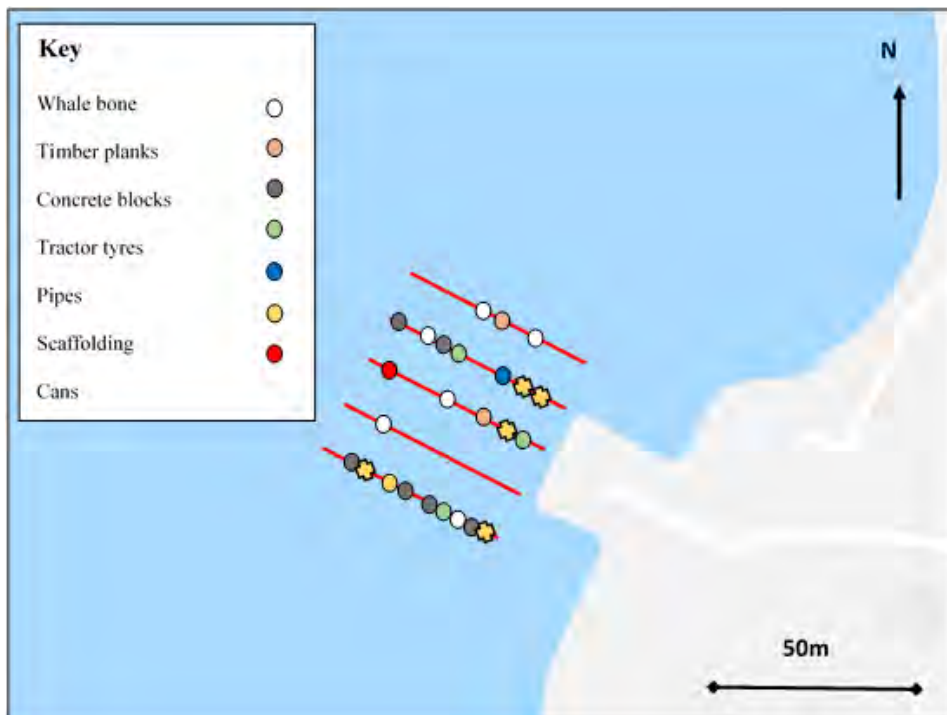


Figure 40. Approximate positions of anthropogenic structures near KEP wharf. The circles represent non-obstructive items and crosses represent potential obstructive structures.

#### 9.2.6. Surface water and flood risk

KEP is constructed on a raised beach promontory at the mouth of King Edward Cove. Several small streams pass down through the surrounding vegetated slopes into the sea with increases in flow rates corresponding to the spring/summer thaw and periods of prolonged rainfall or decreasing almost to zero during periods of prolonged freezing weather.

#### 9.2.7. Glaciology

No areas of permanent ice are present in the vicinity of KEP or Grytviken.

### 9.3. Noise

During much of the summer season the area around King Edward Point is subject to noise originating from the wildlife that occupies the beach area and surrounding vegetation. Vehicles are used occasionally on the island, particularly during ship calls and noise from generators is also infrequent as they are only used when the hydroelectric fails or is being maintained.

### 9.4. Cultural heritage

Grytviken whaling station is located at the west end of King Edward Cove to the west of KEP station. It was the first shore-based whaling station constructed in South Georgia by the Norwegian Carl Anton Larsen in 1904. Grytviken was the longest operation station South Georgia and closed in 1965 due to the collapse of the whaling industry.

A number of original factory buildings still stand at Grytviken including two large areas of oil storage tanks. The original former senior staff accommodation, offices and stores also still stand and are now predominantly used by the South Georgia Museum and Post Office staff. A Norwegian Lutheran Church also still stands at Grytviken next to the football pitch both of which continue to be used today by KEP, GSGSSI and SGHT staff and visitors. At the front of Grytviken on the shoreline are the remains of the jetties, three beached vessels, and the remains of the barque *Louise*.

Approximately 700 metres away from Grytviken to the south is the Grytviken or whaler's cemetery, which holds 64 graves including that of polar explorer Ernest Shackleton (died 1922).

A recent Conservation Management Plan issued in September 2018 by the GSGSSI recognises the heritage importance of Grytviken and provides a framework which sets out the overarching philosophy and approach for the management and conservation of the site.

At King Edward Point itself, there are also a few items of heritage and cultural importance including buildings still in use at KEP station: the Discovery House (1924) and old gaol (1912) as described in section 8.2.1. Other items of note are the wreck of a 1982 Argentinian landing craft, the *Fenix*, on the shoreline at KEP point, whaling era trypots, a beacon (1906) at the entrance to King Edward Cove erected by Larsen and Shackleton's memorial cross on Hope Point (1914).

### 9.5. Wilderness and aesthetic value

South Georgia is one of the world's most remote islands and its distance from areas of large scale human habitation (1400 km from the Falkland Islands and approximately 2000 km from South America) and associated impact have made it a haven for wildlife, including numerous species of bird. The area around King Edward Cove is dominated by the whaling station and the research

station, but once outside this area there are few signs of human presence, bar a small number of unobtrusive field huts and some trails. The dramatic scenery, coast landscape and rich wildlife give the area its high wilderness and aesthetic value.

#### 9.5.1. Aesthetics survey

A survey was undertaken in March 2019 to record visual aesthetic values in the vicinity of the various quarry sites that were originally under consideration within the scope of the KEP wharf works. At the locations detailed in Figure 41, photographs were taken looking towards each of the originally proposed quarry sites, i.e. Quarry 1, Quarry 3, Quarry 5b and Quarry 6. The views of the proposed quarry sites are shown in Table 25 and in some cases, the sites under consideration were not visible from the chosen location.

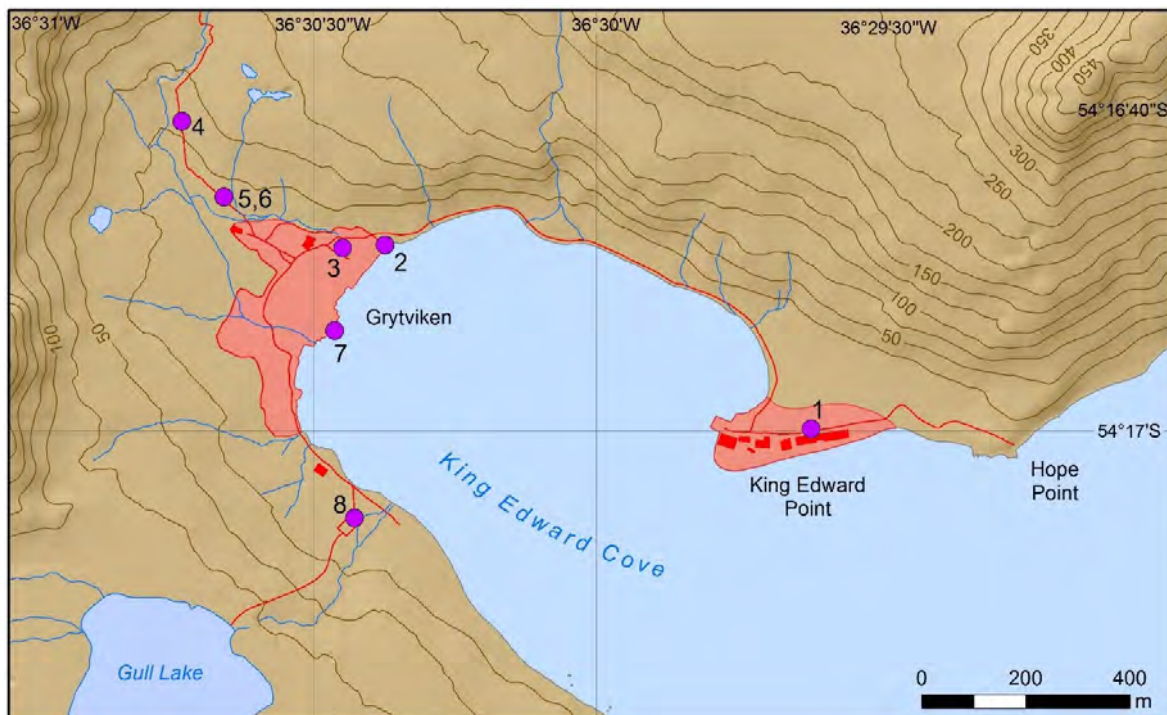












Figure 41. Locations (1-8) where photographs were taken to inform the aesthetic survey. (1) KEP wharf; (2) Zodiac landing site next to 'Petrel' grounded vessel; (3) Grytviken museum; (4) Bore Valley; (5) NNW of Church; (6) front of church; (7) Tijuca jetty; (8) Cemetery gates

Table 25. Views of proposed Quarries from locations are described in Figure 41

**(1) KEP Wharf (54°16.998 S, 36°29.620 W)**

<p>Quarry 1 17mm</p>	<p>Quarry 1 70mm</p>
 <p>A photograph showing a wide view of a turquoise body of water in the foreground, with a bright sun reflecting off the surface. In the background, there are dark, rugged mountains under a clear blue sky with a few wispy clouds.</p>	 <p>A photograph showing a closer view of the turquoise water, with the sun's reflection creating a shimmering path across the surface. The dark, rocky slopes of the mountains are more prominent in the background.</p>
<p>Quarry 3 17mm</p>	<p>Quarry 3 70mm</p>
 <p>A photograph showing a wide view of the turquoise water. The background features a range of dark mountains with some snow patches on their peaks. The sky is blue with a few clouds.</p>	 <p>A photograph showing a closer view of the turquoise water. In the foreground, there are some small buildings and a road on the shore. The dark mountains with snow patches are visible in the background.</p>
<p>Quarry 5b 70mm</p>	<p>Quarry 6 70mm</p>
 <p>A photograph showing a view of the turquoise water in the foreground. The background consists of rolling green hills leading up to dark, rocky mountains with snow patches. The sky is clear and blue.</p>	 <p>A photograph showing a view of the turquoise water in the foreground. In the middle ground, there is a small settlement with several buildings. The background features dark, rocky mountains with snow patches.</p>

**(2) Zodiac landing site next to the grounded vessel 'Petrel' (54°16.808 S, 36°30.374 W)**

<p><i>Quarry 1 17mm</i></p>	<p><i>Quarry 1 70mm</i></p>
	
<p><i>Quarries 3 &amp; 5b obscured by Petrel</i></p>	<p><i>Quarry 6 obscured by Grytviken museum</i></p>
	

**(3) In front of Grytviken museum (54°16.811 S, 36°30.449 W)**

<p><i>Quarry 1 17mm</i></p>	<p><i>Quarry 1 70mm</i></p>
	
<p><i>Quarry 3 17mm</i></p>	<p><i>Quarry 3 70mm</i></p>



*Quarry 5b obscured by whaling station*



*Quarry 6 obscured by museum*

**(4) Bore Valley (54°16.680 S, 36°30.733 W)**

*Quarry 1 obscured by hill*

*Quarry 3 17mm*



*Quarry 5b obscured by angle of ridge*

*Quarry 3 70mm*





*Quarry 6 17mm*









**(5) Slope NNW of the Church (54°16.758 S, 36°30.659 W)**



<i>Quarries 1, 3 &amp; 5b as above</i>	<i>Quarry 6 17mm</i>
	

**(6) Front of church (54°16.758 S, 36°30.659 W)**





<i>Quarry 1 obscured by hill</i>	
<i>Quarry 3 17mm</i>	<i>Quarry 3 70mm</i>
	
<i>Quarry 5b obscured by ridge line</i>	<i>Quarry 6 obscured by church</i>

**(7) Tijuca jetty (54°16.896 S, 36°30.463 W)**

<i>Quarry 1 17mm</i>	<i>Quarry 1 70mm</i>
	

<i>Quarry 3 17mm</i>	<i>Quarry 3 70mm</i>
	
<i>Quarry 5b obscured by ridge line</i>	<i>Quarry 6 obscured by buildings</i>

**(8) Cemetery gates (54°17.090 S, 36°30.428 W)**

<i>Quarry 1 17mm</i>	<i>Quarry 1 70mm</i>
	
<i>Quarry 3 17mm</i>	<i>Quarry 3 70mm</i>
	
<i>Quarry 5b obscured by ridge line</i>	<i>Quarry 6 obscured by buildings</i>

## 9.6. Protected Areas

### 9.6.1. Terrestrial protected areas

Under the Falkland Islands Dependencies Conservation Ordinance 1975, several locations on South Georgia were listed as Specially Protected Areas with access only allowed in accordance with a permit issued by the Government of South Georgia and the South Sandwich Islands (GSGSSI). Since then, The Wildlife and Protected Areas (WPA) Ordinance (2011) was enacted and the GSGSSI are undertaking a consultation to inform future spatial planning and protected areas for the island. The Prohibited Areas Ordinance and associated Order strictly prohibits access to some old whaling stations (and some old jetties) which are considered hazardous due to their structures or presence of asbestos. Husvik, Stromness and Leith Whaling Stations fall into this category and can only be visited with a Prohibited Areas permit.

### 9.6.2. Marine protected areas

In 2012, GSGSSI created one of the world's largest, sustainably managed Marine Protected Areas (MPA) that now encompasses the entire SGSSI Maritime Zone. The MPA area and management plan was updated in 2018. The MPA has been carefully designed to ensure the protection and conservation of the regions rich and diverse marine life, while allowing sustainable and carefully regulated fisheries. The MPA covers a total area of 1.24 million km<sup>2</sup>, which includes the prohibition of all bottom trawling and a ban on bottom fishing at depths less than 700 m and greater than 2,250 m. No-take zones, were created around South Georgia, Clerke Rocks, Shag and Black Rocks and the South Sandwich Islands, and the area within the EEZ south of latitude 60 °S, totalling 284,000 km<sup>2</sup>. Other protection measures within the MPA include a network of benthic no-take-zones (NTZ) in previously popular toothfish fishing areas, and closure of the krill fishery in the summer (start October until end April), – when krill-eating birds and marine mammals are breeding. All these measures provide refuges for fish, protect the benthos and spawning fish and avoid competition between fisheries and land-based foragers.

## 10. IDENTIFICATION OF POTENTIAL IMPACTS AND MITIGATION

This document so far, has described the scope and scale of the proposed activity and outlined the current use of the site and the current environmental conditions.

This chapter first describes the method used to identify the potential environmental impacts and then describes each potential impact whilst also suggesting mitigation measures that could reduce the impact.

### 10.1. Methodology

#### 10.1.1. Scoping Exercise

A KEP EIA Scoping document was prepared by BAS and approved by GSGSSI in January 2019. This was a high level document that highlighted the benefits of the project and identified and assessed the key potential environmental impacts as considered during the early stages of the project.

A scoping checklist template was used based on the European Commission EIA Scoping Guidance (2001). The scoping exercise posed a number of questions which helped to identify potential project activities and the ways in which they could interact with environment therefore potentially causing an impact. The exercise also helped to identify where some activities with a potential high impact were considered and rejected as part of the early design process.

The key anticipated environmental impacts as identified during the scoping exercise are listed below:

- Permanent change in topography and aesthetics of the quarried area;
- Permanent loss of seabed to the extended wharf and new dolphin;
- Temporary impact on the aesthetics of the local area and the normal tourist/visitor operation;
- Temporary damage or loss of vegetation in quarried area and on the tracks used for vehicle movements;
- Risk of introducing non-native species or further spread of already established non-native species in the local area;
- Potential for disturbance or harm to local wildlife including nesting birds, seals and other marine life from physical disturbance, noise and dust;
- Risk of accidents causing injury or death to wildlife or visitors.

These impacts are considered in more detail as part of this EIA.

#### 10.1.2. Impact Identification Process

The scoping exercise detailed above, identified the project activities (at an early stage of the design) which have the potential to interact with the environment and cause an impact. At this later stage of the design and project development, the impacts are re-identified through a three-step process (ATCM, EIA Guidelines 2016):

1. **Identification of the activities** that may give rise to an environmental aspect. For the purposes of this EIA, the activities have been split into the following general categories:
  - KEP Wharf and associated structures activities (detailed in Section 3)
  - Quarrying activities (detailed in Section 4)
  - Project support activities (described in Section 6).
  - General construction activities (detailed throughout Sections 3, 4 and 5).

- Post-construction wharf operation activities (detailed in Sections 1 and 3.4.5)
- 2. **Consideration of the environmental aspects**, - these are the outputs or additions to the environment as a result of the interaction of the activity with the environment. For example, the use of vehicles and plant during the construction project at KEP (the activity) will give rise to a number of outputs such as atmospheric emissions, noise, dust, physical presence, spread of non-natives, fuel spills and more (these are the environmental aspects of the specific activity).

Steps 1 and 2 as described above are represented in more detail in Table 26 (see below), which provides a breakdown of the project activities and considers how these activities will interact with the environment. This overview suggests that noise, vibration and dust emissions will occur as a result of most construction activities. KEP is a small site and the potential for the project activities to take up physical space and increase the footprint of the site is identified as well as the potential for these activities to cause physical disturbance on land, water and to flora and fauna. The risk of fuel spills as a result of vehicle and plant operation and as a result of activities taking place in an area of existing hydrocarbon contamination is also highlighted. The potential to introduce non-native species as a result of input of cargo and personnel to KEP is identified as well as the potential to spread already existing non-native species through the increased traffic on site and excavation and movement of rock.

- 3. **Identification of the environmental impacts** involves recognising the potential changes in environmental value or resource as a result of the activity and its interaction with the environment. A single activity can have numerous outputs which in turn have the potential of impacting the environment in different ways. Using the example from step 2 above, the atmospheric emissions produced by the operation of vehicles at KEP have the potential to contribute to atmospheric pollution (environmental impact 1), the spread of non-native species caused by the movement of vehicles has the potential to alter the local native ecosystem (environmental impact 2), noise produced from vehicles and plant can lead to behavioural changes to local animals (environmental impact 3) and so on.

The environmental impacts which will potentially result from the interactions of the project activities with the environment are detailed in Section 10.2.

#### *Impact Types*

The impacts identified in this section can be further be further categorised into different types as defined below (ATCM, EIA Guidelines 2016):

- **Direct impacts** result from direct cause-effect consequences of interaction of an activity with its environment (e.g. smothering of flora by dust produced by quarrying activities).
- **Indirect impacts** result from interactions between the environment and other impacts which can be either direct or indirect (e.g. mortality of flora and fauna through ingesting contaminated material caused by an oil spill).
- **Cumulative impacts** are the combined impact of past, present, and reasonably foreseeable activities. These can occur over time and space and can be additive or interactive (e.g. emissions to air can cause cumulative contribution to global atmospheric pollution). Cumulative impacts are considered in Section 11.3 below.

Table 26. Identification of activities and their interaction with potential environmental aspects

		POTENTIAL ENVIRONMENTAL ASPECTS												
		Atmospheric emissions	Noise and vibration	Dust	Waste	Light	Physical presence and use of space	Physical disturbance on land	Physical disturbance in water	Fuel or hazardous substances release	Non-native species introduction	Spread of established non-native species	Disturbance or removal of native fauna/flora	Damage to heritage objects
ACTIVITIES	<b>Project support activities</b>													
		Transport of cargo to KEP (shipping)	✓									✓		
		Transport of personnel to KEP (flights and shipping)	✓									✓		
		Provision of accommodation and support services (e.g. power generation, food, water) for personnel	✓			✓	✓							
	<b>General Construction Activities</b>													
		All vehicle, plant and equipment operation	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓
		KEP construction site up and in use by personnel				✓	✓	✓					✓	✓
		Fuel management and refuelling								✓				
	<b>KEP wharf and associated structures activities</b>													
		Installation of sheet piles		✓				✓		✓	✓			✓
		Depositing rock fill material		✓	✓			✓		✓				
		Excavation related to anchor wall and mooring points on land		✓	✓	✓			✓		✓			✓
	<b>Quarrying Activities</b>													
		Site set up for duration of quarrying						✓			✓			
		Excavation of material		✓	✓				✓				✓	✓
		Crushing of rock material		✓	✓									
		Screening of rock material		✓	✓	✓								
		Loading and tipping of rock fill material		✓	✓								✓	
<b>Post construction wharf operation activities</b>														
	Operation of new wharf						✓							
	Maintenance of new wharf throughout its life.	✓	✓		✓					✓			✓	
	Use of wharf by the SDA								✓				✓	

## 10.2. Environmental Impact Identification

This section outlines and describes the potential environmental impacts which may result from the proposed project activities, suggests mitigation measures to minimise or avoid each impact and identifies monitoring activities that can be carried out either during or after the activity.

Using the methodology described above in Section 10.1 and detailed in Table 26 the headings below identify the environment impact which may occur as a result of the environmental aspect produced by the activities. For example, a number of different activities may produce atmospheric emissions which in turn may lead to atmospheric pollution and a number of different activities may produce noise which in turn could cause injury or behavioural changes to animals. In order to prevent repetition of information, each of the headings below relates to the environmental impact rather than the activities that led to them, which may be numerous.

Each environmental impact is also categorised as either direct, indirect, or cumulative or a combination of all three as explained in Section 10.1.2.

Each heading also suggests a number of mitigation measures that can be implemented in order to reduce the identified impact. An assessment of the significance (or severity) of each impact has been carried out and is described in detail in Section 11. The assessment applies a significance value to each impact, prior to any mitigation measures being implemented, and then reassesses the significance value after the mitigation measures have been implemented. This process identifies whether the mitigation has successfully minimised the severity of the impact. In this chapter, all mitigation measures that can be implemented are identified below each identified environmental impact without commenting on the effectiveness of these measures.

Monitoring activities that can be carried out for each environmental impact are also briefly identified in this chapter and discussed in more detail in Section 12 and outlined in the KEP Monitoring Plan. These monitoring activities can be:

- Short-term activities during the construction period that can identify whether modifications are required
- Long-term activities to identify long-term impacts
- General environmental monitoring to ensure the appropriate implementation of this EIA.

### 10.2.1. Atmospheric pollution (Direct/Cumulative)

There will be a minor but cumulative contribution to global atmospheric pollution as a result of emissions associated with transporting people and cargo to and from KEP during construction and as a result of fuel consumption from vehicles and plant during the construction period. Approximately 100,000L of Marine Gas Oil (MGO) and 400L of petrol is expected to be used by vehicles and plant during the KEP wharf construction activities. The predicted emissions associated with this fuel use is anticipated to be equivalent to 278 tonnes of CO<sub>2</sub>. Fuel combustion during construction works will also increase metal and particulate fallout locally.

#### **Mitigation**

- Flights for personnel and shipping for cargo will be routed to KEP using the most efficient routes possible.
- Regular inspection and maintenance will be carried out to ensure all vehicles, plant and generators operate efficiently.
- All drivers will be instructed to turn off engines during periods of waiting for 5 minutes or more.

#### **Monitoring**

Transport data (vessels and aircraft flights) will be collected and the increased contribution to atmospheric pollution will be accounted for in the overall BAS carbon accounts.

### 10.2.2. Damage to heritage items (Direct)

The increased numbers of personnel, increased footprint and increase in use of vehicles and plant on site as well as the excavation works could lead to damage to items of heritage at King Edward Cove.

#### **Mitigation**

- All personnel will be made aware of the GSGSSI 'Code of Conduct Whilst Ashore' and specifically will not remove, disturb, deface or destroy any historical artefacts.
- All vehicle and plant operations will be restricted to KEP and the track between KEP and Grytviken therefore reducing the risk of accidental damage of historical artefacts at Grytviken. Some objects of historic importance are located at King Edward Cove (see section 9.4) and staff will be made aware of these.
- There is a very small risk of non-identified items of heritage being discovered during intrusive works such as the excavation at the quarry site. In this case, staff carrying out excavation will remain alert for any manmade objects in the ground. Should any items be found during excavation works then the GSGSSI GO on site will be notified to supervise the safe removal and ongoing management of any removed items as per the GSGSSI policy.

### 10.2.3. Native ecosystem alteration - introduction of non-native species (Indirect/Cumulative)

Non-native species (including rodents) may be unintentionally introduced to KEP and the surrounding areas through the importation of cargo and equipment and deployment of additional personnel associated with the construction project. This could lead to establishment of non-native species and an alteration to the native ecosystem potentially leading to: changes in ecosystem



structure and function, increased competition, introduction of disease, decline in breeding bird populations and an impact on science.

### **Mitigation**

The risk of introducing non-native species was considered in the project design and the decision was made to quarry for fill material locally rather than importing large quantities of aggregate from outside the territory. This decision reduces the risk of importing non-natives.

Specific biosecurity mitigation measures have been developed for the KEP wharf project and will be implemented for all cargo importation activities. These are detailed in Appendix 6 – KEP Biosecurity Plan. The mitigation measures listed below are a summary of the key actions of the plan:

- All KEP personnel will receive pre-deployment training from the BAS Environment Office that will cover biosecurity.
- All project personnel (deployed to KEP and responsible for cargo packing) will read and follow the guidance of the KEP Biosecurity Plan, the BAS Biosecurity Regulations and the GSGSSI Biosecurity Regulations.
- All cargo packing areas will be clean and free of weeds, plants, invertebrates and rodents
- Appropriate sealed packaging will be used for all materials, where possible.
- All vehicles, plant and tools will be cleaned and inspected before shipping.
- All containers will be cleaned prior to packing and fumigated prior to sealing.
- All cargo will be inspected before it is loaded onto the ship and before it is offloaded to KEP.
- A number of biosecurity checklists have been produced that will be completed at various stages of the cargo transport.
- Any biosecurity breaches or near misses will be reported immediately to the Station Leader, KEP Government Officer (GO) and BAS Environment Office.
- In the event that a rodent is sighted at KEP, the GSGSSI KEP Rodent Incursion Plan (2017) will be followed under the direction of the GO.

#### 10.2.4. Native ecosystem alteration - spread of existing non-natives (Indirect/Cumulative)

A number of invasive non-native plants are already established at KEP and Grytviken (see 9.1.7.1). Bittercress is established in areas of KEP and several different plant species are established at Grytviken. The movement of vehicles between different areas of KEP has the potential of increasing the spread of bittercress.

### **Mitigation**

- The risk of spreading non-natives from Grytviken to KEP and from KEP to Grytviken was considered in the project planning stages and the decision made to restrict operations to the KEP area (station and track) only therefore reducing the biosecurity risk.

Specific on-site mitigations have been developed for the KEP wharf project and will be implemented for all vehicle and plant operations. These are detailed in Appendix 6 – KEP Biosecurity Plan:

- Vehicles and plant will not operate in areas of vegetation
- Vehicles and plant will only drive on the existing KEP road and within the station perimeter, in areas without vegetation.
- Vehicles and plant will not enter Grytviken.
- The road at KEP will be well maintained and drivers will be instructed to keep their wheels on the stone track and avoid contact with the grass verges.

- Bittercress is well established on the village green area at KEP. The village green will be covered in a permeable root barrier membrane and a layer of aggregate and used as a storage location for wharf fill material. This will prevent the interaction of plant and vehicles with the bittercress plants or topsoil. All vehicles and plant involved in preparing the village green for use will be washed prior to being used in other areas at KEP. The root barrier membrane will remain in place upon completion of the project, as agreed with GSGSSI.

### **Monitoring**

The GSGSSI weed team will continue to carry out their planned monitoring and management of non-native plants.

#### 10.2.5. Depletion of water - natural resource (Direct)

There will be an increased demand on water for the domestic purposes of additional personnel and for construction activities which could lead to depletion of the fresh water provided locally. This in turn could put pressure on the existing station facilities and reduce the available water for normal station consumption.

### **Mitigation**

Due to South Georgia's abundant precipitation there is no shortage of water which is directed from a stream, via a dam, to Grytviken and KEP. The temporary increase in water consumption will have no permanent impact.

Where possible, seawater will be used for certain construction activities such as damping down dust.

#### 10.2.6. Increased waste sent to landfill (Direct)

The project will result in larger quantities of domestic waste production and increased quantities of construction related waste. This could result in larger quantities of waste being sent to landfill.

### **Mitigation**

- All waste produced at KEP by BAS and by the construction project (other than sewage, grey water and food waste) will be removed from South Georgia for safe disposal in accordance with the waste hierarchy.
- Domestic waste will be managed by BAS as per the BAS Waste Management Handbook. KEP has maintained a recycling rate above 90% in recent years.
- Construction waste will be managed by BAM as per Appendix 9 – Site Waste Management Plan (SWMP). BAM have committed to diverting 80% of construction waste from landfill.
- All construction waste will be returned to the UK and disposed of by licensed waste contractors in accordance with the waste hierarchy and UK legislation.

### **Monitoring**

Detailed waste statistics will be made available on completion of the project.

#### 10.2.7. Pollution of environment from waste (Direct)

Increased quantities of waste will be stored on site temporarily. There is an increased risk of loss of waste to the environment which could lead to pollution or disturbance, injury or fatalities to local wildlife.

##### **Mitigation**

- Domestic waste will be managed by BAS as per the BAS Waste Management Handbook and stored in designated containers.
- Construction waste will be managed by BAM as per Appendix 9 – Site Waste Management Plan (SWMP)
- A BAM designated member of staff will manage all construction waste.
- Waste will be appropriately segregated and stored in ISO containers as shown in Figure 11 (plant and equipment shown in pink).
- If non-hazardous waste is stored outside this will only be temporarily during the construction period and it will be secured to prevent loss due to weather and possible injury to wildlife.
- Unused construction materials will also be removed from KEP at the end of the construction period. Unused materials can be left on site if the station has a use for them but this will only take place with the agreement of the BAS Station Leader and BAS Environment Office. A plan will be put in place to ensure safe storage.

#### 10.2.8. Pollution of marine environment from effluent (Direct)

There will be an increase in volume of grey water and sewage as a result of the increased population during the construction period. This will be discharged to the local environment and therefore increase the nutrient addition to the marine environment.

##### **Mitigation**

No additional toilets and washing facilities are currently anticipated to be required for the duration of the construction works. Sewage will be macerated and discharged untreated directly to the sea (as per the usual KEP operation). Increased nutrient addition to the sea is expected but the impact considered negligible.

#### 10.2.9. Disruption to science activities (Direct)

There will be a temporary increase in personnel on station during the construction period. This will result in fewer bed spaces available on station and could mean fewer science days being supported. The KEP scientist will also be required to support the project through ongoing breeding bird monitoring surveys and by providing advice as required. In addition, the increased temporary footprint and increased construction activity could impact the operation or data collection of scientific equipment for long-term monitoring.

##### **Mitigation**

- The routine GSGSSI fisheries and marine predator science work will not be impacted and will go ahead as normal. The KEP scientist has been made aware of the additional work responsibilities required throughout the year and this has been factored into their workload.
- No external science is being supported at KEP during the construction period.

- The meteor radar and meteorological station behind the boatshed has been considered in the site layout plan (see 3.7). Equipment will not be stored in the immediate proximity and any cables will be protected from vehicle traffic.
- The institute responsible for managing the seismic station at Hope Point has been informed of the works so that they can take account of any unusual readings caused by the works.
- The tide gauge on the existing wharf will be removed by BAS in consultation with the National Oceanographic Centre (NOC) prior to the works and replaced once construction is complete.

#### 10.2.10. Disruption to station operations (Direct)

The increased numbers of personnel, increased footprint and the temporary lack of access to the wharf and boat mooring facilities may impact on the normal station operation and have a detrimental effect on personnel relations. The RRS JCR and FPV *Pharos* will not be able to moor alongside the wharf during works. The small boats will also not be able to moor or launch from the area.

#### Mitigation

- BAS and BAM will work together to create good working relationships between the construction and KEP teams. A KEP Integration Plan is being prepared.
- Shared catering will be provided for both KEP and construction teams.
- BAS and GSGSSI have taken the construction programme into account and will ensure that any essential cargo operations from the JCR and FPV *Pharos* are carried out prior to the construction works. If necessary, cargo operations will take place via tender vessel during construction works.
- The harbour launches/boats will be relocated to the Tijuca Jetty at Grytviken
- The RIB boats will be stored as usual on a trailer outside of the water and can be launched from the beach along the KEP track, when required.
- Refuelling of small boats will be carried out by a mobile bunded fuel bowser following the refuelling procedures detailed in 5.1.1.1.

#### 10.2.11. Disruption to tourism operations (Direct/Cumulative)

The increased footprint during the construction period could impact on normal tourism operations at Grytviken. The temporary construction activities could also be perceived negatively by visitors and impact on their overall visitor experience. If managed poorly this could reflect negatively on BAS, BAM and GSGSSI leading to reputational loss.

#### Mitigation

- Construction activities are restricted to KEP station and to the track between KEP and Grytviken. The main visitor attractions at Grytviken: the museum, post office, church and Shackleton's grave will be accessible to all those visiting the area.
- The road between KEP and Grytviken will be closed to visitors to ensure there is no interaction of visitors with the construction works.
- Visitors wishing to visit the memorial cross at Hope Point will not be permitted to walk along the track from Grytviken but will instead need to be transported by small boat (see Figure 27).

- A KEP Stakeholder Communications and Engagement Plan is being prepared by BAS in consultation with GSGSSI and BAM. The KEP wharf construction project and its potential impacts and mitigation measures will be clearly communicated to the International Association of Antarctica Tour Operators (IAATO) and other identified stakeholders. IAATO will in turn engage with their clients/tourists. Communication and good working relationships will also be important on the ground at KEP between the project management team, KEP Station Leader and GSGSSI Government Officers.

#### 10.2.12. Behavioural changes, injuries or fatalities to terrestrial fauna from physical disturbance (Direct)

The operation of vehicles, equipment and plant could cause physical disturbance to local wildlife: fur seals, elephant seals, penguins and nesting birds. This could result in behavioural changes, injuries or fatalities. In addition, the use of the crawler crane which stands up to 60m tall (at its full reach) and cannot be lowered, once erected on site, could lead to collisions by birds.

#### Mitigation

- Construction works will begin in mid-January after the peak fur and elephant seal breeding season has ended. Weaned elephant seal pups will have likely left the area by late January. However, fur seal pups will still be being weaned until late March.
- The crawler crane will operate in only two positions during the construction works (either behind the wharf or on the shoreline near the dolphin) and will therefore for the most part remain as a stationary piece of plant during construction works. Due to the relatively static nature of the plant it is anticipated that birds may become habituated to it and avoid collisions. In addition, the crane will also be fitted with streamer lines that may act as deterrent and reduce the risk of collisions at night time.
- Vehicles will only drive on the existing KEP road and within the station perimeter. Driving is not permitted in any areas of vegetation/tussock where birds may be nesting.
- A maximum speed limit of 10mph will be maintained (this is slower than the standard 15mph limit used by GSGSSI).
- Engine idling is not permitted. Engines will be turned off after 5 minutes of waiting.
- All vehicles will be inspected and wheels (and the surrounding area) checked for seals, penguins and other wildlife prior to the engine starting.
- All vehicles will have suitable all round driver visibility achieved by the use of cameras, or mirrors where required. All driving cabs will also be equipped with VHF radios operating on a construction channel.
- Difficult manoeuvres will be assisted by a banksman
- Animals will be given right of way when crossing roads or areas of work. However, if it is deemed necessary (in order to allow the work to progress or for the safety of the animal) then seal displacement will take place by a trained staff member.
- Any wildlife injury or fatality associated with the work should be reported immediately to the Environment Office, Station Leader and Government Officer.

#### Monitoring

- All seal displacements will be recorded for monitoring purposes (see Appendix 11 – Monitoring Plan).
- The KEP scientist will carry out surveys of nesting birds in all the areas of operation prior to and during construction to determine the locations and impact on nesting birds. This will

take place from September until the completion of the project (see Appendix 11 – Monitoring Plan).

#### 10.2.13. Disorientation and disturbance of birds from light (Direct)

The use of artificial lighting during the construction works could lead to disorientation and disturbance of birds and increase the risk of bird strikes on existing infrastructure or construction plant and equipment.

##### **Mitigation**

- The construction programme has been set out to ensure that works are carried out during the hours of daylight only.
- Some task lighting may be required but this will be specifically for the wharf extension to provide lighting between the wall of the existing and new wharf for fitting the waling beams. Lighting will be suspended from the sheet pile wall and lighting will be localised in the specific area below the level of the sheet pile wall.
- In the event that there is a requirement for other artificial lighting during duller weather or hours of darkness, the BAS Environment Office will be notified in advance so that mitigation measures can be agreed.
- Any bird disorientation or bird strikes will be reported to the BAS Environment Office and GSGSSI.

#### 10.2.14. Damage of soil organisms and smothering of flora from dust (Direct)

The process of excavating, crushing, screening, loading, transporting and depositing rock fill material will produce dust which during dry weather will become air born. This has the potential to damage soil organisms and vegetation through direct contact.

##### **Mitigation**

- Plant will be selected that is designed to reduce excessive dust production.
- Good maintenance of all plant and equipment to ensure it is working to optimum capacity.
- Loading and tipping operations of rock fill will be temporarily suspended during periods of high winds. The decision will be made on site based on wind direction and the production of dust plumes.
- At the quarry sites, the screener and crusher will either be fitted with seawater spray bars or a member of staff will be on hand to water down the activities.
- Vehicles transporting rock fill material will be fitted with dust sheets.
- Low speed limit of 10mph will be maintained and enforced on site.
- Areas of excavated rock material and transport roads will be periodically sprayed with pumped seawater to reduce dust levels.
- Double handling of rock will be reduced as far as practical to minimise the overall number of tipping actions.
- Drop heights of rock during tipping operations will be kept to as low as possible.

##### **Monitoring**

Monitoring of dust will take place near the quarrying site and near the wharf construction site to ensure that dust levels do not exceed the EU PM<sub>10</sub> air quality standards. If the dust limits are

exceeded, works will cease until additional mitigation measures can be implemented (Appendix 11 – Monitoring Plan).

#### 10.2.15. Behavioural changes, injuries or fatalities to terrestrial fauna from noise (Direct)

Noise produced in air by quarrying, piling works and general construction activities has the potential to disturb local wildlife potentially resulting in avoidance behaviour, nest abandonment or hearing damage.

A terrestrial noise assessment for the equipment and activities proposed to be used during the construction period has been carried out by Neil Goulding, BAM Environmental Manager. The full assessment including the detailed mitigation is included in Appendix 12 – Terrestrial Noise Assessment. The following mitigation measures are a summary of the conclusions made in the terrestrial noise assessment and standard construction mitigation measures as agreed with the construction partner:

##### **Mitigation**

- The construction works will begin in mid-January after the peak fur and elephant seal breeding season has ended. Weaned elephant seal pups will have likely left the area by late January. However, fur seal pups will still be being weaned until late March and birds will still be nesting with chicks fledging as late as March and April.
- Plant items will be positioned as far as practical from any established nest sites.
- Plant items will be positioned to ensure exhaust outlets point away from sensitive receptors therefore reducing noise received by them.
- Regular maintenance of all plant and vehicles to ensure it is working efficiently and generating as little noise as possible.
- A minimum speed limit of 10mph will be enforced.
- A soft start procedure (gradually increasing noise over a period of time) will be implemented for all noisy equipment (e.g. breaker, vibro and impact piling) and consideration given to the impact on wildlife. Animals on land (except nesting birds) are given the opportunity to move away from the noise source before it reaches its highest levels.
- Acoustic dampening jackets which enclose the hammer head and reduce noise at source will be trialled.
- Dampening of the hammer head, during impact piling, with the use of a resilient pad between the pile and the hammer head may reduce noise generated upon impact.

##### **Monitoring**

- A breeding bird survey will be carried out by the BAS KEP scientist (starting in September and continuing as required until the end of construction, see (Appendix 11 – Monitoring Plan), to establish the locations of nests in relation to noisy activities and to monitor the impact of these activities on nesting success.
- Monitoring of noise will take place near the quarrying site and near the wharf construction site to ensure that noise levels do not exceed the levels which could cause an onset of Temporary Threshold Shift (TTS) in seals and birds as established in the terrestrial noise assessment. TTS is a temporary reduction of hearing capability caused by intensive noise or by prolonged exposure to noise and is considered an auditory/physiological injury. If the

noise levels are exceeded then works in that area will cease until additional mitigation measures can be implemented (see Appendix 11 – Monitoring Plan).

#### 10.2.16. Behavioural changes, injuries or fatalities to marine fauna from noise (Direct)

The activity of vibro piling, impact piling and depositing rock during the wharf, dolphin and slipway construction works will produce underwater sound pressure that has the potential to disturb marine mammals, seabirds and fish resulting in avoidance behaviour or hearing damage.

A marine noise assessment for the equipment proposed to be used for underwater piling (vibro and impact) and by the activity of rock infill has been conducted by noise experts, ABPmer (Appendix 13 – ABP Marine Noise Assessment). The assessment concluded that rock fill activities and vibro piling will have a negligible impact on marine mammals, seabirds and fish and that hammer piling will have a minor adverse impact on marine mammals (specifically phocid pinnipeds such as elephant and leopard seals), seabirds and fish within a 10m radius of the piling works. The following mitigation measures are a summary of the conclusions made in the marine noise assessment and standard construction mitigation measures as agreed with the construction partner:

#### **Mitigation**

- Vibro piling is the main method for driving piles into the seabed and is proposed to be used for the majority of the piling operations. This produces lower source noise levels than impact piling therefore reducing the impact on marine fauna.
- Prior to any vibro piling occurring, a soft start (gradual increase of piling power until full operational power is achieved) of duration of 20 minutes will be used as part of the standard vibro piling methodology to give marine fauna the opportunity to move away from the area.
- Prior to any impact piling occurring, a soft start (by dropping the hammer from the lowest height and increasing to the greatest) will begin to encourage any marine fauna in the area to leave the 10m zone.
- Should any animals remain or enter the 10m zone during the soft start or piling then works will continue on the basis that they are not causing significant disturbance or harm to these animals.
- Whales are very rarely seen in close proximity to KEP. However, if whales are seen within a 500m radius (JNCC piling guidance, 2010) of the marine construction works then piling will cease until the whales have left the area.

#### **Monitoring**

A detailed monitoring methodology for Marine Mammal Observation during the piling works is included in Appendix 11 – Monitoring Plan. Below is summary of the key monitoring requirements:

- A BAM trained Marine Mammal Observer (MMO) will carry out a 10 minute pre-piling search of the area to record all seal movements with a 10m radius (piling will not occur during this time).
- The MMO will continue to record seal activity during the soft start and during the full piling period.
- The MMO will record any unusual seal behaviour and report this to the BAS Environment Office within 24 hours so that mitigation measures can be reviewed.
- The MMO will carry out a whale watch search within a 500m radius (the approximate area of King Edward Cove) during the 10 minute pre-piling search, the soft start and piling activity.



If whales are spotted then piling will be delayed or stopped until the whale(s) have left the 500m radius.

#### 10.2.17. Damage to buildings (and disturbance of wildlife) from vibration (Direct)

Ground vibrations from quarrying and construction activities have the potential to cause damage to structures in their vicinity or harm to humans. The effects of vibration on buildings and humans are well known but the effects on animals (seals and birds) is not well understood.

Vibration levels likely to cause damage to buildings are an instantaneous vibration level where as vibration levels affecting human health are assessed over a 12-hour time period. Both vibration levels will be monitored during the construction period as an indication of potential impact on buildings and humans. The following mitigation measures are a summary of the conclusions made in the vibration monitoring plan (see Appendix 11 – Monitoring Plan) and in consultation with the construction partner:

##### **Mitigation**

- The BAS project manager has discussed the relative sensitivity of structures at KEP and instrumentation (see Section 8.3.3) with the relevant owners and will include all details in the construction impact management plan.
- Before commencing use of high vibration equipment (e.g. piling hammer or hydraulic breaker) a 'soft start' will be employed. This involves the gradual increasing of the vibration caused by an activity. For example, if the drop hammer is used (the loudest item of plant), first the crane will be started, then the hammer power pack, then the hammer will be dropped from a small height and the height of the drop increased gradually until full height of drop is achieved.
- A resilient pad or dolly will also be trialled between the pile and the hammer head when the drop hammer is used to reduce the vibration generated when the hammer strikes the pile.

##### **Monitoring**

Monitoring of vibration will take place as close as possible to buildings in the proximity of quarrying and wharf construction works to ensure that vibration levels do not exceed the British Standard levels for vibration in buildings. If the vibration limits are exceeded, works will cease until additional mitigation measures can be implemented (Appendix 11 – Monitoring Plan).

#### 10.2.18. Pollution of environment from hydrocarbons (Direct/Indirect)

Escaped fuel will contaminate the terrestrial and marine environment and can lead to mortality of flora and fauna through suffocation or through ingestion of contaminated material. Hazardous waste such as contaminated absorbents would also be generated as a result of any spill response.

##### *Vehicles and Plant*

Oil spills and fuel leaks could occur during refuelling of plant and vehicles or through damage to equipment during operation e.g. a burst hydraulic hose or catastrophic failure of a fuel tank.

##### **Mitigation**

- All plant will be inspected regularly to ensure it is in good condition and reduce the risk of oil leaks.

- Refuelling will be carried out by trained individuals
- Refuelling will follow the standard BAS and BAM refuelling procedures as detailed in 5.1.1
- Selected construction staff will attend the BAS Oil Spill Response Course
- Spill response kits will be kept with all vehicles and at the main fuel farm – see 5.1.3
- All spills will be reported to the KEP Station Leader and the BAS Environment Office
- Any response to a spill will follow the BAM Oil Spill Contingency Procedure – see 5.1.2
- A tier 1 spill will be dealt with by the construction team
- A tier 2 and 3 spill will be coordinated by the BAS Station Leader and follow the guidance of the KEP Oil Spill Contingency Plan. The construction team will follow the direction of the station leader.

### *Piling Activities*

Piling is the selected method of driving the construction metal elements into the seabed and shoreline. The ground within the existing wharf and at the location of the proposed mooring points is now known to be contaminated with diesel and other contaminants (see 3.3.1). A risk assessment carried out by Sweco (see 3.3.1.1) has concluded that there is an increased risk of release of diesel (and other pollutants) to the marine environment as a result of piling activities. The risk assessment concluded that piling could disrupt the ground conditions and cause contaminated groundwater to migrate and escape to the water. However, the assessment also concluded that any construction method used will require some form of disturbance of the ground and therefore an elevated risk of water contamination is unavoidable during construction works.

### **Mitigation**

- Precautionary spill response equipment (e.g. floating booms to contain and concentrate oil, a skimmer to selectively recover and pump the oil to a storage container on the shore) will be deployed in the water around the area of operation during piling works of the wharf and slipway to ensure that any unintentional release of oil contaminated water to the sea is contained and removed for safe disposal as per the BAS Waste Management Handbook.

### *Ground Excavation*

There is also a risk that piling activities on the shoreline could come across obstructions when trying to drive the sheet pile into the ground. If obstructions are found then this may require some ground excavation to remove the objects. This excavation would result in contaminated ground arisings and potentially contaminated water, PPE and spill response equipment (such as absorbents).

### **Mitigation**

- Vibro piling has been selected for offshore and onshore works (mooring points and anchor wall) rather than installation of precast elements as it eliminates or reduces the requirement for excavation in the contaminated onshore areas. This change lowers the risks associated with terrestrial fuel contamination.
- Obstructions found during piling of the anchor wall are not expected to cause a problem as individual sheet piles can be cut to length where they hit an obstacle. The anchor wall is made up of numerous sheet piles so as long as the majority of piles reach the required depth, this will provide the necessary support.
- Obstructions are not anticipated to be found in the location of mooring points. However, if some obstacles are found then limited excavation will be required which will result in contaminated ground being excavated and removed from the wharf. Any material excavated

will be stockpiled in a bund to contain the contamination. It is proposed that the contaminated ground will be returned to its location once the obstacle has been removed. Staff and vehicles will be protected from contamination using suitable spill response PPE which will be disposed of appropriately.

#### 10.2.19. Loss of seabed and marine benthic habitat (Direct)

A small area of the seabed and marine benthic habitat will be lost permanently by the extension of the wharf, extension of the slipway and construction of the dolphin. There will be a loss of a few individuals of a limited range of benthic species within the impacted and removed habitat. A survey of the existing marine benthic environment carried out in 2018 identifies the range of species which currently occupies the area (9.1.3.2). Recolonization of the new wharf and associated structures is possible.

#### **Mitigation**

Alternative designs which impacted a larger area of the seabed have been discounted. The proposed design impacts the smallest area of seabed.

#### **Monitoring**

A post-construction marine survey of the newly constructed wharf and associated structures will be carried out by a remotely operated vehicle in the 2020/21 season to determine the degree of change in benthic community relative to the survey undertaken in 2018 (see Appendix 11 – Monitoring Plan).

#### 10.2.20. Removal of local rock and visual change (Direct/Cumulative)

Local quarrying will remove rock material from up to two proposed locations and will lead to a permanent change in the topography of the area. The excavation works could increase the risk of landslides in the area. The visual change could also have a potential impact on the aesthetic value of the site.

This impact could be avoided if rock fill material was imported to South Georgia from outside the territory. The importation of rock fill material would increase the risk of introducing non-native species which is of greater concern to the native ecosystem. On balance, the impact of removing local rock and changing the aesthetic value of the site was considered of lesser concern than the risk of introducing non-native species.

A total quantity of 5,727 tonnes of graded rock material is required for the wharf, dolphin and slipway. It is anticipated that a maximum of 10,412 tonnes of rock may need to be excavated and processed in order to achieve the required quantity of end product material. It is proposed that all rock will be removed from Quarry 1 with Quarry 2 reserved as a backup site for a potential small quantity of material. Other potential quarry areas were discounted as they had a greater risk of spreading already established non-native plants. Other sites were also rejected based on their potential yield or because they were logistically challenging to access/operate in. The aesthetic value of each proposed quarry site was also recorded by photographic survey which captured images of the proposed quarry locations from a number of different viewpoints within King Edward Cove.

## Mitigation

- Once the quarry activities are complete, the unused by-product (as a result of screening or breaking) will be used to fill the excavated areas. The removed topsoil will also be returned to the landscaped area.
- The excavated slopes will be protected from possible landslide risk by forming a berm/lower platform with the by-product.
- An accurate assessment of the final landscaped profile will be made on site and will depend on the total quantity of material that needs to be excavated to achieve the required quantity of graded material.
- A photographic survey of the quarried location could be repeated (see 9.5.1) to determine the impact to the aesthetic value of the site.

### 10.2.21. Loss of vegetation and nesting habitat (Direct)

Quarry 1 and Quarry 2 have been selected for rock extraction. Quarry 1 has two small areas of tussock which have been assessed as suitable nesting habitat for the South Georgia pipit. The vegetation will need to be removed as part of the rock extraction works therefore leading to loss of future nesting habitat.

## Mitigation

- The tussock grass will be removed (along with a layer of topsoil) and put to one side (with the tussock facing up). Once quarrying has finished, the leftover by-product will be put back in the quarried area and the topsoil and tussock returned to the surface. It is not known whether the tussock is likely to survive this removal and replanting.

### 10.2.22. Damage to nests (Direct)

Quarry 1 and Quarry 2 have been selected for rock extraction. Quarry 1 has two small areas of tussock which have been assessed as suitable nesting habitat for the South Georgia pipit. The tussock grass needs to be removed in order for excavation of the ground to begin. It is not known whether pipits will be nesting in this tussock during construction works but the tussock does provide a suitable habitat. Pipits can raise up to three broods in a single season with each brood taking approximately 6 weeks from laying to fledging. Pipits may or may not be nesting in this area in late January when quarrying works are due to begin. If construction works start when pipits are nesting in the tussock this could lead to nest abandonment or injury to bird and chicks.

In order to avoid disturbing nesting birds or causing injury to birds and chicks various options were considered. Removal of the tussock grass in early September (prior to the start of nesting) was considered but rejected because neither BAS or GSGSSI will have the appropriate plant and equipment on site at the time to support the removal of the tussock grass. Netting the tussock grass to prevent nesting was also considered and rejected because netting has the potential to cause bird entanglements and injuries and runs the risk of being destroyed by seals leading to waste netting in the environment. The most practical and proposed solution is to remove any nests which are likely to be disturbed by the tussock removal in late January.

## Mitigation

- Any eggs found in the tussock grass prior to mid-December will likely hatch and fledge before the construction works are due to begin and can be left undisturbed.
- Any nests or new eggs laid in the tussock from early January onwards are likely to delay the start of construction works by up to 2 weeks until the chicks fledge. In this situation, it is proposed that the nests and eggs are removed from the tussock and placed in a new location prior to hatching. The chances of survival of these nests are very low however, the impact will be restricted to a single or a few individual birds.

## Monitoring

- A breeding bird survey will be carried out by the BAS KEP scientist (starting in September and continuing as required until the end of construction, see Appendix 11 – Monitoring Plan) to establish the locations of nests and to monitor the impact of construction activities on nesting success.
- The KEP scientist will be responsible for removing any nests or eggs from quarry site 1 that are laid from early January onwards.

### 10.2.23. New wharf facilities impact on station operations (Direct)

The operation of the new wharf and associated structures could place greater environmental pressures on the station by increasing the capacity of the wharf to support larger vessels, more frequent vessel visits and allowing for an increase in small boating operations.

## Mitigation

- There will be no increase in the number of people on station at KEP as a result of the new wharf and associated structures.
- The new wharf, once operational, will only be used by those vessels that currently use it and by the SDA for which it has been primarily designed. The current BAS ships, the ES and JCR will both be withdrawn from service by 2020 and replaced by the SDA. Therefore, there will be no increase in the intensity of ship visits to KEP.
- There is no intention to increase operations at KEP as a result of the new wharf. The new wharf is intended to improve efficiency of relief by the SDA but will not change the current operation on station.

### 10.2.24. Scour of seabed by SDA operation at the new wharf (Direct/Cumulative)

Scour disturbance and erosion of the seabed caused by the propellers and thrusters of the SDA during berthing operations could cause erosion of the seabed leading to weakening and damage of the wharf structures and disturbance to the marine benthic communities in the vicinity of the wharf.

## Mitigation

Scouring potential of the SDA has been assessed and considered in the design of the wharf. Operational restrictions will be implemented to ensure that the SDA berthing at the KEP wharf does not significantly contribute to scouring. The SDA will be required to operate to a maximum 15% of its propeller and thruster capacity during berthing/departing operations in order to minimise the effects of scouring. Monitoring of the scour will take place by station personnel using a dip stick after each departure of the vessel to ensure that any scour hole developed is at acceptable levels.

#### 10.2.25. New wharf maintenance related impacts (Direct)

The new wharf and associated structures are designed with 50-year design life. The required maintenance identified in this period is minor with only some of the small fixtures such as the dolphin walkway, fenders & chains and the bollards requiring regular maintenance such as repainting and repairs from ship berthing damage. These smaller fixtures will also require major maintenance after a 15-year period. The impacts associated with these activities cannot be fully assessed at this stage but are expected to involve atmospheric pollution from use of vehicles and plant, potential disturbance (from physical presence and noise) to marine mammals in the area, accidental spill of fuels or other hazardous substances as paints leading to contamination of the environment and the production of waste.

#### **Mitigation**

Maintenance works at the wharf and associated structures will be assessed prior to any works under a GSGSSI Regulated Activity Permit and appropriate mitigation measures put in place.

## 11. IMPACT ASSESSMENT

Environmental impacts have been identified and detailed in Section 10.2 above. This chapter firstly describes the method used to assess the impact significance in relation to the severity of the change on the environment. Secondly, it applies the significance assessment in an impact matrix in Section 11.2 and finally describes the impacts which are likely to have a cumulative impact on the environment.

### 11.1. Methodology

In order to evaluate the significance of all the identified potential environmental impacts the following method has been used. It describes the criteria considered for each impact and the values assigned to them in order to produce an overall value risk score that defines the severity of each impact. Finally, it identifies the possible responses that can be applied to each identified impact in order to, where possible, reduce or minimise the impact.

#### *Assessment of Impact Significance*

Significance is a value judgment about the severity and importance of a change in a given environment or environmental value or resource (ATCM, EIA Guidelines 2016). The matrix in section 11.2 evaluates the significance of each impact by considering the following criteria:

- Spatial extent of impact – area or volume where changes are likely to be detectable;
- Duration of impact – time period during which changes are likely to occur;
- Likelihood of the impact occurring;
- Intensity or severity of the impact – a measure of the amount of change on the environment which also considers the resilience of the environment and its ability to reverse the impact.

Each criteria for each impact is given a score from 1 – 5 to identify whether it is considered ‘very low’, ‘low’, ‘medium’, ‘high’ or ‘very high’.

Table 27. Impact value significance criteria and values

Impact Criteria	Definition of Scoring Values for each Criteria				
	Very Low	Low	Medium	High	Very High
	1	2	3	4	5
<b>Spatial extent of impact</b>	Site Specific	Local to KEP and Grytviken and local terrestrial and marine environment.	Regional: Cumberland Bay area.	Territory: South Georgia and South Sandwich Islands and Southern Ocean north of 60° South.	Global: Earth and atmosphere
<b>Duration of impact</b>	Minutes to days	Weeks to months	Several seasons to several years	Decades	Centuries to millennia
<b>Likelihood of impact</b>	Very unlikely to occur under any circumstance.	Unlikely to occur under normal BAS operations and standard procedures.	Possible if normal BAS operations and standard procedures are not followed.	Likely to occur during the project.	Certain to occur. Unavoidable.
<b>Intensity of impact</b>	No direct impact on the environment and local ecosystems.	Impacts may occur but are minimal and reversible in the short term.	Changes to the environment but with no long-lasting affect. Recovery is likely.	Changes to the environment and local ecosystem over the longer-term. Recovery is slow and uncertain.	Major changes to the environment and local ecosystem which are certain to occur, unavoidable and irreversible. Recovery is unlikely.

#### Impact Risk Score Evaluation

Once the significance criteria have been scored for each impact, this is then used to calculate the overall risk score by using the following calculation:

$$\text{Risk Score} = \text{Extent} \times \text{Duration} \times \text{Likelihood} \times \text{Intensity}$$

By multiplying the value of the each criteria it produces a risk score between 1 and 625. This is repeated after the mitigation measures have been implemented to allow for a comparison and to demonstrate whether the mitigation measures have resulted in a reduction of the risk score. The higher the number the greater the environmental risk of the impact. The risk score values have been split into categories of impact and colour coded for ease of identification.



Table 28. Risk Score Values and Interpretation

Description	Risk Score
Impact acceptable and will be managed through normal BAS operating procedures and outlined mitigation measures.	1 - 40
Impact needs active management through mitigation measures and monitoring.	41 - 120
Impact significant. If no practical mitigation measures are possible then BAS and GSGSSI senior management must decide whether to accept the risk.	121 - 625

### Risk Response

Aligned with the risk score, a risk response has been identified for each impact:

- Avoid – apply normal operating procedures and mitigation to prevent impact occurring
- Reduce – apply normal operating procedures and mitigation to reduce risk of impact occurring
- Accept – no further mitigation measures possible and risk is accepted

Where ‘avoid’ or ‘reduce’ is assigned to an impact, the response should involve applying the normal operating procedures and mitigation measures in order to eliminate or reduce the risk. The risk score is then recalculated.

Where there are no practical mitigation measures for an impact the response can only be ‘accept’. Therefore, if the activity takes place and the impact occurs then this must be accepted.

## 11.2. Impact Matrix

This impact matrix provides a breakdown of the predicted environmental impacts and identifies the activities and environmental aspects that led to them. The significance of each impact is assessed through the risk score application (methodology described in Section 11.1 above) and then reassessed after the implementation of mitigation measures. Where there are no practical mitigation measures the impact is accepted.

Activities	Environmental Aspect	Potential Impact(s)	Type of Impact: Direct, indirect, cumulative	Pre-mitigation impact criteria score					Risk Score	Response Action: Avoid, Reduce, Accept	Mitigation Measures	Post-mitigation impact criteria score				
				Spatial Extent	Duration	Likelihood	Intensity	Spatial Extent				Duration	Likelihood	Intensity	Risk Score	
Vessel and Aircraft transport for cargo and personnel.  Vehicle operations at KEP.	Emissions to air	Cumulative contribution to regional and global atmospheric pollution.	Direct Cumulative	2	2	5	2	40	REDUCE	Regular maintenance and inspection of vehicles and plant to ensure efficient working and combustion.	2	2	4	2	32	
										All flights and ships will be routed by the most efficient way.						
										Engines will be turned off when vehicles/plant idling.						
										Emissions will be calculated for monitoring purposes.						
Increased numbers of personnel and activities during construction works.	Physical presence and use of space  Physical disturbance on land	Damage to items of heritage.	Direct	2	3	2	2	24	REDUCE	Staff will not remove, disturb, deface or destroy any historical artefacts.	2	3	1	2	12	
										All vehicle and plant operations will be restricted to KEP and the track between KEP and Grytviken therefore reducing the risk of accidental damage of historical artefacts at Grytviken.						
										Staff carrying out excavation works will remain alert for any manmade objects in the ground. In the event that any items are found during excavation then the GSGSSI GO on site will be notified to supervise the safe removal and ongoing management of any removed items as per the GSGSSI policy.						
Importation of cargo and personnel.	Introduction of non-native species	Establishment of non-native species. Alteration of the native ecosystem. Risk to native species. Impact on science.	Indirect Cumulative	3	4	3	4	144	REDUCE	All staff will attend pre-deployment training on environmental management including biosecurity requirements.	3	4	2	4	96	
										Appendix 6 – KEP Biosecurity Plan will be followed at all times.						
										All equipment and materials will be cleaned and inspected prior to loading and prior to offloading at KEP.						
										All personal items of clothing and luggage will be cleaned and inspected before travel and prior to disembarking at KEP.						
										Any biosecurity incidents will be immediately reported to the KEP Station Leader and BAS Environment Office.						
Movement of personnel and vehicles between areas with established non-native species.	Spread of existing non-native species	Further spread of already established non-native species. Alteration of the native ecosystem.	Indirect Cumulative	2	4	3	3	72	REDUCE	Operations will be restricted to KEP (and the track) only therefore reducing the risk of spreading non-natives from KEP to Grytviken and from Grytviken to KEP.	2	4	2	3	48	
										Appendix 6 – KEP Biosecurity Plan will be followed at all times.						
										The 'village green' will be prepared for aggregate storage by covering it with permeable root barrier membrane and adding a permanent layer of rock. All						

Activities	Environmental Aspect	Potential Impact(s)	Type of Impact: Direct, indirect, cumulative	Pre-mitigation impact criteria score					Risk Score	Response Action: Avoid, Reduce, Accept	Mitigation Measures	Post-mitigation impact criteria score				
				Spatial Extent	Duration	Likelihood	Intensity	Risk Score				Spatial Extent	Duration	Likelihood	Intensity	Risk Score
Use of the village green, a managed bittercress site, for aggregate storage.										vehicles, equipment and personnel involved in the set up will be cleaned prior to use elsewhere on site. Vehicles and plant will stick to prepared roads only and instructed to remain on the track and avoid contact with grass verges.						
Increased numbers of personnel and activities during construction works.	Physical presence and use of water	Depletion of natural resource. Pressure on station facilities. Reduced availability of water for general station consumption.	Direct	2	2	2	2	16	ACCEPT	Use of seawater, where possible, for construction activities.	2	2	2	2	16	
Increased numbers of personnel and activities during construction works.	Waste production	Increased quantities of waste sent to landfill.	Direct	2	2	4	2	32	REDUCE	SWMP to be followed for all construction waste and BAS Waste Management Handbook for all domestic waste. Dedicated member of staff responsible for waste management. Dedicated areas to be set up for waste segregation and storage. Construction waste returned to the UK and disposed of by licensed contractor. Target of 80% diversion of waste from landfill. Waste statistics to be provided for monitoring purposes.	2	2	2	2	16	
Increased numbers of personnel and activities during construction works.	Waste production	Pollution of terrestrial or marine environment in South Georgia as a result of loss of waste to the local environment.	Direct	2	2	3	2	24	REDUCE	SWMP to be followed for all construction waste and BAS Waste Management Handbook for all domestic waste. Dedicated member of staff responsible for waste management. Dedicated areas to be set up for waste segregation and storage. All outside storage of waste to be appropriately secured to prevent wind dispersal or harm to animals. All waste and unused construction materials will be removed from site unless prior agreement given by BAS for reuse of materials on site.	2	2	2	2	16	
Increased numbers of personnel on station			Direct	2	2	5	2	40	ACCEPT	All toilet and washing facilities for construction staff will be provided by existing KEP infrastructure. No temporary facilities are currently anticipated.	2	2	5	2	40	

Activities	Environmental Aspect	Potential Impact(s)	Type of Impact: Direct, indirect, cumulative	Pre-mitigation impact criteria score					Risk Score	Response Action: Avoid, Reduce, Accept	Mitigation Measures	Post-mitigation impact criteria score				
				Spatial Extent	Duration	Likelihood	Intensity	Risk Score				Spatial Extent	Duration	Likelihood	Intensity	Risk Score
releasing increased volume of effluent to environment.	Sewage and grey water waste production	Effluent polluting the marine environment and possible release of pathogens.								Sewage and grey water will be discharged direct to sea as per the usual KEP operation.						
Increased numbers of personnel and activities during construction works.	Physical presence and use of space	Disruption to science. Reduction in science supported at KEP. Damage or disturbance to science equipment or data collection.	Direct	2	2	3	2	24	REDUCE	The core KEP fisheries and marine predator science will be uninterrupted. The KEP scientist will provide some support to the project and this has been factored into the workload of the role.	2	2	2	2	16	
										The owners of scientific equipment at KEP and the wider area have been informed of the works so that if necessary they can account for any construction related impacts on their data collection.						
										Scientific infrastructure near the boatshed and construction works will be protected from vehicle movements and depoted equipment.						
										The tide gauge at the wharf will be temporarily removed during works.						
Increased numbers of personnel and activities during construction works.  No working wharf or slipway for duration of works.	Physical presence and use of space	Disruption to station operations.  Breakdown of working relationship between KEP staff and construction staff.  Disturbance to the small boat operation.  Vessels unable to berth at KEP.	Direct	2	2	3	3	36	REDUCE	A KEP Integration Plan is being prepared to ensure good working relationships between the station and construction teams.	2	2	2	2	16	
										Project chefs will provide all catering for both the station and construction teams.						
										All essential cargo operations will take place prior to the construction work programme.						
										The small boat operation will continue uninterrupted. The harbour boats will be moored at Tijuca in Grytviken.						
Increased numbers of personnel and activities during construction works.  Increased footprint of construction works.	Physical presence and use of space	Disruption to tourism activities.  Construction work areas off limits to visitors interrupting normal walking routes.  Negative perception of construction works leading to poor visitor experience and reputational loss for BAS, BAM and GSGSSI.	Direct  Cumulative	2	2	3	3	36	REDUCE	Construction activities are restricted to KEP and the track. Grytviken will not be impacted.	2	2	2	2	16	
										The road between KEP and Grytviken will be closed to visitors to ensure their safety during construction works.						
										Visitors wishing to visit the memorial cross at Hope Point can be transported by cruise vessel small boat instead of walking along the track.						
										A KEP Stakeholder Communication and Engagement Plan is being rolled out by BAS in consultation with GSGSSI and BAM to ensure the construction project is clearly communicated to all stakeholders including IAATO.						

Activities	Environmental Aspect	Potential Impact(s)	Type of Impact: Direct, indirect, cumulative	Pre-mitigation impact criteria score					Risk Score	Response Action: Avoid, Reduce, Accept	Mitigation Measures	Post-mitigation impact criteria score				
				Spatial Extent	Duration	Likelihood	Intensity	Risk Score				Spatial Extent	Duration	Likelihood	Intensity	Risk Score
Use of vehicles and plant.	Physical disturbance to wildlife	Interaction of wildlife with moving vehicles and plant could result in behavioural (avoidance, aggressive or stress) changes, injuries or fatalities to animals.	Direct	2	2	4	3	48	REDUCE	The construction programme will start in mid-January after the peak fur and elephant seal breeding season. Weaned elephant seal pups will have likely left the area by late January. However, fur seal pups will still be being weaned until late March.	2	2	3	3	36	
										The crawler crane will be fitted with streamers to deter birds.						
										Vehicles are only permitted to drive on the existing KEP track and within the station perimeter. Driving is not permitted on areas of vegetation/tussock.						
										Maximum speed limit of 10mph.						
										Engine idling is not permitted.						
										Drivers will inspect their vehicles (under the wheels) for seals, penguins and other wildlife prior to starting their engine.						
										All vehicles have suitable all round visibility achieved with mirrors and/or cameras and all cabs equipped with radios.						
										A banksman will support all difficult manoeuvres.						
										Animals have right of way and drivers will stop work to allow them to cross their path. However, animal displacement may be required to allow the work to progress or for the safety of the animal. All seal displacements will be recorded.						
Any wildlife injury or fatality associated with the work should be reported immediately to the Environment Office, Station Leader and Government Officer.																
Use of external lighting rigs during dull days or hours of darkness.	Light	Disturbance and disorientation of birds. Injury or death of birds due to collision.	Direct	1	2	3	3	18	REDUCE	The construction programme has been set out to ensure that works are carried out during the hours of daylight only.	1	1	2	3	6	
										Some task lighting may be required but this will be specifically for the wharf extension to provide lighting between the wall of the existing and new wharf for fitting the waling beams. Lighting will be suspended from the sheet pile wall and lighting will be localised in the specific area below the level of the sheet pile wall.						
										The requirement for any other lighting (other than the agreed wharf task lighting) will be submitted to the BAS Environment Office in advance and a justification provided prior to any lighting works being approved.						
										Any bird disorientation or bird strikes will be reported to the BAS Environment Office.						

Activities	Environmental Aspect	Potential Impact(s)	Type of Impact: Direct, indirect, cumulative	Pre-mitigation impact criteria score					Risk Score	Response Action: Avoid, Reduce, Accept	Mitigation Measures	Post-mitigation impact criteria score				
				Spatial Extent	Duration	Likelihood	Intensity	Risk Score				Spatial Extent	Duration	Likelihood	Intensity	Risk Score
Quarrying activities (excavation, screening, crushing), transport and rock loading and tipping activities.	Dust creation and deposition	Damage soil organisms and smothering of flora.	Direct	2	2	3	3	36	REDUCE	Plant will be selected to reduce excessive dust production. Regular maintenance of all equipment to ensure it is working efficiently.	2	2	2	3	24	
										Dust creating activities will be suspended during periods of high wind based observations on site including wind direction and the production of dust plumes.						
										The screener and crusher at the excavation site will be fitted with seawater spray bars or a staff member will on site to water down activities.						
										Vehicles transporting rock material will be fitted with dust sheets.						
										10mph speed limit maintained and enforced on site.						
										Areas of excavated rock will be sprayed with seawater to reduce dust levels.						
										Double handling of rock will be reduced as far as practical.						
										Drop heights of rock during tipping will be kept as low as possible.						
Quarrying works, piling works and general vehicle and plant operation.	Noise in the terrestrial environment	Disturbance to local terrestrial fauna (seals and birds) resulting in avoidance behaviour, nest abandonment or hearing damage.	Direct	2	2	4	3	48	REDUCE	The construction programme will start in mid-January after the peak fur and elephant seal breeding season. Weaned elephant seal pups will have likely left the area by late January. However, fur seal pups will still be being weaned until late March.	2	2	3	3	36	
										Plant items will be positioned as far as practical from any established bird nests.						
										Plant exhaust outlets will be positioned away from sensitive receptors.						
										Regular maintenance of all equipment to ensure it is working efficiently.						
										10mph speed limit maintained and enforced on site.						
										Soft start procedure will be implemented for all noisy equipment (breaker, piling) and consideration given to animals on land. They will be given the opportunity to move away from the noise before it reaches its maximum capacity.						
										Acoustic dampening jackets will be trialled on the piling hammer head.						
										A dampening pad will also be trialled on the hammer head during piling.						
Piling works and rock infill activities.		Disturbance to marine wildlife (seals, seabirds and	Direct	2	2	4	3	48	REDUCE	Calculations indicate that noise levels from rock infill activities and vibro piling will be low and not significant to marine mammals (seals), fish and seabirds.	2	2	3	3	36	

Activities	Environmental Aspect	Potential Impact(s)	Type of Impact: Direct, indirect, cumulative	Pre-mitigation impact criteria score				Risk Score	Response Action: Avoid, Reduce, Accept	Mitigation Measures	Post-mitigation impact criteria score				Risk Score
				Spatial Extent	Duration	Likelihood	Intensity				Spatial Extent	Duration	Likelihood	Intensity	
	Noise in the marine environment	fish) resulting in behavioural changes or hearing damage.								Vibro piling produces a lower source of noise than impact piling and will be the main method for driving piles. A soft start procedure of 20 minutes will be used as standard piling methodology to give marine fauna the opportunity to move away. Impact piling produces a higher source of noise and can cause harm to phocid seals, fish and birds located within a 10m radius from the works. A BAM trained MMO will ensure that a 10m radius around the impact piling is free of wildlife prior to works starting. If deemed necessary, a soft start procedure will be used to encourage any wildlife out of the zone prior to the impact hammer reaching full power. Piling works will cease if whales are seen within a 500m radius of the works.					
Quarrying and piling activities.	Vibration in the terrestrial environment	Ground displacement causing damage to structures and scientific equipment.	Direct	2	2	4	3	48	REDUCE	The BAS project manager has discussed the relative sensitivity of structures and instrumentation with the owners. A soft start procedure will be employed for the piling and impact hammer. A dampening pad will also be trialled on the hammer head during piling.	2	2	3	3	36
Use of vehicles plant and generators	Hydrocarbon release to the terrestrial and marine environment.	Contamination of the environment. Mortality of flora and fauna through suffocation or through ingestion of contaminated material. Generation of contaminated spill response materials.	Direct Indirect	2	2	3	3	36	REDUCE	Regular maintenance of all equipment to ensure it is working efficiently and reduce risk of oil leaks. Refuelling will be carried out by trained individuals. Refuelling will follow the standard BAS and BAM refuelling procedures. Selected construction staff will attend the BAS Oil Spill Response Course Spill response kits will be held by all vehicles and at the main fuel farm. All spills will be reported to the KEP Station Leader and BAS Environment Office. BAM will respond directly to any small tier 1 spills. Larger tier 2 or 3 spills will be coordinated by the KEP Station Leader as per the KEP Oil Spill Contingency Plan. The construction staff will be under the Station Leaders direction.	2	2	2	3	24
Piling activities	Hydrocarbon release to the	Piling activities may increase risk of contaminated groundwater release to the sea leading to contamination	Direct Indirect	2	2	4	3	48	REDUCE	Precautionary spill response equipment (e.g. floating booms to contain and concentrate oil, a skimmer to selectively recover and pump the oil to a storage container on the shore) will be deployed in the water around the area of operation during piling works on the wharf and slipway to ensure that any	2	2	3	3	36

Activities	Environmental Aspect	Potential Impact(s)	Type of Impact: Direct, indirect, cumulative	Pre-mitigation impact criteria score					Risk Score	Response Action: Avoid, Reduce, Accept	Mitigation Measures	Post-mitigation impact criteria score				
				Spatial Extent	Duration	Likelihood	Intensity	Spatial Extent				Duration	Likelihood	Intensity	Risk Score	
	marine environment	of the environment as described above.								unintentional release of oil contaminated water to the sea is contained and removed for safe disposal as per the BAS Waste Management Handbook						
Excavation of rock at wharf and mooring points.	Hydrocarbon release to the terrestrial environment	Excavation of rock at wharf and mooring points will create fuel contaminated ground arisings which may lead to contamination of the environment as described above.	Direct Indirect	2	2	3	3	36	REDUCE	Vibro piling has been selected for installing onshore mooring and the anchor wall instead of burying precast elements. This eliminates or significantly reduces the need for ground excavation in the hydrocarbon contaminated areas.  Excavation can be avoided if obstructions are found whilst installing the anchor wall sheet piles by cutting the obstructed sheet pile to the required length where it reaches the obstacle.  Preliminary trial pits at the mooring points indicated that obstacles are unlikely to be found in this area. However, if obstacles are found then some excavation should be expected to remove the obstruction. Removed contaminated ground will be temporarily stored in a bund. Staff will use appropriate PPE to protect themselves from contamination. Once the obstacle is removed, the contaminated material will be returned. Any contaminated PPE will be disposed of as per the BAS Waste Management Handbook.	2	2	2	3	24	
Extension of wharf and slipway footprint and construction of new dolphin.	Loss of seabed area	Permanent loss of small area of marine benthic habitat and loss of a few individuals of a benthic species.	Direct	1	5	5	4	100	ACCEPT	The selected design impacts the smallest possible area of the seabed. Recolonization of the new wharf and structures is possible in time.	1	5	5	4	100	
Quarrying activities leading to excavation and removal of local rock.	Removal of local rock	Loss of natural resource and permanent change in topography of quarried site.  Visual change and potential impact on aesthetic value.	Direct Cumulative	2	5	5	5	250	ACCEPT	All unused by-product from the excavation will be used to fill the excavated areas.  The removed topsoil will be returned and the area landscaped. An accurate assessment of the final landscaped profile will be made on site once the total quantity of material required to be excavated is known.  The excavated slopes will be protected from landslide risk by forming a berm with the by-product.  A post quarrying photographic survey will be taken from the main viewpoints to allow a comparative assessment of the viewpoints pre and post construction works.	2	5	5	5	250	
Quarrying requires excavation and removal of topsoil and vegetation.	Removal of vegetation	Removal of tussock and possible loss of suitable terrestrial habitat.	Direct	1	4	5	4	80	REDUCE	The tussock will be removed with the topsoil and replanted after quarrying is finished. If successful, then the nesting habitat will be preserved.	1	3	4	4	48	



Activities	Environmental Aspect	Potential Impact(s)	Type of Impact: Direct, indirect, cumulative	Pre-mitigation impact criteria score					Risk Score	Response Action: Avoid, Reduce, Accept	Mitigation Measures	Post-mitigation impact criteria score				
				Spatial Extent	Duration	Likelihood	Intensity	Spatial Extent				Duration	Likelihood	Intensity	Risk Score	
Quarrying requires excavation and removal of topsoil and vegetation that is suitable nesting habitat for pipits.	Removal of nests	Possible disturbance of nesting birds or damage/destruction of nests.	Direct	1	2	4	3	24	REDUCE	The KEP scientist will monitor the tussock in Quarry 1 from September until construction works begin and record any nesting birds in the area.	1	2	3	3	18	
										Any eggs found in the tussock grass at Quarry 1 prior to mid-December will likely hatch and fledge before the construction works are due to begin and can be left undisturbed.						
										Any nests or new eggs laid in the tussock from early January onwards are likely to delay the start of construction works by up to 2 weeks until the chicks fledge. In this situation, it is proposed that the nests and eggs are removed from the tussock and placed in a new location prior to hatching. The chances of survival of these nests are very low however, the impact will be restricted to a single or a few individual birds.						
Post construction operation of the newly constructed wharf.	Physical presence and use of space	Potential to support greater activity therefore increasing the general environmental pressures on station.	Direct	2	3	3	2	36	REDUCE	The number of people supported by KEP station will not increase as a result of the new wharf facilities.	2	3	2	2	24	
										Once operational, the new wharf facilities will only be used by the vessels that currently use it and the SDA for which it has been primarily designed. The current BAS ships will both be withdrawn from service by 2020 and replaced by the SDA therefore there will be no increase in the intensity of ship visits to KEP.						
										There is no intention to increase operations at KEP as a result of the new wharf. The new wharf is intended to improve efficiency of relief by SDA and will not change the current operation of the station.						
Post construction use of the wharf by the SDA	Physical disturbance in water.  Disturbance of marine fauna.	Use of the wharf by the SDA has the potential to lead to greater scouring leading to damage of the wharf structures and destruction of habitat for marine benthic species.	Direct  Cumulative	1	2	5	4	40	REDUCE	The design of the wharf has considered potential scouring caused by the SDA.	1	2	3	4	24	
										Operational restrictions will be implemented to ensure that the SDA uses 15% of its thruster and propeller power during berthing/departing operations to minimise scour effects.						
										Monitoring of scour will take place after each SDA departure.						
Wharf maintenance	Atmospheric emissions, Noise, physical disturbance of marine mammals, waste, hazardous release.	Maintenance works of the wharf and associated structures during its lifetime have the potential to lead to atmospheric pollution, disturbance of wildlife and hazardous contamination of the environment.	Direct	1	2	3	3	18		The impacts associated with these activities cannot be fully assessed at this stage. However, maintenance works at the wharf and associated structures will be assessed prior to any works under a GSGSSI Regulated Activity Permit and appropriate mitigation measures put in place.	1	2	2	2	8	

### 11.3. Cumulative Impacts

Cumulative impacts are the combined impact of past, present and future activities over time or space. Therefore, even though an individual impact may initially be considered small, its interaction with other impacts and its continuing effect over a longer period of time may cause an accumulative impact.

King Edward Point has been almost continuously inhabited since 1912 and the first jetty/wharf was built in 1925. The station and boating facilities have evolved and expanded since their early days. Prior to this, KEP was also used as a sealing site. The proposed wharf and associated structures development will marginally increase the overall footprint of the current station by extending the wharf and slipway and constructing a new dolphin. In addition, the proposed excavation at the quarry site will permanently change the topography of that location. The current operational and scientific activities undertaken at KEP will remain unchanged as a result of the proposed works. However, the intention is that relief of the station will become more efficient and that the 50-year lifespan of the wharf will allow station activities to continue into the future.

The impacts of the wharf redevelopment and excavation activities and the proposed mitigation measures are described in detail in the sections above. Impacts are identified as a result of the planned construction activities but the majority will only be experienced during the limited period of the construction period. However, some activities have the potential to have a cumulative impact beyond the construction period as listed below:

- Emissions to air will contribute to global atmospheric pollution
- The possible introduction, establishment or further spread of non-native species over time could lead to alteration and decline of the native ecosystem.
- The removal of rock at the local quarry will lead to a change in the topography and could change the aesthetic value of the area.
- The construction works could lead to disruption of tourism operations and has the potential for long-term reputational loss for BAS, BAM and GSGSSI.
- The operational use of the wharf by the SDA could have long-term scouring impacts which has the potential to cause weakening of the wharf structures and damage to the marine benthic communities.

## 12. MONITORING & AUDIT REQUIREMENTS

### 12.1. Monitoring Plan

A monitoring plan has been prepared and is presented in detail in Appendix 11 – Monitoring Plan. This outlines the monitoring activities to be undertaken during and after the construction period and details the day to day environmental management activities which will be undertaken.

The monitoring tasks are divided into three groups:

- 1) **Short-term monitoring** - activities which could result in an immediate impact on the environment and can be modified during the construction period to reduce or eliminate the negative impacts.
  - Managed wildlife displacement
  - Distribution of breeding birds
  - Terrestrial noise from quarrying and construction activities
  - Vibration from quarrying and construction activities
  - Marine mammals and seabirds potentially impacted by marine noise from piling activities
  - Airborne dust

This monitoring data will be reported to the BAS Environment Office throughout the construction. Any changes to the proposed activities as a result of the monitoring data will be discussed and agreed between the BAS KEP Project Manager and the BAS Environment Office.

- 2) **Long-term monitoring** - activities which could result in long-term impact and are unlikely to be modified during the construction period.
  - Marine benthic invertebrate communities survey
- 3) **Environmental management activities** – these will be undertaken by the construction partner as indicated in the table below and the data or findings reported to the BAS Environment Office.

Table 29. Environmental Management Activities

Environmental Management Activity	Location in EIA	Reporting Output
<b>Biosecurity:</b> Implementation of the KEP Biosecurity Plan at all stages of cargo and personnel movement	Appendix 6 – KEP Biosecurity Plan	<ul style="list-style-type: none"> <li>▪ Biosecurity Checklists</li> <li>▪ Biosecurity breaches reported</li> </ul>
<b>Waste Management:</b> segregation, packaging, storage and disposal of waste as per the SWMP and BAS WMH	Appendix 9 – Site Waste Management Plan	<ul style="list-style-type: none"> <li>▪ Waste Transfer Notes</li> <li>▪ Waste Data</li> </ul>
<b>Fuel Management:</b> daily refuelling as per refuelling procedure.	BAM refuelling procedure – Section 5.1.1	<ul style="list-style-type: none"> <li>▪ Training records of refuellers</li> <li>▪ Fuel spills reported</li> </ul>

		<ul style="list-style-type: none"> <li>▪ Fuel consumption for carbon accounting</li> </ul>
<p><b>Oil Spill response:</b> BAM staff will respond to all Tier 1 spills and follow the direction of KEP Station Leader for all Tier 2 and Tier 3 spills. BAM will provide appropriate spill response equipment.</p>	<p>BAM Oil Spill Contingency – Section 5.1.2</p> <p>BAM Spill Response Equipment – Section 5.1.3</p>	<ul style="list-style-type: none"> <li>▪ Fuel spills reported</li> <li>▪ Spill kits used and disposed of appropriately</li> </ul>
<p><b>Noise reduction:</b> BAM staff will implement a soft start procedure for all noisy equipment and trial a resilient pad when using the impact hammer.</p>	<p>Noise mitigation measures – Sections 10.2.15 and 10.2.16</p> <p>Noise monitoring activities - Appendix 11 – Monitoring Plan</p>	<ul style="list-style-type: none"> <li>▪ Written feedback on the implementation and success of these measures as part of the EIA review process.</li> </ul>
<p><b>Dust suppression:</b> BAM staff will implement a number of measures to suppress airborne dust during construction works including halting work during periods of high wind and damping down dust producing activities.</p>	<p>Dust mitigation measures – Section 10.2.14</p> <p>Dust monitoring activities - Appendix 11 – Monitoring Plan</p>	<ul style="list-style-type: none"> <li>▪ Written feedback on the implementation and success of these measures as part of the EIA review process.</li> </ul>
<p><b>Quarry tussock grass replanting:</b> BAM staff will attempt to replant the removed tussock to quarry site 1 after completion of works</p>	<p>Tussock mitigation measures – Section 10.2.21</p>	<p>Written feedback on the success of the tussock replanting as part of the EIA review process.</p>

## 12.2. Audit Programme

An audit will be undertaken during the construction works by the BAS Environment Office (or delegated to other project staff members) to ensure that the actions and mitigation measures committed to in this document are being adhered to and are effective. The audit will also be conducted in compliance with the ISO14001:2015 standard to which BAS is registered. The project staff members will also undertake periodic checks of mitigation measures and required monitoring to ensure project compliance with the EIA.

The BAS Project Manager may also invite the GSGSSI Government Officers to carry out audits during the construction period.

On completion of the works, an EIA review will be completed which will review compliance of the project.

## 13. GAPS IN INFORMATION & UNCERTAINTIES

### **KEP Wharf Design**

The majority of the design described in this document represents the 65% design stage. However, the mooring points and anchor wall design are only at the concept design stage due to late changes in the design in response to the hydrocarbon contamination. In addition, the design and construction/installation methodology for the sinker anchor (specifically required for the berthing of the SDA) is not yet confirmed. Over the next few months, the design will be refined and finalised at 100% and therefore some minor changes to the detailed design represented in this document are expected. However, the overall environmental impacts identified in this assessment are not anticipated to change.

### **Site setup locations**

The general locations of material storage areas and plant and equipment positioning have been provisionally identified in the site layout drawings - 3.7. Further discussion is required between the construction partner, the BAS project manager and Station support to consider and finalise the detailed locations.

### **Logistics**

Changes to the proposed logistics and indicative dates may occur over the next few months as logistics are finalised. In addition, unpredictable and difficult weather conditions may impact the arrival and departure dates of cargo and personnel. BAS will advise GSGSSI of any changes as they arise and identify how these changes may impact the project. Approximately, 2 weeks demurrage has been factored into the programme to deal with unexpected changes/delays.

### **Quarry Sites**

The quantity of material required as fill for the wharf, dolphin and slipway is 5,727 tonnes. However, the quantity of material that needs to be excavated in order to produce the 5,727 tonnes of graded is expected to be approximately 10,412 tonnes of rock. The exact tonnage of excavation cannot be confirmed with 100% certainty, as it will depend on how much material needs to be crushed and screened.

It is anticipated that the all the required fill material can be extracted from Quarry 1 but there is small possibility that a second quarry may also need to be excavated. In addition, the final landscaped profile of the main quarry site cannot be accurately assessed, as this will depend on the volume of material that is excavated and processed. Therefore, the final impact on the aesthetics of the site cannot be assessed at this stage.

### **Scouring by SDA**

Scour protection of the seabed has not been included as part of this design because the decision has been made to limit the development of scour through setting operational restrictions on the SDA during its berthing operations at the wharf. The depth of the seabed at the wharf will need to be monitored post-construction. If scour does develop then scour protection options may need to be investigated.

### **Hydrocarbon Contamination**

The full extent of the hydrocarbon contamination at KEP is not known. Samples taken at the wharf and mooring points provide an indicative picture of the contamination spread on land however

water samples and sea sediment samples have not been taken for analysis. Therefore, the potential impact of vessels berthing at the wharf and giving rise to mobilisation of contaminants has not been considered in this EIA.

## 14. CONCLUSIONS

This EIA identifies the need for the KEP wharf redevelopment in order for BAS to be able to fully utilise the new BAS ship, the SDA, to allow for ongoing and long-term support of KEP station and for GSGSSI to secure the long-term use of the wharf by FPV *Pharos*. The EIA also recognises the benefits it will provide to the efficient resupply of the station.

The potential environmental impacts which may result from the identified construction and operational activities are identified in Section 10. Mitigation measures have been proposed in addition to existing BAS procedures to reduce or eliminate the impacts and the effectiveness of these measures described in the Impact Matrix in Section 11.2. In addition, specific monitoring requirements are also stipulated to allow for additional modifications during the construction period.

The most significant environmental impacts identified as part of this EIA are:

- Introduction of non-native species
- Spread of already established non-native species
- Removal of rock resulting in change in topography and aesthetics of King Edward Cove
- Loss of marine benthic habitat
- Loss of terrestrial nesting habitat
- Disturbance to wildlife from noise and physical interaction with construction activities
- Terrestrial or marine pollution from existing hydrocarbon contamination

The majority of the identified impacts were predicted in the scoping document which was finalised in January 2019 (see Section 10.1.1). The only newly identified environmental impact is the potential for pollution from the hydrocarbon contamination in the existing wharf and on the shoreline near the proposed mooring points. The contamination in this area is historic and was identified and confirmed by site investigations carried out in November 2018/February 2019 and laboratory analysis completed in early 2019 (see Section 3.3.1). This information was not available at the time of the Scoping document assessment. In addition, impacts on tourism activities were initially considered a key impact in the assessment carried out in the Scoping document. However, as part of this EIA assessment, impacts on tourism are not considered significant as the construction activities will have limited interactions with visitor activities at King Edward Cove and the mitigation measures identified are considered effective.

The risk of introducing non-native species to South Georgia through the importation of large quantities of cargo and additional personnel when the vessel is alongside at the wharf is considered a significant risk. However, the project has committed to enhanced biosecurity measures and other mitigation measures, in line with GSGSSI advice, to reduce the likelihood of non-native species and specifically rodents being re-introduced to KEP.

The most significant potential impact identified in the EIA, which cannot be further mitigated against, is the permanent removal of rock from a quarry on the track for use as fill material in the wharf and associated structures. This will permanently change the topography of the site and potentially change the aesthetic value of King Edward Cove. The decision to excavate locally has

been influenced by the need to reduce the risks of introducing non-native species from aggregate imported from outside the territory. The volume of fill material required has been reduced to as low as possible through ongoing refinement of the wharf design.

It is considered that the majority of the potential impacts will be successfully minimised provided that the mitigation measures are implemented successfully. It is also acknowledged that some activities will have a greater impact than others with a longer-term effect. However, in conclusion the environmental impacts identified in this EIA are considered acceptable considering the significant operational and scientific advantage that will be gained as result of the completed project.

## 15. AUTHORS OF THE EIA

This EIA has been prepared by Anna Malaos of the BAS Environment Office. The environmental baseline section was written by Kevin Hughes with input from a number of expert contributors listed below in the acknowledgements section. Construction specific mitigation measures, biosecurity procedures, spill response and waste management procedures were written in conjunction with Neil Goulding of BAM.

## 16. ACKNOWLEDGEMENTS

Expert contributors to the Baseline section include the following personnel: Teal Riley, Richard Phillips, Iain Staniland, Jennifer Jackson, Philip Hollyman, John Dickens, Jerry Gilham and Kelvin Floyd.

Detail on the design and construction elements of the project have been provided by BAM personnel Daan Aldenberg, Renée Siemensma, Lloyd Wickens. Information on BAS logistics was provided by Joe Corner, BAS.

Jan Cordon of BAM produced the quarry site investigation report and David Kilburn of BAM produced the mooring point and anchor wall trial pit report.

Sweco produced the Contaminated Ground Risk Assessment.

Neil Goulding of BAM produced the Terrestrial Noise Assessment.

ABP produced the Marine Noise Assessment.

This EIA has been reviewed internally at BAS by Clare Fothergill and Rachel Clarke of Environment Office and Joe Corner Project Manager for the KEP redevelopment and David Seaton AIM Programme Manager. It has also been reviewed by Daan Aldenberg, Renée Siemensma, Neil Goulding and Lloyd Wickens from BAM.



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Appendix 1 - Wharf Structural Assessment Report

Appendix 2 – KEP Ground Investigation (Trial Pits)

Appendix 3 – KEP Water Environment Risk Assessment

Appendix 4 - Extent of ground contamination

Appendix 5 - DEEP Offshore Survey Report

Appendix 6 – KEP Biosecurity Plan

Appendix 7 – Construction Materials

Appendix 8 – Equipment and Plant

Appendix 9 – Site Waste Management Plan (SWMP)

Appendix 10 - KEP Quarry Site Investigation Report

Appendix 11 – Monitoring Plan

Appendix 12 – Terrestrial Noise Assessment

Appendix 13 – ABP Marine Noise Assessment

Appendix 14 – Alternative wharf designs

***ALL APPENDICES CAN BE REFERENCED AS INDIVIDUAL DOCUMENTS***