Preliminary Operational Plan For Rodent Eradication from Tristan da Cunha

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Cover photograph: Tristan da Cunha from the sea. © Clare Miller.

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Contents

1 Operational summary

Location	Tristan da Cunha: 9,837 ha, in the Tristan da Cunha archipelago, South Atlantic Ocean, 3,000 km W-SW of Cape Town South Africa
Primary target species	Ship rat (*Rattus rattus*)
Secondary target species	House mouse (*Mus musculus*)
Benefit Species	Tristan thrush *Nesocichla eremita*, Gough moorhen *Gallinula comeri*, Tristan bunting *Nesospiza acunhae*, Atlantic petrel *Pterodroma incerta*, sooty shearwater *Puffinus griseus*, grey petrel *Procellaria cinerea*, other burrowing seabird species, native and endemic invertebrates.
Island description	A large oceanic island dominated by a high volcanic cone, with significant cliffs encircling the island. A limited range of habitats and vegetation types influenced by altitude and human modification.
Climate characteristics	Cool temperate oceanic
Start and end date	Baiting to occur July of any year, to be completed by October of same year. Absolute minimum time required for field operations is estimated to be 25 days, to complete two separate aerial drops and to hand-bait the settlement.
Methods	Two aerial broadcasts, at least 10 days apart, of a total of 200 tonne of Pestoff 20R, a pelleted cereal bait containing brodifacoum, with additional hand-baiting around residential and livestock areas.
Biodiversity/ conservation outcomes	Recovery of threatened and/or endemic bird populations, and the return of areas of the island to a seabird-dominated ecosystem. Recovery of many other fauna species including invertebrates. Greater bio-security for adjacent rodent-free islands of high conservation value.
Socio-economic outcomes	Significantly improved agricultural opportunities, plus health benefits. Potential growth in eco-tourism as a result of recovery of native wildlife.

2 Introduction

The feasibility and the potential benefits of eradicating rodents from Tristan da Cunha are discussed in Angel & Cooper (2006) and Brown (2007). These documents conclude that the eradication of rodents from Tristan would deliver major benefits to the island, and is technically feasible. The aim of this Operational Plan is therefore to describe comprehensively the planning, equipment, transport, personnel, logistics and costs required for the proposed eradication of rats and mice from Tristan da Cunha.

There will inevitably be a time-lag between the production of this Plan and the actual eradication operation. Because of rapidly changing technology, the accumulation of experience, and the acquisition of new information, this Plan would need to be comprehensively revised at the outset of any operation. Its publication in this form serves as a detailed guide to the type of operation that will be needed and the resources that would be required; these are indispensable during the planning and fundraising stage.

Tristan da Cunha is the largest, and only inhabited island (*ca*.9,387 ha) in a remote archipelago lying approximately 3,000 km west-southwest of South Africa. It is administered as a United Kingdom Overseas Territory.

The Territory holds the highest number of endemic and globally threatened species of any of the UK Overseas Territories. Tristan da Cunha, along with the other major islands of the group (Gough, Nightingale and Inaccessible), has been recognised as an Important Bird Area (IBA) by Birdlife International (Hilton & Rowlands 2006).

The ship rat *Rattus rattus* and the house mouse *Mus musculus* are the only alien predatory vertebrate species currently present on the island.

The island has a resident population of approximately 285 people, all based at the one settlement 'Edinburgh of the Seven Seas'. It rises to 2,048 m (6,760 ft) asl, and the flanks of the conical peak dominate the topography. Encircling the island from near sea level to *ca*.600 m are cliffs that separate the coastal plains and shoreline from the upper portion of the island, which is known locally as 'the Base'. There are four small coastal plains below 'the Base' cliffs, namely the Settlement Plain, Cave Point, Stony Beach, and Sandy Point. Winds can be strong but gales occur on only 10% of winter days. Rainfall is *ca*.1,675 mm year^{-1}, with an average of 157 mm per winter month. Snow regularly falls and lies on the upper portions of the island's peak.

3 Justification

The Tristan da Cunha Environment Charter states as one of its commitments '*to safeguard and restore native species, habitats and landscape features and control or eradicate invasive species*'.

The draft Tristan da Cunha Biodiversity Action Plan (Tristan NRD & RSPB 2006) has as its overall goal '*to conserve the native biological diversity of Tristan da Cunha*' and indicates that this will be achieved by '*halting or, in the case of some species, reversing the rate of biodiversity decline*'. One of the key objectives is that '*the impact of invasive alien species [is] reduced or eliminated*'.

For a more detailed assessment of the feasibility and benefits, refer to Brown (2007) and Angel & Cooper (2006).

In short, the likely benefits of removal of rodents from Tristan are:

- Recovery and expansion of the remaining burrowing seabird colonies (*ca*.7 species, including the IUCN 'Vulnerable' Atlantic petrel *Pterodroma incerta*[1] and the 'Near Threatened' grey petrel *Procellaria cinerea* and sooty shearwater *Puffinus griseus*) and of ground-nesting seabirds (noddies and terns).
- Possible recolonisation by smaller seabird species (eg Kerguelen petrel *Lugensa brevirostris*, little shearwater *Puffinus assimilis*, diving-petrel Pelecanoididae and storm-petrel Hydrobatidae species) which have previously been extirpated, the inferred cause being predation by rodents.
- Recovery and expansion of the 'Near Threatened' endemic Tristan thrush *Nesocichla eremita.*
- Recovery and expansion of native and endemic invertebrate populations.
- Possible reintroduction of a race of the 'Vulnerable' Territory-endemic Tristan bunting *Nesospiza acunhae* from Inaccessible Island or Nightingale Island.
- Increased agricultural and horticultural opportunities for the resident human population.
- Social and health benefits for the resident human population.
- Removal of the presumed main source of threat of rodent introduction to Inaccessible or Nightingale Islands, which are of global conservation importance and contain native and endemic species that would be threatened with extinction if rodents arrived.

[1] All species common names, scientific names and threat designations refer to the BirdLife International World Bird Database and the 2007 Red List of Threatened Birds (www.birdlife.org)

4 Project objectives

Eradication of ship rats *Rattus rattus* as a primary objective and house mouse *Mus musculus* as a secondary objective, using the best available knowledge and expertise, chiefly through two separate helicopter broadcast brodifacoum bait spreads over the entire island.

This is to allow the ecology of Tristan da Cunha to be restored, so that it is able to provide a secure home for populations of threatened and indigenous plants and animals that are currently present, and those that could potentially be translocated or naturally recolonise. The eradication of rodents will also have considerable socio-economic and potential health benefits for the Tristan public.

5 Prior requirements

There are a number of tasks that will need to be completed before a rodent eradication proceeds. Many of these are in effect 'non-negotiable', being fundamental precursors to the operation, while others significantly improve the prospects for success of the eradication.

5.1 OFF-ISLAND REQUIREMENTS

1. Full funding for operation secured.
2. Full support obtained from all major external stakeholders (funding agencies, conservation groups, relevant UK government agencies, UK mainstream animal welfare groups).

5.2 ON-ISLAND REQUIREMENTS

5.2.1 Led by Project Team or Prior Contractors

1. A pre-operational visit to the island by the appointed Project Manager and the Chief Pilot for site familiarisation and further development of any issues
2. Collation of all available information on the issues of concern (health risks, risks to animals and wildlife, etc) for an appropriate expert (eg a toxicologist) to provide a full briefing of the Tristan community. This should include a full account of existing knowledge on the potential effects of brodifacoum, the risk vectors and the options to avoid, remedy or mitigate these. From the feedback of the Tristan community, develop favoured options which reduce any major concerns to an acceptable level (if feasible), and gain consensus from the Tristan community on these. This briefing needs to be done before seeking funding – there is no point in going ahead unless the proposed project has the complete backing of the Tristan community.
3. Construction of holding aviaries for Tristan thrush and Gough moorhen to protect populations of these species from poison bait during the rodent eradication operation.
4. DNA sampling of Tristan rodents as baseline genetic material. Any rodents that may reappear on Tristan da Cunha in the future can be tested genetically against this baseline information. This can help determine if the reappearance of rodents was as a result of a failed operation (the rodent(s) are likely to be genetically very similar to the current populations) or as a re-invasion from outside sources (likely to have different genetics).
5. Development and implementation of an effective bio-security (pest quarantine) plan and operating system. It will be a critical and fundamental requirement of the eradication operation that an effective bio-security plan and operating system is developed and implemented on Tristan, to reduce as far as practical the

chance of any successful rodent re-invasion of the island after the eradication. The plan should be developed as a precursor to the eradication project commencing. Following the advice of external experts, the Tristan government should take the steps necessary for its effective implementation and maintenance in the long term.

5.2.2 Led by Tristan Government:

1. On the basis of information presented to them by members of the project team (see above), support of all residents for the proposed action, and legal 'sign-off' ie acceptance of the 'unknowns' and the risks associated with the operation. If the Tristan community cannot accept the potential risks, the project could not proceed.
2. Significant improvement to current bio-security measures, to reduce the likelihood of rodent re-invasion. This would include: (1) improving procedures for the packaging, storing and transporting and unloading/ unpackaging of materials imported to the island; (2) an on-island focus on detection monitoring and contingency responses; (3) training and assigning of on- and off-island staff in bio-security measures, including a government-supported permanent position on the island. Exact lines of authority would need to be clarified as the position has relevance to natural resources, conservation and agriculture. It is likely that it would not be a full-time position at present, given the number of ship visits to the island, so it may for efficiency be merged with other related tasks such as control of existing weeds on the island.
3. Substantial reduction of wild sheep numbers (and preferably total removal), to reduce potential bait take by these animals and to reduce the potential sheep carcass food resource for rodents during an eradication operation.
4. Pens or holding yards for cattle at Sandy Point, Stony Beach, and the Caves (if the preferred option of temporary or permanent removal of cattle from these areas is untenable). This is to reduce the possibility of cattle eating substantial quantities of bait, which would have an operational risk as well as being a health risk to the cattle, and to humans that consume their meat.
5. Fence repairs to ensure reliable containment of Settlement Plain livestock within specific pastures, to safely exclude these animals from areas of pasture with freshly sown baits, with associated reduction in stock numbers to sustainable levels and development of strict rotational grazing programmes.
6. Rubbish removal and rubbish dump improvements. These may include installation of rodent- and dog-proof sealed household rubbish containers, the separation of food wastes from inorganic material to better facilitate its disposal, and the development of an incineration/containment system for waste food at the

rubbish dump. The aim of these measures is to eliminate or substantially reduce a major food resource for rodents, which may artificially increase rodent populations in the area and/or lower the attractiveness of the toxic baits to such rodents.

7. Improved system for fish factory waste disposal (ensure the waste disposal unit is fully 'enclosed' and empties to sea, not foreshore, so that rodents cannot access food wastes). This may not be an issue if the factory is not operational when the aerial bait drop occurs.

8. Improved offal and waste disposal processes for livestock slaughtering activities (eg deep burial or incineration), to prevent any rodent access to these potential food resources.

9. Improvement in the general attitude of the Tristan public toward waste disposal (eg fish carcasses left on the wharf, food eaten in the field, etc), to prevent such food resources being available to rodents.

10. Sewage treatment improvements to eliminate raw effluent discharge into open areas accessible to rodents. The current system is poorly performing and allows sewage to spread over marshy ground where potential food resources (eg food scraps washed down kitchen sinks) are freely available to rodents. Exact requirements and options to rectify the problem need to be examined by engineering and wastewater experts whose advice should be sought. The aim for this operation is to minimise rodent access to food matter within sewage, while there are also clear human health and aesthetic reasons to improve the current situation. Some options could include ensuring septic tank systems are fully operational and fully enclosed; having large steep-sided settling or treatment ponds; or piping the wastes out to sea.

11. Ensure that all poultry pens and feeding systems are built to a standard sufficient to minimise waste and rodent access. While the standard of feeding systems varies with individual owners, most feeding systems appear messy and provide a significant rodent food resource, while the design of many pens offers ideal rodent habitat. The large quantity of food and immediately adjacent refuge may reduce the desire or ability of rodents living in such areas to seek out enough rodent bait to receive a toxic dose.

12. Cease all rodent poisoning by at least six months prior to operation (revert to trapping only, and then only where necessary) so that any possible aversion to toxic baits as a result of the on-going control operations is reduced.

13. Wildlife monitoring, possibly including census of Tristan thrush, Gough moorhen and burrowing seabird population, if considered necessary or desirable by major stakeholders. While not essential to the operation, this monitoring would provide valuable baseline information from which assessments can be made of the recovery of these populations. Demonstrable

recovery of such species would be important to justify the efforts, risks and costs of this and future rodent eradications.

6 The project team

6.1 CRITICAL REQUIREMENTS

The proposed eradication of rodents from Tristan da Cunha is a considerable challenge, pushing the boundaries of existing rodent eradication experience and technology. To maximise the chance of operational success in such a costly and complicated project, the core operational team must be selected on the basis of being the best available in terms of relevant skills and experience. Wherever possible local or other staff will be trained and utilised, but this will not be at the risk of operational success.

Key staffing requirements for the operation would be:

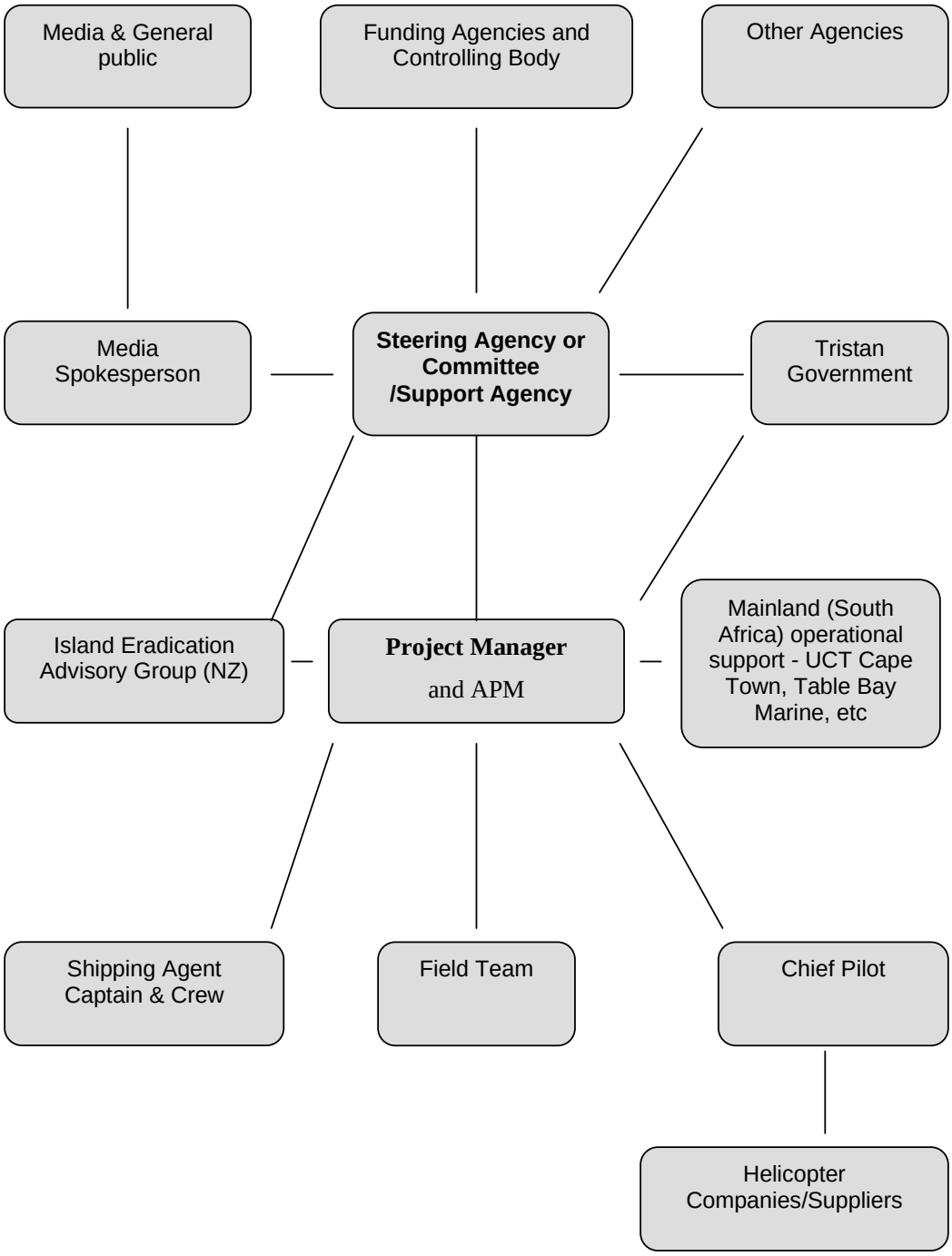
- Highly skilled helicopter pilots with previous experience in eradication operations and bait-sowing, and operating in difficult flying conditions.
- A Project Manager and key support staff with broad experience in rodent eradication work.
- Highly motivated staff with appropriate experience and a strong commitment to the task.
- Staff able to work harmoniously for extended periods, under stressful conditions, in remote areas.
- Complete support from the people and government of Tristan da Cunha.

Another key aspect for eradication projects of this scale is that the Project Manager and operational staff are - within the prescription of the operational plan - allowed to conduct their work with the minimum possible interference or unnecessary complication from any other source, be it administrative, political, health, ethical or academic.

The project team's sole focus should be on the operational detail and precision required to maximise the chance of success. Senior managers and funding agencies must be prepared to support and commit to the project for its entire duration – for eradication projects 'the people and money must be available to carry out all tasks efficiently whilst not providing incentives for shortcuts' (Broome *et al* 2004).

6.2 ORGANISATIONAL STRUCTURE

Figure 1. External and planning relations



6.3 THE ON-ISLAND PROJECT TEAM - SPECIFICATIONS

6.3.1 Project Manager

The project manager will have clear overall responsibility for the planning and execution of the project.

The project manager (PM) is responsible for on-site financial management, project implementation and liaison with all parties and stakeholders (ship's master and crew, Tristan government and public, funding agencies, helicopter contractors, general staff, plus the IEAG and other specialists as required). The PM will be responsible to the steering committee established for the project. The PM could be based at his/her home location for the bulk of the planning and preparatory work, but will require travel to South Africa and possibly UK (if not based at either) for specific tasks. The PM will need to be based in Cape Town for several weeks prior to the ship departure, and will be on Tristan da Cunha for the field operations and will act as the operational co-ordinator for the bait spread and will be responsible for daily decision-making on the ground.

The PM will require an in-depth knowledge of rodent eradication and aerial bait application, and must have considerable practical experience in this field. The position will require a person able to plan, co-ordinate, and delegate all tasks effectively, and maintain effective communication with all parties.

The PM will be employed on a part-time basis from a period no less than 12 months before ship departure, to undertake or co-ordinate bait ordering, quality assurance, bait delivery, selection of staff and allocation of responsibilities, and all other pre-operational requirements. The post should become full time from at least 1st March of the bait year.

The PM should also be required to provide a debriefing for interested stakeholders and a written report on the operation at the conclusion of the project. He/she should be re-contracted two years after the eradication, to write an official operational review when it is clear whether the project has been a success or not.

6.3.2 Assistant Project Manager

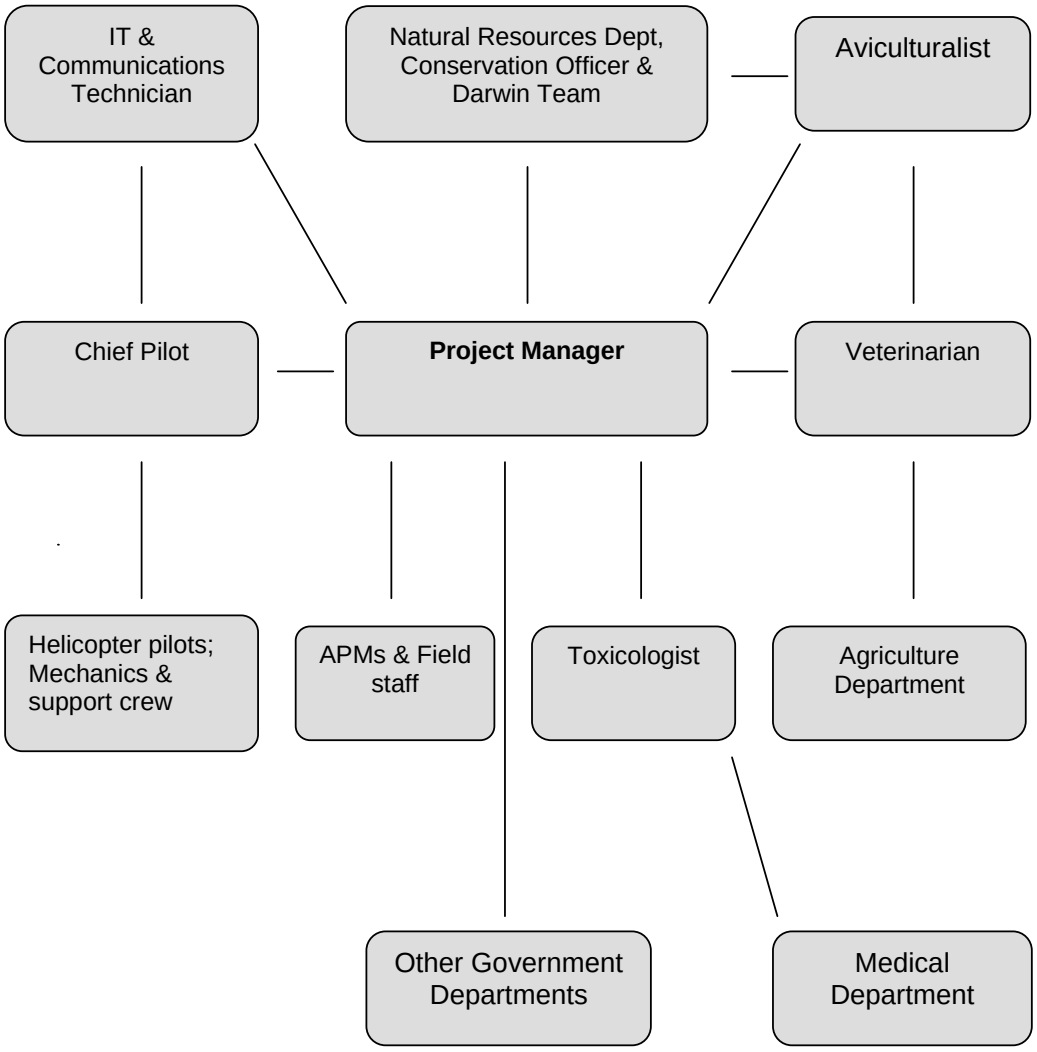
The Assistant Project Manager (APM) will work alongside the PM in all aspects of the operation. Some aspects of the operation may be delegated to the APM, and should the PM be unable to carry out his operational role on Tristan da Cunha for any reason, the APM will step in. As with the PM, this person should be familiar with aerial bait application and rodent eradication.

This person should be identified as soon as feasible, and be employed on a casual basis to assist in the production and review of planning documents, checklists etc. The person should then employed on a more regular part-time basis from March of the bait year, to assist the PM wherever necessary (eg bait-bucket calibrations, bait analysis and production monitoring). The position would be a full-time contract from May of the bait year until

conclusion of the operation (*ca*. October of the same year).

In view of the possibility of the loss of the PM and/or APM, another suitable candidate to fill the APM role will be placed on standby up until the departure of the ship, and will be kept abreast of planning and developments in the project via regular updates. It is feasible that this person, having been kept abreast of all planning etc, then accompanies the operation as a second APM or general hand, in case of any on-site incapacitation of the PM or APM.

Figure 2. On-island project team



6.3.3 Chief Pilot

The Chief Pilot (CP) should be experienced in operating helicopters in such environments, and should also have experience in bait-sowing applications. The CP should be very familiar with DGPS navigational systems, including the operation of software.

The CP will be responsible for:

- Pilot selection and training
- Ensuring compliance with all civil aviation regulations and requirements for operating in South Africa and Tristan da Cunha
- Helicopter selection and hireage contracts
- Configuration, maintenance and storage of helicopters in transit and during operation
- Selection, maintenance and operation of bait-buckets and other helicopter-related equipment
- Flight safety during the operation (including the determination of suitable bait-sowing conditions).

The Chief Pilot will need to be employed on a part-time basis to undertake pre-operational tasks for 12 months prior to the operation. These tasks include a key role in selection of pilots and ground staff, the sourcing of helicopters and other machinery, the calibration of bait buckets, and organisation the delivery of bait-buckets. The post should become full-time from May of the bait year at the latest, and should be based in Cape Town for the weeks preceding ship departure.

6.3.4 Pilots

The number of pilots to be used will be dictated by the helicopter company that wins the tender, and by the number of helicopters selected for the operation. However, it is envisaged that at least two bait-sowing pilots and one support pilot would be a minimum requirement. It would be highly advantageous to have at least one more pilot than helicopters, in case of pilot sickness or excessive flying hours, etc. It is possible that the 'extra' pilot could fulfil the roles both of replacement bait pilot and/or support pilot if appropriately qualified.

Bait-sowing pilots should have considerable proven experience of bait-sowing using DGPS navigational systems. They should hold the equivalent of a New Zealand agricultural operator's certification, issued by the Civil Aviation Authority under CAA rule part 137.

Experience in flying in difficult conditions (eg subantarctic, high altitude, high winds, low visibility) would be a major advantage. Familiarity with the type of helicopter used for the bait-sowing operation is a fundamental requirement. An understanding and acceptance of the high degree of accuracy required is also paramount in such work.

The support pilot(s) should have experience in flying in the type of weather conditions experienced on Tristan, and considerable experience of lifting stropped (under-carried) loads. Ideally, they should also be capable of substituting for the bait-

sowing pilots in contingency scenarios.

Pilots should be available as necessary to obtain the relevant South African qualifications (if required), but otherwise should be contracted from mid-June of the bait year for pre-operational training and briefings in Cape Town, through to conclusion of the baiting operation.

6.3.5 Helicopter Ground Staff

The helicopter maintenance crew (engineers / mechanics / loaders) should be capable of undertaking most if not all repairs conceivably necessary whilst operations are underway. The ship's helicopter workshop and the Tristan mechanical depot will be kitted out with all necessary equipment and spares required for such tasks.

The number of ground staff required will be determined by the helicopter company that wins the tender, and salary costs etc will be borne by the helicopter company as part of the tender price. However, for administrative purposes (accommodation, etc) it is envisaged that two or three ground staff would be sufficient for most foreseeable requirements. Ground staff should be mainly required to undertake technical work, as local staff and APMs, etc will undertake the bulk of the basic labour (bait-loading, etc).

As with the pilots, ground staff should be available as necessary to obtain the relevant South African qualifications (if required), but otherwise should be contracted from mid-June of the bait year for pre-operational training and briefings in Cape Town, through to conclusion of the baiting operation.

6.3.6 Bait Loaders

The helicopter ground staff, the PM, APM(s), IT technician (see below), and the ship's crew will be available to conduct the unloading of baits etc from the ship. Tristan residents could also assist, particularly on the landward side.

For the actual bait-sowing operation, the helicopter ground staff, PM and APMs would undertake or supervise the loading of bait into bait buckets during the sowing operation. This can be greatly assisted by local (Tristan) labour resources, following appropriate safety training.

While in normal situations, baiting operations would run with two loading teams (four-five people at a remote loading site and two at the supply base), it is possible that up to three separate loading teams will be required at any one time during the operation. In some situations two teams may be required for two separate 'remote' bait-loading sites, and one team for loading of 'ferrying flights' carrying additional bait and fuel etc to the remote sites, a total of perhaps 12 people. Thus, experienced staff will need to be spread between the three locations, with local labour employed to assist where necessary.

6.3.7 IT Technician

The IT technician will need to be totally competent in DGPS software and familiar with Geographical Information Systems (GIS).

The IT technician will have been given prior opportunity to study the GIS, and will be aware of all software and hardware requirements to run the system on Tristan. The IT technician will be responsible for ensuring that contingencies are in place for all electronic equipment.

The IT technician in normal situations should have spare time to support other positions, as determined by the PM. It may be possible that this role is carried out by a person also fulfilling another role on the island (eg the APM), but it is more likely that the IT technician focuses on that role alone, but can be available for other work when free of IT requirements. If possible or necessary, this role can be supported by the Tristan government IT specialist.

The IT technician will also be responsible for receiving daily synoptic weather charts, and maintaining the communications systems (eg ensuring all VHF radio batteries are charged, etc).

6.3.8 Aviculturalist

The aviculturalist will have responsibility for holding a pre-established number of pairs (or potential pairs) of Gough moorhen and Tristan thrush in captivity for the duration of the operation, until deemed safe for release. Construction of aviaries, and their enhancement through planting etc would precede the actual operation.

The aviculturalist would need to be employed for a period prior to the operation:

- To establish the avicultural requirements of the species through consultation with relevant avicultural institutions and experts.
- To design aviaries that will fulfil these needs, again using information from relevant avicultural institutions and experts.
- To source and procure all materials required for the construction, and to organise the transport of these to Tristan.
- To travel to the island some time in the year preceding the baiting operation to oversee construction (using local labour) and to investigate and trial the capture and temporary holding of the species to identify any potential issues.

The aviculturalist would travel down on the preceding year's SA Agulhas trip (or a suitably timed fishing trip) to construct the aviaries with local assistance. The interior layout (plantings, shelters, etc) would also be carried out on this trip, and the subsequent care of the aviaries (without birds) would be left with the Tristan Conservation Officer or another nominated person. During this trip, some investigation of the capture and transportation methods and materials required would be determined. Some temporary holding of both species would also occur, as a 'dummy run' to test both the facilities and the adaptability of the birds to captivity, to enable any potential issues to be identified and if possible resolved prior to the bait operation.

The aviculturalist would be contracted again to return on a fishing vessel or other ship a month or so prior to the bait ship. With the assistance of local

staff (eg NRD staff or the Darwin team), they would immediately undertake the capture of the appropriate numbers of birds, prior to or concurrent with the commencement of baiting. This process could take place over a considerable time period, as parts of the island will remain untreated for many days after bait-sowing commences. If the capture of the required quota of birds has not occurred prior to arrival of the bait ship then members of the rodent eradication project team would assist with catching the remaining birds required, immediately prior to the baiting operation. Work for the aviculturalist may also need to extend for at least one month and up to several months beyond the conclusion of the bait drop, to ensure risk from baits is all but eliminated before release of the captive birds. It will only be possible to determine this at the time, based on the rate of decay of any uneaten bait and on observations of the actual effect of the baiting operation on the wild populations.

6.3.9 Veterinarian

The veterinarian should have extensive experience in dealing with dogs and livestock, and should ideally have training and/or experience in toxicology issues. This person would be contracted to travel down on the bait ship, and would stay if necessary for a month or more following the conclusion of the baiting (if any affected animals still require treatment or monitoring). In this case, the vet would return to Cape Town on the next available ship.

The main roles of the veterinarian would be to monitor the island's cattle, sheep, donkeys, pigs, poultry and dogs before, during and after the operation, and to take whatever practical steps are necessary to prevent the avoidable loss of any animal to the toxic bait.

After the conclusion of the operation, the vet will take samples from livestock for analysis of brodifacoum residues (this may necessitate the slaughter of some animals). The vet will also be responsible for storage and delivery of any non-target wildlife samples. These will be analysed (preferably in South Africa if a suitably accredited facility exists), or alternatively air-freighted to NZ analytical laboratories (MAF in Wallaceville, or Landcare in Lincoln), where staff are highly experienced in such analyses.

Repeat sampling of brodifacoum residues in livestock may be required over the course of the next two years to ascertain what risk, if any, remains for human consumption of meat. This can be achieved through local Agriculture Department staff sending samples to the appropriate laboratories, or samples could be collected by a veterinarian or other trained operator during annual servicing trips or fishing vessel visits to the island.

The veterinarian will liaise closely with the local doctor on possible human health issues, and with the Agriculture Department with regard to livestock matters.

Members of the Agriculture Department, who have had some veterinary training, and have wide practical experience in handling local animals, will assist the vet.

6.3.10 Toxicologist

If there are any serious concerns raised by any of the major stakeholders regarding human health issues, there is an option to employ a specialist medical person (toxicologist) to assist the local medical staff. While most procedures relating to analyses and treatment of potential brodifacoum poisoning could be carried out by local staff (with some prior familiarisation), the addition of an experienced toxicologist could be invaluable from a practical and quality assurance perspective. However, it would likely be at significant additional cost to the project so this position should only be considered if major stakeholders decide that it is necessary.

An off-island toxicology contact could be considered, as a lower cost alternative to this, to provide advice as and when required.

6.4 LOCAL (TRISTAN RESIDENT) SUPPORT

6.4.1 Cook & Domestic Help

A full-time local cook (or roster of individuals) would be employed to assist the non-resident members of the bait drop team for the duration of the operation. This person or people would be responsible for the planning and cooking of evening meals, the purchase and/or provisioning of food for breakfast, lunch and snacks, and domestic support such as cleaning and dishwashing. This will allow all field staff to maximise actual field time and efficiency.

6.4.2 Natural Resources Department

The Head of the Natural Resources Department (NRD) will play an important liaison role for the project team and will be fully involved in all operational briefings and discussion of practical issues.

The NRD should re-allocate any existing work commitments to enable the Conservation Officer's time to be fully allocated to the rat eradication operation for as long as deemed necessary, especially during the baiting operation. The NRD can also provide on-island road transport, and an additional 'emergency' labour force when necessary.

6.4.3 Conservation Officer

The local conservation officer will have a key role in the operation, as the liaison person ('first point of contact') between the project team and the local people and agencies. He will work closely with the PM to ensure the entire operation runs as smoothly and efficiently as possible. All their time should be fully allocated to supporting the operation for as long as necessary.

6.4.4 Darwin Initiative Team

The 'Darwin team' (if still recognised as such) will provide a core local support team to back up the Conservation Officer. They can be expected to assist in the capture of moorhens and thrushes, avicultural care of these birds, and general fieldwork such as the loading of bait-buckets at remote sites. Darwin team members are already trained and kitted out for work in remote locations

on the island and would therefore be the most suitable group of individuals for remote fieldwork. If for any reason the Darwin team is not available, then a pool of suitable workers will be decided upon, before the operation begins.

6.4.5 Medical Department

The Medical Department would be responsible for dealing with any potential or suspected effect of brodifacoum poisoning within the resident human population of the island or the project team. In conjunction with the PM, the Medical Department will ensure they have the necessary equipment and materials to test for and treat any suspected poisoning event.

6.4.6 Agriculture Department

The local Agriculture Department would be responsible for shifting of livestock to specified paddocks as and when directed by the PM. They would also assist the vet in sampling and treating any affected livestock.

They may also be required to pen the cattle at The Caves, Stony Beach and Sandy Point prior to the baiting of those areas, and subsequently to provide food and water to these animals.

As the Agriculture Department has current responsibility for rodent control, their staff could possibly play a key role in the placement and checking of hand-laid baits in all buildings on the island.

6.4.7 Administrator

The support of the Administrator would be key to the success of the operation. The Administrator has the authority to support or pass on all requirements of the operation to various department heads – eg the making available of staff, vehicles or other resources needed for the project, often at short notice and possibly to the detriment of normal departmental operations and priorities. While it is vital that the Administrator supports the project, he/she could also fulfil a role of an independent 'watchdog', to ensure project requirements do not unduly override the rights or needs of the Tristan people. He/she will be kept informed of day-to-day activities either through the PM or various department heads.

6.4.8 Chief Islander & Island Council

The full support of the island's people is fundamental to the success of the operation. The Chief Islander and the Island Council will be kept advised and updated of all significant developments by the PM, and regular liaison will be actively sought.

6.4.9 All Other Government Departments

All other Government Departments would be asked to respond as requested to all requirements and notifications from the rat eradication team. Close coordination will be required with all agencies for hand-baiting of buildings under their care, for general public safety, and for any other issues where the baiting

operation impacts upon their work or vice versa.

Public Works may have significant additional demands placed on them for the duration of the operation (eg for mechanical repairs, rubbish disposal, supply of drivers and/or machinery for moving heavy loads of bait or fuel around, etc.).

6.4.10 Tristan Public

The project will not succeed without the full co-operation of the general public on the island.

They will have a vital role in several ways:

- Facilitating access to all buildings
- Taking individual responsibility for the protection of their children, pets and livestock
- Following recommendations for disposal of food-wastes, and for the feeding of poultry and other stock.

Others may voluntarily assist by picking up and removing bait from sensitive or highly public areas such as roads, backyards, and the school playground, etc. They could also help reduce health or poisoning risks through the safe picking up and disposal of dead rodents found, as per prior directions from the PM.

Input and timing of such would be directed by regular (possibly daily) information updates from the PM (written public notices and or regular verbal evening reports).

6.5 OFF-ISLAND SUPPORT

6.5.1 Ship's Captain & Crew

The ship's captain and crew has a well-defined role – to get the project team and all supplies and equipment to the island safely and on schedule, and to return the team to Cape Town following the conclusion of the baiting operation.

They will be familiar with the procedures for loading and provisioning the ship for trips of this nature, and will be relied upon by the PM to meet with requirements for this operation.

6.5.2 Financial & Project Controller

While a contracted project manager will run the project, the project's administration and finances should be overseen by a steering committee or specific agency. The PM should be able to authorise purchase of items identified as necessary for the operation, but the process for purchasing and the subsequent payments should be controlled by the designated agency.

The PM and field team should be relieved of as much administrative burden as possible to focus on the operational demands. The financial system should be designed to recognise this, and should be as streamlined as possible to ensure rapid payment of providers, which will foster goodwill, which may be important in the long run.

6.5.3 Media Spokesperson

There should be a single person through which all media issues should be channelled. This person should be a designated individual from the project management agency or steering committee. This person would be responsible for:

- Dealing with all media and public enquiries
- Issuing media releases
- Vetting any media reports (proposed interviews with project staff, etc)
- Preparation of background documents to support the project and defend if necessary any potentially contentious aspects of the operation.
- Production of pre- and post-operation articles for environmental magazines, etc.

This person would be appointed some time before operation (part-time first, then full-time).

It is possible that this person would travel to the island with the operational team to gather first hand publicity material (photographs, video, interviews, etc) but it is probably more appropriate for them to be based off-island (within the lead agency overseeing the operation) so as to be more readily available to media outlets. In the latter case, on-site collection of media-related material (photos, video, etc) would be achieved by members of the operational field team.

6.5.4 Weather Forecaster

A contract weather forecaster would provide specific advice to the project team. It is likely that this position would be based in South Africa, but could be at any location where South Atlantic Ocean conditions are routinely monitored. The role will be to provide daily synoptic weather charts, a forecast for the following day and a long-term weather outlook. The forecast will cover the chances of rain, predicted wind strengths and directions, with information on position and movement of depressions and anticyclones in the South Atlantic.

6.5.5 Island Eradication Advisory Group (IEAG)

In 2005 the New Zealand Minister of Conservation extended an offer to assist where possible in the control of mice on Gough Island. As New Zealand has pioneered rodent eradication technology and its Department of Conservation (DoC) has the greatest overall experience in such work, such offers should be gratefully accepted. It is to be hoped that this offer of support would extend to the closely associated eradication of rodents from Tristan da Cunha as well.

A very obvious means by which the New Zealand DoC can assist is through advice from their Island Eradication Advisory Group (IEAG). The IEAG acts as a review and advisory team for eradication project trials, design, and implementation. The IEAG contains staff with eradication experience and senior technical support officers from the regional offices of DoC. It can also

seek further expert opinion from a network of external eradication experts. The IEAG should also be consulted as required on any operational issues that cannot be worked out on the island.

If the PM, after consulting with the decision team and other team members, believes that there is an issue that requires the input of the IEAG, he will contact Keith Broome or other IEAG members and inform them of the issue and what guidance is required. Depending upon the urgency and nature of the issue, this will be via radio/phone/fax or e-mail. Keith Broome is then responsible for obtaining a consensus from the group members and then communicating this to the PM by the appropriate system.

7 Baits

7.1 PURCHASE AND PRODUCTION

The manufacture and supply of brodifacoum baits required for this operation should normally go through a tendering process. However, there has only been one manufacturer and one type of bait used in nearly all the major aerially-dispersed bait operations for rodent eradication world-wide.

It is vital for such a costly operation that the bait to be used is:

- Proven highly palatable
- Proven weather resistant
- Proven effective in terms of consistency of toxin concentration and likelihood of providing toxic doses to rodents
- Suitable to the bait-bucket delivery system (eg wax-based blocks will cause blockages/restrictions in bucket apertures, resulting in potentially disastrous stoppages or alterations in sowing rates).

Unless a clear alternative option is presented in the near future, and proven through use in other eradication operations, the bait to be used should be the 'tried and tested' bait manufactured by Animal Control Products (ACP) in New Zealand.

This is to be the standard 10-mm diameter 'Pestoff 20R' pelleted cereal-based bait produced to standard specifications as laid out in a bait order contract approved by the IEAG. The average pellet will weigh 2 g or more. Up to three pellets are required to deliver a toxic dose to an individual ship rat, and less than one for a mouse, based on recorded LD50's for ship rat and house mouse (Fisher & Fairweather 2005). The bait will be bagged in 25 kg bags. These bags are produced for the purpose of holding bait and have a breakable polythene coated liner, as used for all recent eradications and trials. The bags will be appropriately labelled as legally required. Ideally no Bitrex (a bitter tasting additive designed to deter human consumption) will be added to the bait, due to the perceived problem that some rodents may be able to detect and subsequently avoid it. However, it may be an option to consider as a means of decreasing the risk of bait ingestion by children.

The bait will be produced in 200 batches (1 tonne lots), probably starting in Jan/Feb of the bait year and continuing until the order is completed. Exact timing will be dictated by the requirements for shipping, with a time allowance of several weeks between completion of the order and the shipping date to allow for any unforeseen delays. This will ensure that the bait is available for shipping when required, but is as fresh and palatable as possible. All processes will adhere to the ISO 9001 standards required.

Specifications will include:

- Bait formulation, including size, weight, toxic loading, moisture content, colour, hardness and maximum permitted fragmentation
- Packaging and delivery standards

- Supply dates
- Packed on clean and certified kiln-dried pallets
- Inspections made during production
- Laboratory testing (assaying) to ensure standards of toxin loading and physical quality of bait is maintained throughout the production run.

As much advance warning as possible should be given to ACP of the probable quantities and date of delivery. Notification of bait order should occur as early as possible, and no later than nine months prior to expected date of delivery, with confirmation of the precise order no later than January of the bait year.

Bait production dates will be determined by the requirement that the total consignment arrives in Cape Town no later than June 15th of the bait year.

7.2 QUALITY CONTROL

7.2.1 Assaying / Bait Sampling

To provide reassurance that the bait has the appropriate toxin loading, 20 samples will be tested. The samples will be collected from the Wanganui factory by the PM or a local contractor or delegate (it is possible that local DoC staff can be contracted to do most of this, as they have prior experience and it would reduce travel and accommodation costs). This will give a reasonable confidence level that any problem with toxin loading will be detected.

These samples will be sent to the Landcare (Lincoln) and Ministry of Agriculture (MoA) (Wallaceville) testing laboratories for analysis. Each sample of pellets will be divided in half, with one half then being sent to MoA for analysis and the other half to Landcare, as a quality control measure. These analyses should be booked for a time during bait production and the results must be available prior to the bait being loaded on the transport ship. The appointed bait monitoring person will visit the factory as deemed appropriate during the production run to visually inspect the condition of the bait in terms of fragmentation, moisture etc. A check sheet will be prepared for this, for each batch inspected.

As a further check, ACP will provide a sample of stock solution for analysis by Landcare and will then provide copies of the ISO printouts to show that the toxin has been put in the bait.

ACP will test the bait for hardness and moisture content and supply the results to the Project Manager.

A sample of bait will be taken from random batches for analysis of mould spores as long after manufacture as possible, but in time for analysis prior to shipment to Cape Town. Analysis of mould spores by ESR labs in Auckland is done to check whether the bait has a higher than acceptable chance of going mouldy during transport or in storage on the island. The samples will also be tested for moisture content at ESR, as this is a primary indicator of the likelihood of mould forming.

A random sample of bags may be opened while bait is in storage at the port of export and visually inspected prior to loading. This is a visual/manual inspection only. Bags will subsequently be sown up.

As the bait is being loaded into the buckets immediately prior to dropping, samples will be collected – approximately 50 g from randomly selected pallets or pods (production batch numbers are recorded on each bait bag). These will be labelled and kept in case an issue of bait condition is raised later.

7.2.2 Mould Issues/ Deterioration of Bait

All possible precautions with bait during transport will be taken, including checking the bait prior to leaving the factory, again at Cape Town, and ongoing monitoring on the island (see previous section). The best practical options for bait storage will be used. A number of different options could be considered, including large storage warehouses or covered workshops associated with the Public Works Department or other government departments, or the fish factory (possibly not in use at the time of year of the bait operation). Another option is to enclose all or most of the bait pallets within plywood pods so that these can be stored outside, especially if suitable internal storage is limited. The most appropriate bait storage option(s) will be selected by the PM in consultation with the Tristan government.

7.3 STORAGE AND TRANSPORT

7.3.1 Insurance

The bait should be insured for the entire transportation phase from the factory to Cape Town.

7.3.2 Transport – Factory to Export Port

A transport agent will be contracted (ACP to arrange) to transport the bait consignments between the closest feasible port to Wanganui (or other location where bait is manufactured) to Cape Town. This is probably the port of Wellington. A shipping agent will be contracted to receive, store and ship the bait from there.

One tonne loads will be made up by stacking forty bags of bait, each weighing 25 kg, onto standard 1.6 x 1.2m pallets at the ACP Wanganui factory. Two hundred such loads will be made up. Each pallet will have a cardboard layer placed between the pallet and the bags, and will be wrapped with shrink-wrap.

These will be loaded either directly into shipping containers established on site, or loaded single height onto track/trailer units for transport from Wanganui to Wellington (preferred option to be decided closer to the date).

There will need to be several delivery trips as storage space at ACP is at a premium. Bait will be transported as it is produced, not all at once. Bait consignments will be railed or trucked directly to the shipping agent's yard for storage until loading of the ship. The shipping agent will take responsibility for the bait as each consignment is unloaded upon arrival in the port.

If bait is still on un-containerised pallets, it will either be loaded as it arrives into the shipping containers, or placed in covered warehouses for later loading.

The bait manufacturer or shipping agent (whichever loads the containers) will ensure that all containers are protected against condensation by installing waterproof protective covers between the container roof and the pallets. ACP is experienced in the shipping of bait consignments and will employ current best practice measures to protect the bait.

The PM will check with ACP on the frequency of transport and volume of bait per load, and preferred method for loading at ACP (into shipping containers or onto trucks). The PM will also liaise with the shipping agent as required, to ensure storage and shipment details are appropriate.

7.3.3 Loading at Export Port

The pallets of bait will be loaded single-height into 20 ft shipping containers protected against container condensation. Each container will hold 8 x 1 tonne pallets of bait protected by a shrink-wrap plastic covering.

There may be an option to use 40ft containers – with potentially lower 'per tonne' cost – the PM should check this, and whether there are any disadvantages of 40ft containers.

The helicopter bait-buckets (x 4) and spare parts for these are also to be loaded into containers.

Any key component of helicopters, bait-buckets, portable high speed fuel pumps, DGPS navigational system items (base units, etc) or other bulk items that cannot readily be sourced in South Africa are also to be loaded.

7.3.4 Sea Transport to South Africa

The shipping agent (to be identified) will be responsible for organising the loading of containers, the placement of containers on the ship, and its safe transportation to Cape Town.

The standard time taken for sea transport between Wellington and Cape Town is 40 days (B. Simmons ACP *pers comm*). Therefore, the last of the bait would have to leave Wellington absolutely no later than 5th May of the bait year, and preferably at least two weeks before this to allow for any delays.

7.3.5 Customs Requirements

Customs charges and the process to clear South African customs are still to be investigated.

7.3.6 Storage in Cape Town

A bonded warehouse may be required for NZ-sourced bait and equipment. If so, a separate storage area for South African-sourced items will be needed. It may be possible to source this through Table Bay Marine (food, general equipment) and the helicopter company for all helicopter-related equipment and fuel. The rules for access to such an area of bait quality monitoring are still to be investigated.

Bait should be removed (still on pallets) from shipping containers as soon as practical because of condensation concerns, and transported to the secure storage area. This will possibly require the hire of forklifts and operators for loading the transport trucks (also to be hired), and unloading at the storage warehouse.

Security protection of the bait and other equipment will be necessary. This is to be arranged between the shipping or storage agent and the PM.

7.3.7 Bait Quality in Cape Town

The PM or delegated person will initially and periodically check the storage and bait condition for the duration of its storage in Cape Town. Action will be taken as necessary to protect the quality of the bait (this may include changing of storage areas, or greater on-site protection from problems such as humidity, dampness, physical damage to bags or pallets, vermin, etc).

The bait needs to be protected from damage by rodents while in storage. Damaged or soiled bags will present a problem later in the operation, and may hasten degradation of bait. A series of bait stations will be installed in the Cape Town storage facility (if not already in place) and operated continually until the bait consignment leaves the storage facility for loading onto the ship.

7.3.8 Storage at Tristan

Minimum requirements for covered storage of bait on Tristan are:

- 400m^2 floor space accessible by forklift or pallet truck
- Concrete floor
- Fully protected from rain and surface water

If covered storage is not available, bait could be stored outside in weather-tight plywood pods but the construction of these (200 or more) would be at additional cost to the project.

Fuel storage will be required for Jet A1 helicopter fuel drums. This can be outside, and should be in a designated fuel storage area.

All other equipment can be stored at or near the accommodation block.

A contingency or overflow option also needs to be established.

7.3.9 Bait Storage Pods

At least 16 purpose-built plywood pods will be constructed in Cape Town [perhaps by Table Bay Marine, who regularly build similar boxes for Tristan supplies], based on a design submitted by the PM, for use at the remote loading sites. These are likely to be a version of the pods successfully used in the Campbell Island and other New Zealand operations (design and material requirements will be available from New Zealand DoC). They are plywood cubes built over a pallet, which means bait can be transported both on the ground and in the air, fully protected from the weather.

Exact specifications for construction will be determined once the helicopter type and lifting capacity are known. More pods may be constructed if necessary - enclosing the bait within pods enables the bait pallets to be stacked while in transport on the ship. Stacking open pallets is not possible, as it will cause crushing of the bait pellets. Pods would also enable bait to be stored outside while on Tristan, if suitable covered storage areas are not available.

It is feasible that the entire bait consignment could be placed within such pods, and while being of considerable extra cost, this would alleviate any concerns about open pallets of bait being affected by moisture (eg rain) while being loaded or unloaded at various points along the transportation route.

While pallets of bait can be flown uncovered under normal circumstances, mist or rain could damage the bait and the risk of this occurring on Tristan is high. Therefore, the base team would load all bait required for the remote bait-loading sites into the pods.

Some of these pods will be used at the remote bait-loading sites both as a loading platform to speed the filling of each bait-bucket load, and also to serve as weatherproof transport and storage for a set amount of bait.

Having such storage available at the remote sites means that any bait unused at the onset of bad weather can be safely stored. When conditions are again suitable for flying, there is an immediately available source of bait on-site. Four pods will be required at each remote bait-loading site to form the bait-loading platform and to provide the immediate source of bait. These pods will be kept on-site until that particular remote bait-loading site is no longer needed.

With at least two remote bait-loading sites required, up to eight pods will be needed at any one time for the bait-loading platforms. The support helicopter will ferry the remaining eight or more pods to and from the remote loading sites as required.

Pods emptied at the remote bait-loading sites will be returned to the base area, carrying rubbish (shrink-wrapping, empty bait bags, etc which will be removed and stored for later disposal), and the pods will then be re-filled with full bags of bait.

The refilling of pods allows for the alteration of load weights as appropriate (and as dictated by the ferry helicopter pilot).

All pods will be individually numbered in case they need to be re-located at any stage eg due to leakage.

7.4 SAFETY AND BAIT HANDLING

There is no precedent for work of this nature on Tristan, and as a result, there are no directly relevant guidelines or regulations. Therefore, as a basis for safety, New Zealand DoC's 'Handling of Toxins Standard Operating Procedures' document will be complied with, which in summary prescribes:

- When handling bagged bait, overalls and rubber boots will be worn. This includes when loading the boat and any handling of bags required on the island
- When dealing with loose bait (eg loading the bait-buckets), white overalls, white rubber boots, face mask and goggles will be worn
- If operating under helicopters, earplugs and hardhats will be worn.

The PM will hold copies of this SOP, and other reference material relating to the bait (eg Material Safety Data Sheet) and will make these available to stevedores, ship's crew, Tristan officials, etc as required).

It is possible that at some stages of the transportation process some resistance or concern may be expressed by handlers or storage personnel about the 'safety' of the bait, generated either by the large quantities or the obvious 'toxic' identification. Such potential instances should be expected and prepared for.

8 Ship

8.1 SPECIFICATION REQUIREMENTS

The ship that will be used to transport the bulk of the equipment for this project must have:

- Helicopter storage (for a minimum of two and ideally at least three helicopters) and ideally an aviation workshop
- Helicopter fuel storage capacity (bulk bunker for at least 180 x 220-litre drums)
- Covered, waterproof holds or similar for bait storage (dry and secure holds for 200-plus tonnes of bait plus an estimated 50 tonnes of other dry goods). Estimated floor space required is 600m^2 for bait, 200m^2 for helicopter fuel, 50m^2 for other supplies
- Accommodation for a field team of up to 12 people
- Accommodation for Tristanians on the return voyage to Cape Town. Any Tristanians that do not wish to be present during the baiting operations will be provided transport from the island for the duration of the operation
- Communications systems (satellite phone, marine radios, etc) to communicate effectively with the island and project team
- Food etc for the duration of the journeys
- Guaranteed availability for the duration of the charter (and ideally an emergency substitute vessel will also be identified).

8.2 DETAILS OF THE CHARTER

8.2.1 Timing & Duration of Sailing

The ship will be required to sail for Tristan no later than 25th June, and ideally by 20th June. Loading would have to be completed prior to this. Travel is expected to take approximately six days, though longer travel time can be expected in adverse conditions.

Once at Tristan, it is expected that up to three days will be required to offload all equipment, and to backload any passengers and materials from Tristan. From there, it could return directly to Cape Town.

The ship will then remain at Cape Town under contract, until returning to Tristan either on a prior arranged date, or by notification from the PM that the bait drop is near completion (or the operation is judged unable to be completed). This option (of the ship returning to Cape Town to await completion of the baiting operation) is probably cheaper than to have it remain off the island itself for the duration, but this needs to be investigated further. It also removes a potentially serious issue in that the significant daily cost of maintaining the ship on station at Tristan would place considerable pressure on the PM to 'speed the project along' in order to save costs. This may lead to pressure to cut corners or take risks with regard to weather suitable for baiting or other important operational issues.

The return of the ship to Cape Town also provides the opportunity for any Tristan islanders uncomfortable with the poison bait operation to temporarily vacate the island.

Once completion of the baiting is envisaged, the PM will contact a pre-designated representative of the shipping agency to request/confirm a specified pickup date, and this date (or best alternative) will be confirmed by the representative to the PM.

On this second journey to the island, the ship will be available for general Tristan freight and passengers on both legs of its journey.

Once at Tristan, the ship will be loaded with as much excess fuel, empty drums and other items as possible, and will return to Cape Town with the helicopters, associated equipment and the bulk of the off-island team.

8.2.2 Loading of Bait Ship at Cape Town

All crated items that are not readily identifiable by sight will have a clear non-removable label listing the contents. This will be important to speed the process upon unloading at Tristan.

The charter would ideally start at 8 am on the 20th June. Loading will start as soon as possible on 20th June with the boat leaving as soon as practical after loading has been completed. This is expected to take one full day and certainly no more than two.

Key items to be loaded:

- Bait (mainly on pallets, some possibly in plywood 'pods')
- Bait-buckets, and spares, securely strapped on pallets.
- Fuel for bucket spinners
- Helicopters (in hangar)
- Helicopter fuel (in 220-litre drums, strapped together on pallets)
- Helicopter maintenance equipment and spares.
- Navigational and communications equipment (DGPS base station, VHF mini-repeater, etc)
- Bait pods (these can be used to store office equipment, etc for the journey)
- Bulk office and field equipment
- Bulk food
- Staff and their personal equipment

If, for any reason, loading is delayed, the ship's departure will be delayed accordingly.

8.2.3 Transport to Tristan

All project staff not already on the island, or resident on the island, will travel to Tristan aboard the ship transporting the bait.

It is an option for a member or members of the project team to head to the island prior to this (on a fishing vessel, if schedules permit) to assist or guide local staff in on-island preparations, and to ensure that these have been completed satisfactorily and on time. The PM will establish the need (and opportunities) for this in the months leading up to the bait ship's departure.

If a large number of people (i.e. more than five project staff) need to go to Tristan prior to the operation, an extra

charter trip should be investigated to reduce pressure on berths on the fishing vessels which are already over-subscribed.

8.2.4 Unloading at Tristan

The heavy-lift helicopter will unload the majority of bait, using a long lifting chain to lift predetermined load sizes (as prescribed by the Chief Pilot) from the deck of the ship. Individual loads will have been placed on deck by the ship's cranes, and stropped and otherwise made ready by the ship's crew for lifting by the helicopter.

This unloading can be supported by use of landing craft, but only in suitable sea conditions, and at the discretion of the PM - under no circumstances is the bait to get water or sea-spray on it. Similarly, critical or delicate equipment (bait buckets, DGPS station, etc) will also be unloaded by helicopter. Other operational supplies (fuel drums, bulk food, etc) can be unloaded by barge to reduce helicopter time.

If the unloading is undertaken entirely by helicopter, there will be an estimated 300-400 lifts to unload the ship (200+ lifts of bait, 60+ of fuel drums, 50 of other materials). It is expected that this could take several days, but the timeframe will be dependent on the efficiency of the unloading crews and what can be safely unloaded by barge.

To speed the process as much as possible, the helicopter will take the shortest possible route from the ship to a pre-determined unloading area, where road vehicles will transport the pallets into the covered storage as soon as possible after they are landed.

It may be feasible to use a Rapid Attachment Harness (RAH) system rather than strops, if this will speed the unloading process. The Chief Pilot will determine the specific requirements, in consultation with ship's load-master, to facilitate the most time-efficient safe method for unloading the ship.

While the heavy-lift helicopter is unloading equipment, the bait-sowing helicopters will have already been flown off the ship, and their pilots can be preparing for baiting operations (general familiarisation, establishing helicopter storage/tie-down areas, undertaking reconnaissance flights, mapping GPS boundaries, selecting and setting up remote bait-loading sites, etc).

All food and field equipment will be taken directly to the hostel or pre-determined storage facilities on their pallets or pods. Any pods used for transporting other equipment will be unloaded as soon as possible. Any frozen goods will be unloaded directly into the pre-determined freezer storage areas. The pallets of fuel will be stacked at the pre-designated fuel storage area.

For unloading, the project team's site controllers will be the APM (on the boat) and PM (on-shore). They will both be supplied with a radio for communications with the pilot(s), ship's crew and Tristan barge operators. Any other project team members shall be allocated tasks as required by the APM on the ship, or the PM on the island. All project team personnel involved in loading or unloading goods under the helicopter will wear high-visibility safety vests, hard-hats, safety boots and gloves.

8.2.5 Availability of the Ship for Other Purposes

If a ship the size of the SA Agulhas is used, there is likely to be passenger and cargo space available in addition to the requirements for this operation. Where it does not compromise the potential outcome of the operation, this space should be made available to the Tristan Government for transporting people and supplies as they wish.

However, the requirements of the rat eradication project shall take utmost priority for the bait delivery ship, and no significant delays or complications would be tolerable. The second trip, to pick up helicopters and the rat project staff at the conclusion of baiting, can be used for major freight and passenger requirements from Cape Town to Tristan.

9 Helicopters, fuel & bait-buckets

9.1 PILOT SELECTION

It is critical to the success of the operation that highly skilled pilots, with extensive previous bait-sowing experience are recruited.

All pilots will need the appropriate (and current) air operator's certifications for this type of activity, as established by the civil aviation regulations and authorities in the country of origin of the company that makes the successful tender for helicopter operations. It will be the responsibility of the Chief Pilot and individual pilots to comply with this requirement.

Selection criteria for bait pilots:

- Experience in GPS-guided bait-sowing operations using an underslung bait- bucket
- Appropriate current certification (for flying helicopters with underslung bait-buckets). Certification requirements may vary from country to country, so compliance with relevant regulations will need to be determined by the Chief Pilot)
- Experience and confidence in difficult flying conditions, including presence of albatrosses, tricky winds, high altitudes and low visibility.

Selection criteria for the support pilot include:

- Experienced at loading and carrying heavy loads using a long-strop system.
- Appropriate current certification
- Confident in high wind/low visibility situations

9.2 HELICOPTER SELECTION

For the bait-sowing operations, two to three smaller helicopters would be preferable, rather than one large one, for operational security – if one is damaged or breaks down, then others can complete the operation. They should ideally also be of the one type, to minimise the need for separate spare parts, etc. However, there will be practical limitations on the number of helicopters that can be used, especially through hangar space available on the transport ship. The more bait-sowing helicopters that can be used (up to four) the better, but getting them there and back would be a significant extra logistical burden and financial cost.

In addition to the bait-sowing helicopters, there should be a larger support helicopter that is capable of lifting the heavy pallets of bait and fuel drums, and capable of transporting a field team (four-five personnel) in one load. It would be ideal, and could be feasible, that this helicopter would also spread bait when not required for other purposes, but this would require that the pilot is also proven competent in such operations.

Minimum helicopter requirements are:

- For the support helicopter: one helicopter capable of lifting a minimum of 750 kg, and ideally up to one tonne. Preferably an

AS-350 Ecuriel ('Squirrel') B2, but it could also be a Bell 212 or 205

- For the bait-sowing: two or more helicopters of a type proven to be reliable and efficient for bait-sowing, preferably Bell 206 Jet Rangers, or possibly Squirrel BA's or B2's.

An alternative option would be to use only two helicopters, both capable of bait spreading and transporting bulk bait to remote bait-loading sites, eg Squirrels or Bell 212/205's. This would require that the pilots used are fully competent in both types of work, or that different pilots are used for different aspects of the job. The smaller number of helicopters would be balanced by greater bait-carrying capacity, reducing the overall re-loading and ferrying times. Larger machines do however have a greater 'per-hour' cost and cannot actually apply the bait at a significantly faster rate (airspeed of larger machines may be higher but the bait must come out of the hoppers at the same rate irrespective of size of the helicopter). Therefore, there is likely to be little difference in overall cost, and having fewer helicopters adds a greater operational risk because of the potential for breakdown of a helicopter.

It is critical that the precise type and number of helicopters to be used is identified as early as possible, as the type and capacity of bait-buckets is dependent on helicopter type. Other planning issues such as size of the pods and perhaps also fuel requirements are also dependent on knowing the capabilities of the selected helicopters.

9.3 HELICOPTER OPERATIONAL CONSIDERATIONS

The Chief Pilot will establish the precise requirements for the safe and efficient operation of the helicopters in this operation.

Helicopter operational considerations include:

- GPS system installed in each helicopter, of a type proven suitable for such bait-sowing operations
- Confirmed capability of each individual machine (including the support helicopter) for use of the chosen bait-buckets
- Security of machines from damaging salt-spray, strong winds, wildlife damage, both on the ship and on the island
- Determining and obtaining an adequate fuel supply to cater for all reasonable possibilities
- Ensuring a crew of experienced support personnel are selected for refuelling, maintenance and breakdown requirements
- Wash-down facilities on the island
- Appropriate 'safety around helicopters' training for all field staff and loading personnel
- Security of all materials (loose materials, rubbish, etc) in or near helicopters in operational conditions.

9.4 HELICOPTER TRANSPORT, EQUIPMENT, STORAGE

9.4.1 Helicopter Transport to Tristan

At around 3,000 km from the nearest re-fuelling point, it is inconceivable that the helicopters could safely fly to the island. It will be necessary for a ship to transport all the helicopters used for the operation to and from the island.

The helicopters will be flown from their base to the ship at a practical time prior to sailing, to ensure they can be stored and secured before the ship gets underway. They will be stored as pre-arranged within the helicopter hangar of the ship (or for the third helicopter if it cannot be fitted within the hangar, elsewhere as pre-determined).

9.4.2 Helicopter Storage on Island

The helicopters will be stored on the grass area near to the school and Administrator's residence, or other designated site, using tie down systems acceptable to the pilots and installed by them or under their direction. A more protected alternative site needs to be identified and prepared, in the case of extreme weather. This could be in the relatively sheltered hollow near the Mission Gardens. Consideration should also be given to the option or possibility of storage of helicopters inside or adjacent to buildings (requiring flat-deck wheeled trailers which may be available on the island or which may need to be brought off the ship specifically for this purpose). Sites will be identified in pre-operational site investigations.

Requirements:

- Tie-down systems
- Identification and preparation by the set-up team of the main storage site and the extreme weather site
- Remove livestock from the area, and maintain stock-free until the operation is concluded.

9.4.3 Breakdown/Spare Parts

All helicopters to be used in the operation will have comprehensive inspections and services completed as close as practicable prior to loading on the ship. It is envisaged that the programme will be completed before the next 100-hour servicing is required on each individual aircraft.

The helicopter contractors will supply adequate spare parts to enable repair whilst on Tristan of all foreseeable mechanical or electronic breakdowns. A helicopter mechanic/engineer will be a core component of the team to facilitate this.

Some workshop facilities and general machinery are already available on Tristan (in the Public Works Department workshop facilities) to provide additional back up if required. The PM will liaise with the Head of PWD to ensure that they are aware of this potential need.

In addition to a spare bait-bucket, adequate spare parts for the bait-buckets will be supplied as part of the contract. A range of 'baffles' (bucket aperture sizes to attain the prescribed bait sowing rates) will be supplied to cater for the two proposed baiting

rates to be used on the island. This will include spare baffles of the most likely sizes, to allow for any loss or damage while on the island.

9.4.4 Estimated Flying Time

Based on previous operations, it is considered that, on average, 150 ha can be treated per flying hour, although this can vary considerably with circumstances (length of ferrying time between bait-loading area and treatment site, wind conditions, terrain, etc).

Based on the baiting requirements as outlined in the 'Bait Estimates' section, it is considered that *ca*.200 flying hours are required to apply all the bait. In addition, there are expected to be *ca*.80 flying hours for the support helicopter for ferrying bait and personnel, and 25 hours for unloading the ship. A contingency factor must be allowed for to ensure that in all feasible circumstances the helicopters have enough fuel to carry out all tasks required.

9.4.5 Helicopter Safety

All helicopter safety regulations will be followed as per legislative requirements.

All staff involved in the operation, especially those working around the helicopters will be briefed on:

- All safety features on the aircraft being used
- Operational procedures for attaching and unhitching stropped loads
- Procedures for safe approach to, embarking and disembarking from helicopters
- Signals and call-signs for visual and oral communication with the pilots
- Bait-loading procedures
- Emergency response options or procedures in response to being in or witnessing helicopter accidents

Helicopter pilots will be fully briefed on flying hazards on the island (albatrosses, any strung wires in possible flight paths, etc).

The PM and Chief Pilot will, in consultation with Tristan authorities, establish and mark out 'no-go' secured areas for non-involved personnel and Tristan Islanders for safety purposes and to protect equipment from damage.

Tristan da Cunha has a resident doctor, nurses and basic operating theatre for emergency requirements.

9.4.6 Availability of Helicopters for Other Tasks

The application of bait will be the sole focus for the helicopters and pilots until the entire quantity of bait is dispersed.

At the conclusion of the operation, the helicopters may be available for other uses (eg trips to Nightingale or Inaccessible, or shifting materials and people around Tristan). The Tristan Government can prepare a list of possible tasks, but there is no guarantee that these could be fulfilled before the ship and helicopters are due to leave. However, every endeavour

would be made to make use of the rare opportunity for helicopter use.

9.5 FUEL REQUIREMENTS, TRANSPORT, USE & STORAGE

The ship should have capacity to store bulk (bunkered) Jet A1 fuel for initial use (unloading stores, etc) until the ship is unloaded and can depart.

The Jet A1 fuel for use on Tristan will be in 220-litre drums. An estimated 180 drums will be required for the operation and for contingency supply. They will be stored and transported on pallets for ease of loading/unloading, and drums on each pallet will be strapped together with appropriate strapping bands.

The fuel will be supplied for the operation on the basis of a tender, and will be delivered to the ship's loading site at a date co-ordinated by the ship's master and/or the PM.

The bulk drums will ideally be stored under cover, but can be outside in a safe location. Day-to-day supplies may be held at or near the helicopter storage site, for efficiency. Pilots will have equipment to test for moisture contamination of any suspect drums, if required.

Any fuel remaining at the end of the operation can be loaded onto the ship and returned to South Africa and potentially resold to recover some costs. Jet A1 fuel can also be used as a diesel alternative so it may have some potential use on Tristan, and could be donated to Tristan – the PM will in consultation with Tristan officials consider the options at the conclusion of operation.

Helicopter refuelling will generally be carried out at the base area. The base loading team will position drums to speed this up. Some fuel (and refuelling pumps) may be ferried to the remote bait-loading sites on a day-to-day basis, to speed refuelling process on bait-days. Refuelling will be the responsibility of the pilots unless they delegate otherwise.

9.6 BAIT-BUCKETS

Buckets for sowing the brodifacoum baits are required for this operation. At least three (and preferably four) will be required, one for each bait-sowing helicopter, plus at least one spare. An option for a larger bait-bucket for the support helicopter should not be discounted.

All bait-buckets will have mechanical spinners to accelerate the bait out of the hopper to create a minimum swath width of 80m (40m to either side of the bucket).

These bait-buckets are likely to be sourced in New Zealand. They (and associated spare parts) would be transported by road to the port of export, and would be loaded and shipped to destination in conjunction with the bait consignment.

Buckets will be pre-calibrated to a 4 kg ha^{-1} sowing rate (and possibly aperture sizes for a 3 kg ha^{-1} sowing rate also established) prior to transportation, so that any further adjustments on Tristan should be relatively minor.

As soon as practical prior to loading for shipment to Tristan, all buckets to be used will be test-run and where possible the bait-sowing rate will be calibrated, with a project team observer (PM, Chief Pilot or APM)

present. Effective swath width and dispersal rate will be measured and the apertures used to give the desired results will be clearly marked (see below for details of the procedure).

The off-site calibration will use non-toxic bait, produced to the same specifications as that to be used in the operation. While field conditions (eg humidity) affect the flow rate in various locations, a pre-shipment calibration and test-run will give improved information about each bucket to be used, and will provide a start-point for later on-site refinement. A further calibration (using toxic bait) will be conducted immediately prior to, or as the initial part of, baiting operations on the island itself.

10 Bait-sowing operations

10.1 RISKS TO LIVESTOCK

It is very important to note that the application of bait on Tristan will be outside of the normal Code of Practice (Epro 2006) established for application of Pestoff 20R brodifacoum baits in New Zealand, especially with regard to treatment of livestock areas. Some livestock will eat the pellets, and will accumulate and store brodifacoum in body tissue, which can be a potential health issue both for the animal concerned and for any human later consuming meat from the animal. The relevant restrictions in the Code of Practice largely apply to risk of contamination of meat for commercial supply, an issue of great sensitivity for New Zealand's livestock industry but not directly relevant to Tristan.

The health risk to the Tristan livestock and the human population through subsequent consumption is a considerable issue for the project, but can almost certainly be reduced to an acceptable level through a range of preventative or remedial actions. However, it is acknowledged that some issues in relation to the proposed Tristan operation are untested, in that directly comparable operations have not been undertaken elsewhere. These issues include the fact that large numbers of livestock on Tristan will, despite all practical mitigation, probably encounter bait, and some bait will be consumed. It is essential that all areas (including pasture) have thorough coverage of bait, and it will therefore be almost impossible to prevent some access of livestock to bait.

The level of ingestion of brodifacoum can be mitigated to some degree, but will still be unknown, due to factors such as how much bait will be removed by rodents, and how attractive the bait will be to the livestock (dependent on availability of other food sources, etc). Consumption will vary between individuals and locations, as will the precise effects on the animals concerned. How long any brodifacoum residue takes to break down and be excreted from the body of affected animals is unclear in field situations, though limited research has been conducted (eg Day 2004; Fisher & Fairweather 2005). In all likelihood, there will be a large difference between acceptable risk and absolute certainty regarding the safe withholding period before people can resume slaughtering livestock for consumption. What level of safety the Tristan people wish to accept will be at their discretion.

These facts must be accepted by all parties, otherwise it is unlikely that the operation can proceed.

The bait sowing operation will operate according to New Zealand DoC current agreed best practice for the aerial application of brodifacoum baits for rat eradication. The following sections reflect the current [November 2006] best practice recommendations, but it should be noted that these might change in light of future developments

10.1.1 Work Necessary at the Start of or During Baiting

The PM will ensure the following tasks are completed as and when required. Specific tasks will be allocated to local staff (government agencies, individuals, etc) where possible, but otherwise will be supervised or carried out by the project team.

- Instructions to all residents – safety issues, requirements for co-operation, timetables, etc.
- Capture of Gough moorhen and Tristan thrushes for captive holding during baiting
- Disposal (burial or incineration) of any livestock carcasses
- Containment of all poultry within pens
- Shifting of stock to designated pasture
- Protection of dogs – indoor confinement, etc
- Water supplies action (to be determined)
- Dead rodent disposal (procedures for the disposal of carcasses of any rodents found dead or dying (in either open 'field' situations or within buildings), to reduce risk to scavenging animals such as dogs, poultry or skua, and to reduce any health risk to humans)
- All offal pits closed and deeply buried
- Hand-laying of baits in every house, hut and building and other 'special treatment areas'
- Hand-laying of bait in bait stations for stocked pastures [if 'Option Two' is desired, see section below)
- Temporary evacuation to ship of any humans not wanting to be present when bait is dropped.

It may be possible for a team member or members to travel to Tristan on a fishing vessel before the bait ship, if required or desired. This group would be tasked with ensuring the above tasks are on-track, as well as setting up the base operation as far as possible so that everything is ready for the arrival of the main team and the bait. This would mean that, should weather permit, bait dropping can start as soon as possible after the drop helicopters arrive. This preparation will include:

- Liaison with Tristan officials and public on any issue relating to the operation
- Ensuring key pre-operational tasks (stock movement, rubbish disposal improvements, water supply protection, etc) have been achieved
- Ensuring areas for storage of bait etc are clean and available
- Setting up the initial food stores
- Setting up the communications system – radio and satellite phone/fax
- Setting up the desk-top computer
- Setting up fuel storage area(s)
- Preparing the helicopter storage area, including placing of tie-downs.

10.1.2 Timing of the Bait-drop

The bait-drop is ideally scheduled to begin on 1st July of the bait year or up to a week earlier if the weather is right

and all pre-baiting requirements have been dealt with.

This timing is to coincide with a period of low natural food availability for rodents on Tristan, thereby increasing the acceptability and effectiveness of the bait. It is also a non-breeding period for rats, thereby avoiding a period when breeding females may alter feeding behaviour or when near-independent juveniles are present but are not able to access bait.

Given the vagaries of availability of ship transport to Tristan, a time window within which the operation must commence needs to be established. The operation should not begin any earlier than 1 May, or commence any later than 30 August of any given year. All baiting activity should ideally be completed before 30 September.

10.1.3 Bait-bucket Calibration

Trials prior to the shipment of the bait-buckets to Cape Town will have allowed the selection of the bait bucket aperture disks that give approximately 4 kg ha^{-1} for the first round of baiting, and 3 kg ha^{-1} for the second. However, as the bait flow varies considerably with humidity etc, this will need to be reviewed at the beginning of the bait drops, using the GPS summary. This can be achieved by comparing hectares covered in GPS-logged baiting runs with amount of bait used, as determined by how many bags have been emptied. If necessary, the disks can be changed accordingly, and alternative sizes of apertures will be on hand on the island.

The re-testing of calibrations on Tristan da Cunha will use toxic bait. No non-toxic bait will be used on Tristan itself, to remove the possibility of rodents eating this in preference to toxic bait, or the potential for the bags of non-toxic bait to be inadvertently mixed with the toxic bait.

10.1.4 Application Prescription

The bait will be sown during two separate aerial applications, a minimum of ten days apart. The reasons for applying the bait in two separate applications are:

- To ensure complete coverage of the island with bait, with minimum risk of any gaps in coverage occurring
- To minimise the risk of bad weather washing out both applications of bait
- To ensure the rodents are exposed to bait for a long period of time
- To substantially reduce rat numbers in the first drop so that mice have a greater chance of accessing bait on the second drop
- To ensure that any rats or mice that, for whatever reason, cannot access bait from the first application have access to bait from the second application.

The two-application method is important to maximise the chances of eradicating the mice. Rats may dominate the consumption of bait in the first baiting round, and behavioural interactions between the two rodent species may mean that some mice are excluded from accessing the bait. By the second round, most if not all rats should have

died or at least slowed or ceased consumption of the bait, making it far more accessible to mice.

Rodent densities appear to vary considerably across various habitats of the island, based on information gathered by Brown (2007) and Sommer (2006). Rat densities appear to generally decline with altitude, and mouse density is generally low but patchy, being highest round the settlement area. It is considered that standard bait-sowing rates used elsewhere will be sufficient for this operation.

Bait will be applied at an overall density of 8 kg ha^{-1} for the first application and 4.5 kg ha^{-1} for the second.

For the first application, the bait-bucket calibrations and air speeds will be matched to give a nominal rate of bait-sowing of 4 kg ha^{-1}. Based on bait-buckets providing an effective swath width of 80m, the parallel flight lines will be spaced to give a 40m (50%) overlap in bait-sowing swaths and hence an effective application rate of 8 kg/ha.

The second application will be completed at the nominal sowing rate of 3 kg ha^{-1} but with a 20m (25%) overlap in swaths, to provide an effective application rate of 4.5 kg ha^{-1}.

Flight lines for the second application will, if possible, be flown at approximately 90^0 to those used for the first drop, to reduce the risk of gaps in bait spread. If this is not possible on Tristan da Cunha, because of the steep slopes on the Peak, then the second drop lines will be run at whatever different angle to the first is practical.

During each application of bait, the island's coastline will be flown a second time using a combination of parallel flight lines and line of sight, to ensure adequate bait coverage. The coastline will be flown using two to three swath widths with a 40m overlap, to guard against gaps occurring at the end of the parallel flight lines.

The bait drop will start at the settlement for logistical ease during the initial stages of the operation, and to better co-ordinate all the activities necessary in the area (livestock restrictions, etc). Thereafter progress will be along the Settlement Plains (excluding livestock containment zone) with movement up the Base cliffs and across the island in a single rolling front running across the island in a virtual north-south line.

The PM and Chief Pilot will pre-establish working 'blocks' which will be practically manageable units of land (usually bound by certain geographical features such as cliffs or gulches), and assigned crews will work on individual blocks until they are completed. Dividing the island into blocks will promote helicopter safety (keeping them out of each other's way) and provide practical boundaries for progressive advancement across the island, and will be sub-units through which to confirm bait use rates in relation to size of area treated.

A rolling front will be used, with the drop helicopters working around the island in approximately two-hour 'bites' (each covering approximately 250-300 ha) for bait-sowing. This is to minimise the risk of not completing a geographic block and thus leaving an

additional front that could increase the risk of re-invasion, area required for overlaps, etc. The PM and Chief Pilot will endeavour to make use of any period of suitable weather that is likely to be two hours or longer.

The helicopters will work on a single block, dividing it in half and working parallel blocks in the same direction. (ie the block will be split along an east/west line and each pilot start on the northern edge of his sub-block, working southwards). This means that pilots will be working with safe distances between them. As required, one helicopter will work the cliff areas, as these will require particular attention.

It is possible that a block will not be finished on any given day. If this occurs, the decision team will decide on a case-by-case basis whether to re-do the whole block or if not, how much overlap is required. This will largely depend upon the area involved and the time-gap between drops. If the time between drops is greater then 14 days or the PM and decision team are uncertain of what overlap should be used, the IEAG will be consulted for input.

Some areas will need re-treatment because of weather, or to create a 'buffer zone' when there have been lengthy delays (of more than 2 days) in treating an area.

10.1.5 Flying Time

The success of the operation will depend on maximising actual flying time during suitable weather. It is estimated that up to 200 hours flying time is required to cover the 30,000 ha minimum area that needs to be covered at the rates prescribed here, allowing for extra time for contingencies and re-treatment of buffer areas etc.

If each of the two bait helicopters operates for 8 hours day^{-1}, it would take six-seven full flying days to complete each of the two baiting rounds. As weather and other delays are almost inevitable, each round is expected to take a minimum of two weeks, and in extreme circumstances perhaps more than three times that much.

Daylight hours in July on Tristan will be very limited (*ca*.9½ hours day^{-1}), so it will be very important to maximise flying opportunities in daylight hours through continuous advance preparation and streamlining of operational activities as much as possible.

10.1.6 Bait Estimates

Geographic information used for bait calculation:

- Cliffs are defined as slopes >60°
- Approximate length of coastline is 38 km (estimated 9 km 'non-cliff', 23 km cliff)
- 'Major' cliffs are approximately 37 km in total length, mostly being coastal, but there is *ca*.14 km of inland cliffs. Maximum planar width = 800 m, average <400 m.
- In addition, there are approximately 6 km of smaller coastal cliffs (at the Caves, Patches-Hillpiece and Volcano-Pigbite areas).

Table 1. Bait calculations, first bait drop

Land Type	Area (ha)	Baiting Regime	Tonnes of bait	Flying Hours
Entire island	9,850	First drop @ 4 kg ha^{-1}; Swathes 40m apart (50% overlap); Effective rate 8 kg ha^{-1}.	78.8	66
Major cliff areas (37 km length)	1,500	In addition to above, 4 kg ha^{-1} swathes 40m apart (50% overlap) (effective rate 8 kg ha^{-1})	12	10
Minor coastal cliffs (6 km)	60	As for main portion of island plus 1-2 additional swathes @ 4 kg ha^{-1}	0.36	0.5
Non-cliff coast (9 km)	72	As for main portion of island plus 1 swathe @ 4 kg ha^{-1}	0.29	0.5
Offshore Islets	> 5	1 'hover' drop (nominally @ 4 kg ha^{-1}), or hand-treated	0.1	0.5
Settlement	*ca*.200 buildings	Hand-treatment (extra to aerial), 200 buildings @ 50g each	0.1	0
Outlying huts & sheds	*ca*.100 buildings	Hand-treatment (extra to aerial) 100 buildings @ 50 g each	0.05	0
Expected repeats	80	10 repeats @ 4 kg ha^{-1} 2-4 swathes 40m apart along a 4 km front	3.2	2
TOTAL	11,567		94.9	79.5

Table 2. Bait calculations, second bait drop

Land Type	Area (ha)	Baiting Regime	Tonnes of bait	Flying Hours
Entire island	9,850	Second drop @ 3 kg ha^{-1}; 25% overlap in swathes = 4.5 kg ha^{-1} total	44.4	66
Major cliff areas (37 km length)	1,500	In addition to above, 3 kg ha^{-1} swathes 40m apart (25% overlap) (effective rate 4.5 kg ha^{-1})	6.75	10
Minor coastal cliffs (6 km)	60	As for main portion of island plus 1-2 additional swathes @ 3 kg ha^{-1}	0.27	0.5
Non-cliff coast (9 km)	72	As for main portion of island plus 1 swathe @ 3 kg ha^{-1}	0.22	0.5
Settlement	*ca*.200 buildings	Hand-treatment (extra to aerial) – not likely to be required but checks should occur and re-bait where needed	0.05	0
Outlying huts and sheds	*ca*.100 buildings	Hand-treatment (extra to aerial) – possibly not required, but checks should occur and re-bait where needed	0.025	0
Expected repeats	80 ha	10 repeats @ 3 kg ha^{-1} 2-4 swathes 40m apart along a 4 km front	2.4	2
SECOND BAIT RUN TOTAL	11,562		54.1	79

Table 3. Overall bait requirements

Activity	Hectares	Bait Required (tonnes)	Flying Time (hours)
First bait run	11,567	94.9	79.5
Second bait run	11,562	54.2	79
SUB-TOTAL	23,129	149.1	158.5
Contingency (33% sub-total)	7,633	50.0	40
TOTAL	30,762	*Ca*.200.0	*Ca*.200

N.B. It is anticipated that all bait taken to the island will be applied (see 'Surplus Bait' section). Therefore, certain areas will receive a higher quantity of bait per hectare than the standard prescription.

10.1.7 Drop Zones

Because of the roughly circular nature of the island, there are few geographical features (bays, ridgelines, etc) that could assist in the splitting of the island into discrete drop zones.

Baiting will start on the Settlement Plain and will progressively work on a 'rolling front' northwest-to-southeast across the island. Wherever possible, the advance of baiting across the island will be a single unbroken line. However, weather is likely to play an appreciable part, often meaning that work could continue on one sector of the island while cloud or other factors prohibit flying activity elsewhere. If this is the case, the baiting will progress on a radial basis around the Peak, advancing the line wherever this is possible, without creating any gaps. Thus, portions of the line may be advanced on any given day while others remain static. This will not be a problem, so long as static portions are given priority on subsequent days. Prescriptions are provided (see 'Strategies Following Downtime' section) for re-treating buffer zones, should portions of the front not move for several days or more.

If static fronts have to be created for several days or more, then ideally these should be in the high altitude (alpine tundra) zone, as very few rodents will be present in this area, especially during winter months.

10.1.8 Priority Areas for Baiting

10.1.8.1 Bait-sowing over cliffs

The cliff areas (both coastal and inland) are subject to the most difficult flying conditions. In premium flying weather, the top priority will be to cover as much cliff area as possible while weather permits.

10.1.8.2 Bait-sowing in gulches

The island has numerous watercourses (many of which are ephemeral), which radiate from the Peak, often with steep-sided and deeply incised channels (known locally as gulches). Ensuring complete coverage of bait in these gulches may be difficult, because their narrowness may limit the amount of bait entering them, while self-contained rodent enclaves may occur within sections of the gulches. Ensuring that all individual rodents within gulches receive enough bait may therefore be a problem. This will be reduced somewhat by the intended double application of bait.

The gulches will consequently be a primary target for use of any surplus bait at the conclusion of the baiting operations. A single run of bait-sowing, following the direction of the gulch, will be used to ensure the flanks and bottom of the gulches receive adequate bait.

10.1.8.3 Bait-sowing at high altitudes

The high altitude zone (above 1,500m asl, an area of approximately 670 ha) is comprised of very sparsely vegetated volcanic scoria. It is known to have extremely low densities of rodents (E. Sommer *pers. comm.*) even in summer months, presumably due to cold temperatures and lack of food resources. During the baiting operation this area is likely to be at least partly snow-covered.

Completing bait coverage in high altitude zones will be a priority when the weather is good, as they are the most likely to be affected by cloud or other weather conditions unsuitable for flying. However, they are likely to present a buffer for rodent movement – rodent density at high altitude on Tristan is comparatively very low, even in summer, and during winter with the presence of ice and snow the rodent population is likely to be almost nil. As a consequence, movement of individual rodents across the high altitude zone (eg from an untreated area into a previously treated area where bait may no longer be available) is considered unlikely. Thus it is considered that static boundaries between treated and non-treated areas within the high altitude zone can safely remain for longer than at lower altitudes before re-treatment of buffer areas behind the boundaries is necessary. The high altitude zone may therefore be deliberately targeted as a useful natural buffer when planning day-to-day baiting strategy. .

10.1.8.4 Bait-sowing around the coast & waterways

While every practical endeavour will be made to minimise the dropping of bait into the marine and freshwater ecosystems, the need to ensure that the bait drop covers all possible rat home ranges means that this will occur. This is recognised in the planning process. When operating around the coast, a rubber curtain or similar pre-tested and approved device may be attached to one side of the bait bucket. This is so that the pilot can fly accurately around the coast ensuring that all the area is covered and minimising the bait that may go into the water. This will also put additional bait around the coast, which is an additional benefit. This will mean that for these areas the machines can only drop in one direction but will enable the pilots to better concentrate on targeting the bait up into the cliffs so that a greater percentage stays where it is required.

10.2 WEATHER FORECASTING

Bait will be sown on all suitable days or parts thereof. Baiting does not require a fine forecast, and bait-sowing will only cease if heavy (> 12.5 mm within 24 hours) rain is forecast. The forecasts from the South African Weather Service should primarily reflect whether heavy rain is predicted or not. This is the most important aspect of any forecast made, as heavy rainfall is the greatest operational weather risk. Expected wind strengths, cloud cover and cloud base will also be required, but to some degree the PM or pilots can make on-site (and immediate) assessments of whether accurate bait placement is possible in the current wind and cloud conditions. The forecast will be emailed if possible, or otherwise faxed, daily – time to be confirmed by the PM to the weather bureau. Back up is via email, fax or phone to the Tristan Government.

Requirements:

- Confirm timing and contents of forecasts
- Confirm mode of communicating forecasts

The daily decision to proceed with bait spreading is outlined in the decision tree in Flowchart 1.

Strong wind, low cloud or mist, rain and snow will cause delays and operational changes with bait spread. Bait spread will cease in the following conditions:

- At any site where wind conditions are averaging over 25 knots or gusting more than 30 knots
- All areas obscured by cloud or mist, which in the pilot's opinion will reduce safety margins to unacceptable levels
- Where heavy rain or snow (> 12.5 mm in a 24 hour period) is forecast within the next 12 hours

The baits are tolerant of moderate rain and to a certain degree will withstand repeated rain episodes. The toxin within the bait is not water soluble (it remains toxic as long as the bait is intact). However, it is important that rodents have access to baits before any significant degradation of baits occurs through moisture absorption (and subsequent mould growth, insect attack, etc) as this may affect bait palatability and potentially also the quantity of bait accessible. Heavy rain events may 'wash out' baits spread in previously dry watercourses or move baits placed on steep slopes, etc., creating potentially large and operationally disastrous gaps in actual coverage.

10.3 SNOWFALL

It is likely that snow cover will be encountered during the baiting operation, particularly at high altitudes. Although the high altitude areas are likely to have few if any rodents present in winter, it is feasible that some may remain in the area and this must be planned for. It is also possible (though considered unlikely) that either the snow layer will prevent the rodents gaining access to bait, or that behavioural changes in rodents (eg a cold climate winter 'torpor' reported from some subantarctic islands) will mean that the rodents do not take the bait. In practical terms, these potential problems need to be accepted. Avoiding times of snowfall will be impossible, as it occurs year round at the highest altitudes. Although prior experience of spreading bait in snow areas is very limited, it is thought that the risk posed to the successful outcome of the project is very small because:

- The rodents in such areas should be under severe environmental stress due to the conditions and should find the bait highly attractive and seek it out by smell even if it is covered by snow
- The density of rodents in such areas will be extremely low, meaning that even if much bait gets damaged or lost in the snow, there should still be ample quantities available
- Bait should last in reasonable condition if frozen and will only degrade significantly once the snow itself begins to melt.

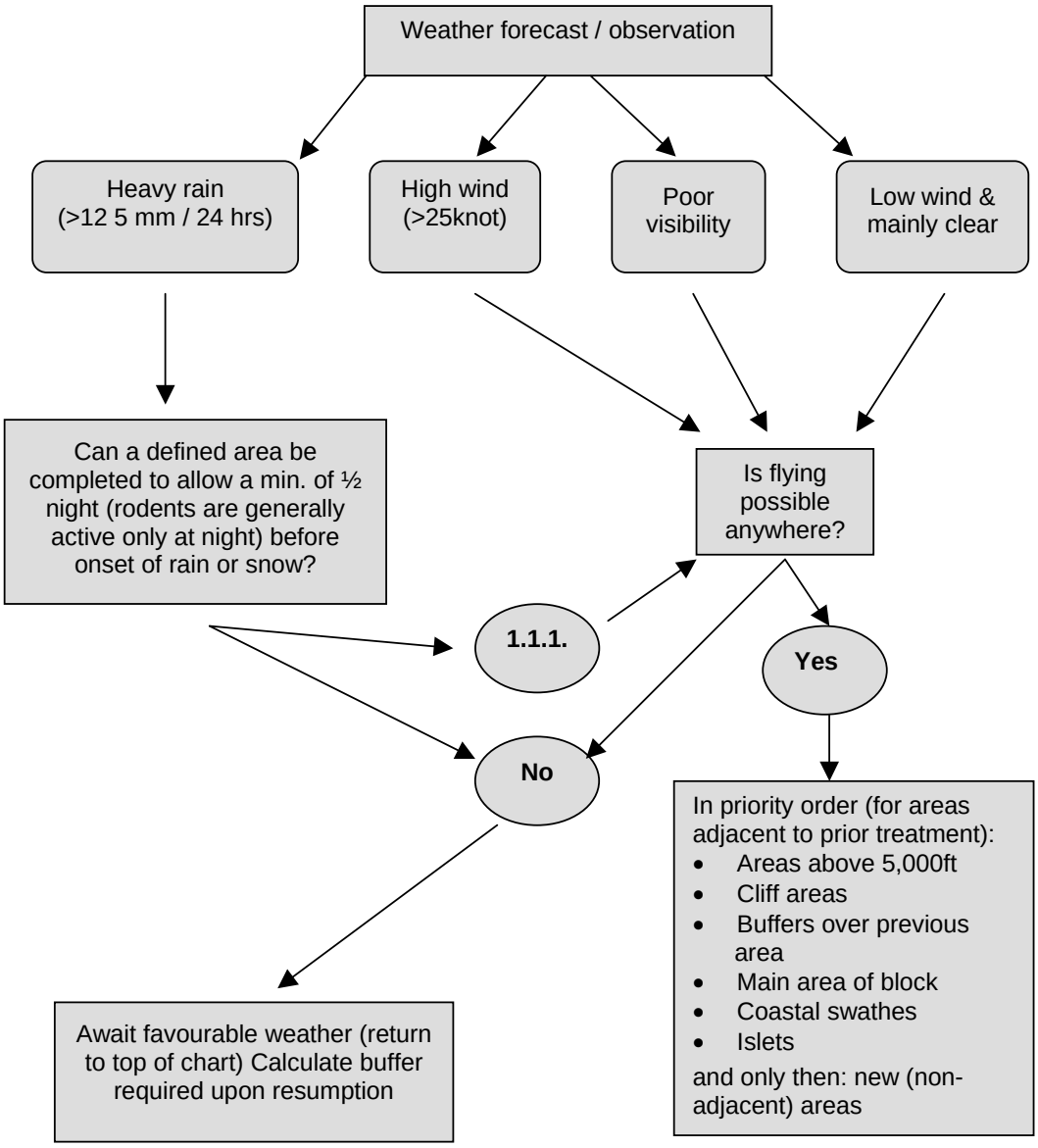
If it snows once bait is on the ground, no additional actions will be taken. No immediate or unscheduled re-treatment of the area will be considered. If bait is dropped on top of lying snow (as it will be, if suitable bait-dropping weather occurs after a snowfall), the follow-up actions will depend on how long the snow is present and over what area. It is thought that the longer the area remains under snow, the greater the

need for additional re-treatment. Some site inspections may be necessary to determine the quality and abundance of bait lying on the ground at certain times after the bait drop at such a site. The decision on re-baiting strategy should be made by the team on the island at the time but if there is uncertainty the IEAG will be contacted for input.

If it is considered that the affected area will need to be re-baited (beyond the second scheduled drop), this area could be a priority for use of any surplus bait remaining at the end of the operation.

10.4 DECISION TO START OR RECOMMENCE BAIT-SOWING

Figure 3. Priority assessment for bait-sowing



Doing a quality job is vital for the success of the operation. If weather conditions are not suitable, then bait will not be sown, regardless of the stage of the operation.

Best practice ise to continue bait-sowing in a single contiguous block, having additional bait spread 'flowing out' to adjacent areas from the current bait-sowing boundaries, rather than starting on any new and geographically isolated areas.

If weather conditions prohibit bait-sowing in areas adjacent to prior bait coverage, but would allow work to start in 'new' areas, this could be considered by the PM, but should generally not be recommended except in extreme situations. If it must occur for practical reasons, then the aim should be to link and merge the two areas as soon as practically possible.

10.5 BAIT-LOADING

Bait-loading platforms made from the plywood pods will be set up at the remote bait-loading sites as soon as possible after unloading the bait ship, for safe loading and tipping bait into the bucket. They will be constructed of four pods, tied together with webbing strapping in a 2x2 formation.

Bait-loading will occur in a similar fashion at the base site. Pods may be used as a loading platform, but existing or alternative options may already exist. We need to determine where base bait-loading would occur – ideally close to the bait storage area.

Each bait-loading site will have at least five personnel. A site controller will be responsible for overseeing the operation, safety, and communicating (via a headset radio) with the PM and pilots. Two bag-tippers will tip the bait into the bucket, passing the empty bags back to the two bag-collectors.

Prior to the helicopter arriving to pick up a bait-load, a suitable and pre-determined number of 25-kg bags of bait will be placed on the loading platform (exact number depends on the helicopter type – for the Bell Jet Ranger, 14 bags, or 350 kg would be standard). The bags will all be opened by removing the top string (they are not to be cut open as this causes unnecessary rubbish, which presents an additional risk to the helicopters). When the helicopter arrives, one of the bag collectors, who will have previously been delegated the task, will catch the bucket and guide it next to the loading platform. The bucket must have been allowed to touch the ground prior to anybody coming into contact with it, to remove any static electricity. Once the bucket is in place, the two loaders begin tipping bags of bait into the bucket and passing the empty bags back to the bag holders. When the bucket is full, the pilot, who is able to see the loading operation, will depart. Once the helicopter has left, the bags will be rolled up and packed into another bag and then into an empty pod for later counting and disposal. The next batch of bait bags will be then placed on the bait-loading platform and opened, ready for the next helicopter load.

The bait-sowing pilots will decide which bait-loading site they will load from, so as to minimise ferry time, though in most cases this will be predetermined on any given day. Top priority is for the bait-sowing helicopters to keep working as efficiently as possible, therefore the support helicopter transporting the

full pods to the bait-loading sites will have lower priority than the bait-sowing helicopters.

Baits and pods can be shifted around between remote bait-loading sites as areas are completed. Baits would be kept at remote bait-loading sites only when that site is likely to be in use. Unused bait remaining at the remote bait-loading sites at the end of each flying period will be protected from weather and stored thoroughly to keep it inaccessible to wildlife, by placing it back within one or more of the pods and sealing them up again using cordless screwdrivers.

An adequate supply of water will be held in 20 litre plastic containers at each remote bait-loading site to enable staff to wash prior to eating/drinking. A barrel continuing basic survival gear (tent, food etc) will be held at each remote bait-loading site in case of injury or inability to return to base.

Each field team operating at a remote bait-loading site will have a hand-held GPS with safety routes pre-installed in case of the need to walk out (eg due to sudden onset of mist or cloud which would make evacuation by helicopter impossible).

10.5.1 Remote Bait-loading Sites

Two to three remote bait-loading sites will be established around the island to minimise ferrying time of the bait-sowing helicopters during bait-sowing. It is vital to the outcome of the operation that these helicopters are used as time-efficiently as possible, so the ferrying of bulk bait will be conducted by the larger support helicopter, while the smaller bait-sowing machines maximise their daily bait-sowing opportunities. As the bulk of the bait will be dropped on portions of the island above the encircling cliffs, it is operationally logical to operate the bait-sowing helicopters from somewhere on the Base (ie above 600m), to minimise the costly gains in altitude required if operating from sea level. Usually only one remote bait-loading site will be in operation at any one time, though it is possible that two will operate simultaneously, in some circumstances.

The proposed bait-loading areas are:

- **The Settlement** – main bait storage area, and for Settlement Plain area and coastal cliffs
- **In the vicinity of Big Green Hill** – for areas of the Base up to the Peak, from Hottentot Gulch clockwise around to approximately Deep Gulch
- **Near Green Hill /Gipsy's Gulch** – for the area clockwise from Deep Gulch to Hottentot Gulch.

Treatment of remote coastal areas (Sandy Point, Stony Beach, Cave Point) will either be from the nearest remote bait-loading site, or from the main base, or other temporary options, dependent on weather and other circumstances. For some areas, such as the low-lying areas from Anchorstock to Stony Beach, it may be feasible to use tractors or trucks to move pallets of bait to the Burntwood end of the Plains, to minimise helicopter ferrying time between loads. Bait could be loaded directly off the trailers or back of trucks, or other suitable bait-loading platforms could be temporarily erected on site.

The precise number and location of bait-loading sites, will be determined

by the Chief Pilot, the bait-sowing pilots and the PM, in consultation with local people, at the earliest possible opportunity.

10.5.2 Bait Transport to Remote Bait-loading Sites

An AS-350 Ecuriel ('Squirrel') or Bell 205 helicopter or other helicopter capable of lifting between 750 and 1,000 kg will carry out the bait ferrying task from the base to the remote bait-loading sites. It is estimated that about 5-10 minutes per load, or an estimated 20-30 hours total ferry time, are required to get all bait needed at remote bait-loading sites to location, though obviously this will be spread out over many days or even weeks. A team of two staff will hook up the pods at the operational base, possibly using Rapid Attachment Harnesses (RAH's), ready for flying to the remote bait-loading loading sites.

Pods of bait will be ferried to the remote bait-loading loading sites as required, but always keeping at least one pod (approximately 2-3 bait bucket loads) ahead of the loaders working at the remote bait-loading site(s). Should the bait-sowing be stopped for any reason, the remaining full pods at remote bait-loading sites will be more vulnerable to weather conditions than those under storage at the main base. Therefore, not too much bait should be taken up at any time.

The support pilot responsible for bait-ferrying should endeavour to co-ordinate his arrival at the bait-loading sites with the loading of the bait-sowing helicopters; the bait-sowing helicopters have priority for the attention of the ground team. This will also ensure that the people required to unhook the pods are available and not otherwise engaged with bait-loading. Prior to arrival of the bait-sowing helicopter, the site controller will oversee the removal of one side of the pods for access to bait. This will require one or two battery-operated cordless drills. When a pod is empty, the side will be reattached and it will be flown back to base as a back-load.

10.5.3 Monitoring of Bait-spread

As it is impractical to physically check the bait spread over such a large area, and because the likely problem sites (ie cliffs) are impossible to check, no co-ordinated on-the-ground check of the bait-sowing will be carried out. However, whenever staff are moving through areas that have recently had bait sown over them, they will record their observations. In general, the operation will rely on the GPS printouts and the skill of the pilots to ensure that the whole island is covered.

10.5.4 DGPS System

Differential Global Positioning System (DGPS) hardware and software proven suitable for this purpose will be used and the chief pilot and bait-sowing pilots will be familiar with its use (as examples, New Zealand operations have used TrimFlight 3 and Ag Nav systems). At least one ground-based person (the IT technician) will be familiar with the selected DGPS system's use and basic fault finding. The helicopter DGPS system should be capable of downloading DGPS information into files compatible with

GIS software on the project team's PC or laptops on the island, so they can be used as a backup to upload and view flight-line records.

The precise boundaries of the treatment area will be defined at the start of the operation. The Chief Pilot and PM will fly the entire circumference of the island while recording their flight path using DGPS. The resulting boundary will define the operational area and will be used for the subsequent bait-sowing operations. Using this boundary rather than a previously obtained map ensures that the PM has the discretion to include for treatment all areas that he considers necessary (eg dubiously intertidal areas, rock stacks, etc) and reduces any possibility of incomplete bait coverage due to map errors, however small.

The aim will be that a full printout of flight-lines can be provided within one hour of completion of each daily bait-sowing application.

The DGPS to be used requires a fixed base station. The helicopter contractor will test the system prior to the operation, to gauge DGPS coverage of the island. This could be carried out by the PM or CP on a pre-operational site inspection or in the preparation days immediately before the drop, though the latter gives no time to fix any problems that may occur. However, it is expected that any on-site issues will be manageable by the Chief Pilot and IT technician.

If used, the portable base station will be installed and tested once again the day before bait application, and a back up base station should be on site in case of failure.

10.5.4.1 DGPS - quality assurance

Pilots flying the helicopters will be experienced in this type of operation. The information will be viewed on screen, and printed off at the end of each day. Assuming bait is falling when the DGPS is logging flights, the screen displays or printouts will clearly show any deficiency in coverage. Any such deficiencies can be rectified by repeat bait-sowing in the affected areas. Checking of bait-sowing will rely on checks of printouts only (this is now accepted as best practice).

The normal procedure would be for each pilot's data to be downloaded and examined at the end of each working day. Any potential gaps will be identified and re-flown if it is deemed necessary. This data will also help establish actual bait-sowing rates through correlation of area covered with quantities of bait used.

In addition to this, it may be possible and indeed desirable (to speedily identify and rectify any potential problems, particularly in the early stages of the operation) to download information throughout the day. This can be achieved without compromising the efficiency of bait-sowing by doing it when the bait-sowing helicopters stop to refuel. Whenever refuelling occurs, the GPS screen may be checked by pilot and the IT technician or PM, for potential problem sites or bait rate issues and if possible the data could be downloaded onto a laptop.

A backup GPS and gear for checking the software, as well as means to repair basic hardware problems will be taken to the island. The IT Technician will be trained on likely

problems. Direct phone contact with pre-identified experts could be established if required.

10.6 STRATEGIES FOLLOWING DOWNTIME

It is highly likely that there will be delays in the bait-sowing operation due to unsuitable weather or other issues. In theory these delays allow for movement of individual rodents from untreated to treated areas, where they may not encounter sufficient remaining bait to receive a toxic dose, hence they could survive the operation. To minimise the possibility of this, a 'buffer zone' should be treated following any delay in bait-sowing. The following strategy will be deployed upon resumption of bait-spreading:

- Flying the following day – no buffer areas required
- No flying for 1-3 days since last bait drop - three swathes (105 m) immediately behind the front should be applied, with 50% overlap, at the standard sowing rate.
- No flying for 4+ days - five swathes (175 m) to be applied, at 50% overlap, at the normal sowing rate.
- If there are any concerns regarding bait-sowing, the PM will consult with IEAG.

10.7 DAILY SCHEDULE OF ACTIVITIES

Every day will be treated as a bait-sowing day until declared otherwise. The PM and Chief Pilot (or delegates) will need to decide at dawn whether bait-sowing is possible. If not (eg strong winds or mist) the team can sleep in or carry out other work. If bait-sowing is possible, even if it is unlikely, the team will get ready – prepare lunch etc and be ready to go until officially stood down. The team must remain on standby around the base at all times (unless otherwise approved by the PM) as the weather may improve at any time and bait-sowing could start.

10.7.1 Pre-flying Activities:

- Latest weather reports received
- On-site weather assessment with pilots as soon as possible after daylight
- Confirm proposed action and logistic requirements (options will be predetermined the night before).
- Notify all team members of the day's proposed action
- Assign team members to tasks (will be pre-determined in most cases)

10.7.2 Bait-sowing Activities:

- Bait-loading teams are to get to the site and prepare for bait-loading. If remote bait-loading sites are being used, this may require use of support helicopter to get them there before bait-sowing helicopters arrive.
- Bait-sowing helicopters hook up to bait-buckets at base site, and go to the chosen bait-loading site, to begin bait-sowing (there will be bait reserves at remote sites to enable loading before the support helicopter arrives with more bait).

- The support helicopter and base loading team are to ferry more bait pallets to remote bait-loading sites as necessary.
- PM and pilot(s) review DGPS screen as required or possible eg during refuelling stops.

10.7.3 Post Bait-sowing Daily Activities

At the end of each day's flying operations, the following actions will be undertaken:

- Tallies of number of bait bags used
- GPS data downloaded and printed
- From the above, calculate bait used versus area covered, to verify baiting rates
- A CD of each set of data copied and stored separately
- Empty bait bags and pallets bundled and taken to storage (for eventual disposal)
- Empty fuel drums stored
- End-of-day review with all team members
- Possible options and priorities listed for the next day or next flying period

The accuracy of the day's baiting application will be assessed by key personnel (PM, APM, Chief Pilot and/or others) through analysis of the flight-line printouts as soon as the IT technician has downloaded these from the helicopters. Any obvious gaps or doubts in the quality of the bait-sowing will necessitate a follow-up application of bait on the next day or flying opportunity. The pilots can return to a predetermined area with a very high degree of accuracy using the DGPS system.

The operational team will hold at least two laptops for the downloading and storage of such information. There will also be a number of desktop computers available on the island, for use if necessary.

11 Special treatment areas

There are several areas that will require treatment in addition to the aerial bait-sowing. These are:

- All buildings within the main settlement
- Huts and sheds elsewhere on the island (Patches, Caves, Stony Beach, Sandy Point, etc)
- Caves of over 20m in depth
- Islets and rock stacks

11.1 BAIT IN & AROUND BUILDINGS

For ease of operation, and for ensuring a comprehensive coverage, the Settlement will have bait aerially sown over it. There will be pre-arranged signals (perhaps use of the 'gong') to signal to all people that bait-sowing will commence, and precautionary measures will have already been taken to protect children, dogs, poultry, etc. (see following section).

If aerial bait-sowing over buildings is deemed unacceptable, then the 'Option 2' baiting strategy provides an alternative– see relevant section.

Immediately after the baiting of a housing/hut area, selected local staff can:

- Remove all obvious pellets from backyards, roads and grass berms, and place these in crevices in nearby rock walls or amongst dense vegetation
- Inspect and clear all gutters of any bait

Priorities will be any area where children have unrestricted access, and public areas.

When bait is sown around or on any building, (the Settlement and outlying huts), bait will also be spread by hand under and in those buildings at the same time. Sufficient bait will be used to ensure adequate coverage. This bait will be put in foil or plastic dishes so that the take can be monitored and bait replaced as required.

It is envisaged that a set amount of bait (*ca*.20-50 g) will be hand-placed in:

- The attic space (if there is one) of every house and building
- Every work or office building, in every kitchen space or room in which a mouse could feasibly survive.
- Every room of the school
- Every garden shed or any other out-building
- Every garage
- Every other building (eg glasshouses) irrespective of whether it is currently in use
- Cellars and spaces under houses (if any)

The actual living spaces of each house may also have bait laid within them, if the owners are willing. However, there may be some resistance to this, particularly in the case of households where young children could gain access to the bait. It is considered that the actual living areas of each house are unlikely to hold rodents that permanently reside in that space

(these rodents would either be quite noticeable and/or would tend to move around enough to find baits laid in surrounding sites (sheds, attic, etc). However, all residents would be encouraged to have either baits or effective snap traps set at key locations within the house (especially in food storage areas such as pantries), and would be strongly urged to report and act upon any suspected rodent inhabitation of actual living spaces.

N.B. All houses, huts and sheds will need to be treated, including those of people off the island – access (eg padlock keys) will need to be provided by all building owners/ occupiers. Compliance with this need is expected in nearly all cases, but almost inevitably there will be exceptions, for whatever reason. If a hut is locked and no key is available, the lock may need to be broken to gain access, but this would be replaced at no cost to the owner as soon as possible.

At the completion of the operation, a measured amount of bait will be left in these stations with a map of all sites for future reference. A list of buildings is included as Appendix 2.

As each building is treated it will be marked off against a register or map of buildings in the settlement. A map of houses currently exists, and is available from the Tristan Government. This should be updated prior to the operation to include all new buildings.

11.1.1 Huts Elsewhere

These include all huts or sheds at:

- Potato Patches
- The Caves
- Stony Beach
- Sandy Point
- The Administrator's hut near Burntwood.

As each hut is treated, it will receive a 'mark' on the door or entranceway (probably a dab of paint or indelible marker pen), to indicate that it has been treated. In this way a double-check can occur to ensure that all buildings in each area are treated.

11.2 SMALL ISLETS

All outlying islets and rock stacks which have not been confirmed as rodent-free will have bait sown on them. Nightingale and Inaccessible and associated islets will not be treated. The helicopter sowing bait along the adjacent cliff areas as it works its way around the coast will treat all islets within 500 m of Tristan if possible. However, the standard bait-sowing bucket may be too inaccurate (or spread bait too widely) to achieve coverage of the pinnacle-like stacks. Some hand-baiting of these islets will be considered if bait-sowing buckets cannot provide adequate coverage.

The islets requiring bait coverage are:

- The Potato Patch Hardies (x 2)
- The Hillpiece Hardies (x 2).

The Sailshardy Rocks (off Stonyhill Point) are non-vegetated and often awash. Consequently, they are considered very unlikely to hold rodent populations. Nevertheless, this will be re-examined during the operation and bait will be sown on them if considered necessary.

No other rock stacks or islets are known.

11.3 CAVES

At least six caves have been identified that may require specific hand baiting, as they are feasibly large enough to sustain individual rodents within them, and will not be adequately covered by the aerial sowing of bait. Any cave that is more than 20 m deep should have bait hand-laid in several locations within it. Caves of lesser size or depth should also be identified and examined if possible before or during the operation.

The caves identified so far are:

- Top of Hottentot Gulch
- The Devil's Hole (Knockfolly Ridge)
- Below Hillpiece
- Between Cave Gulch and Round Hill
- North of Round Hill
- Between East Castle and Nellie's Hump

Map references are included for these caves in Appendix 2.

Caves should be treated at a similar time (the same day or 1-2 days after) to the aerial treatment of the surrounding area. Baiting of caves must occur for the first baiting round, but will be of lower priority during the second round, though a check and re-bait (if necessary) should preferably occur. A small quantity (c. 20g) of bait should be placed in discrete piles in dry locations every 10 m or so into the cave, as far in as possible, up to 100m. In areas of rock rubble or multiple deep fissures, additional small amounts could be hand-scattered.

The latter three caves on the above list are of relatively small size, and may not require baiting, but are unseen by the author, so should be considered for treatment unless otherwise decided by a rodent eradication expert.

If any further caves are located, they should be added to the list. The Conservation Officer should be given the task of consulting with all people with experience of the remote areas of the island, in order to obtain knowledge of any caves currently known but not already on the list.

Each cave in itself presents only a very small risk of holding a rodent population that could not access bait from an aerial drop. It is not considered critical to the operation that all caves are located, but highly desirable that as many as possible are identified and treated to reduce this risk to the lowest practical level.

Prior to the operation, searches for unknown cave systems should be actively encouraged when people are travelling across the island for other purposes. Pre- bait-sowing helicopter flights (to familiarise pilots to the island, to set up DGPS or VHF repeater stations, etc) could also be utilised for close-order aerial views of likely cave areas.

12 Surplus bait

It is calculated that about 150 tonnes of bait are required to cover the whole island twice, including a double run around the cliffs. As *ca*. 200 tonnes of bait will be taken to the island, there is a large safety margin of bait. This is enough bait to treat the whole island, without any gaps under all reasonable scenarios, with an additional 33% extra to allow for any necessary overlaps or re-treatments due to delays, washouts etc.

The intention is to spread all of the bait taken to the island, unless the weather later in the trip prevents it. Once the entire island has been treated to standard, the priority for using the remaining bait will be:

- Areas where there was any doubt on bait coverage, bait weathering, or very wet areas
- Areas where snow has lain for extended periods during the bait-sowing operation
- Large and/or steep-sided gulches
- The rubbish dump area
- Sewage out-fall area
- Cliff areas – both coastal and inland
- Non-cliff coastline

It is possible that not all bait will be spread before it is necessary for economic or logistical reasons to cease helicopter flying. In extreme situations, it is also possible that a significant amount of the bait may not be dropped (eg major accidents/ breakdowns with helicopters, or prolonged bad weather) before the successful completion of the operation is seen as unobtainable. The decision to stop before dropping all the bait would need to be discussed with the steering committee, and with the IEAG who could advise on the issue.

Options for any unused bait include:

- Disposal in the Tristan landfill
- Storage on Tristan for future rodent control or rodent quarantine measures
- Donation to Falklands or elsewhere for smaller scale rodent eradications
- Donation to St Helena or elsewhere for rodent control measures.

If the rodent eradication operation on Tristan da Cunha is completed before the proposed mouse eradication on Gough Island, it is possible that surplus bait could be held for subsequent use on Gough. Although this could be considered at the time, this option is not recommended, as the bait used for such a large-scale eradication should be as fresh as possible to minimise bait deterioration and palatability issues.

13 A potential alternative for baiting sensitive areas ('Option 2')

One of the stakeholders (particularly the Tristan public) may consider it unacceptable to have bait aerially sown over the Settlement and/or over livestock areas, because of any unresolved or unalleviated health concerns.

If so, the options available are either to abandon the project completely, or to employ ground-based operations in 'sensitive' areas, through a grid of bait stations. The latter option is discussed here as 'Option 2'.

Option 2 would entail any designated 'sensitive' area having a system of bait-stations established in lieu of aerial bait-sowing. For all other parts of the island, aerial bait-sowing would occur as prescribed in previous sections. While feasible, the added cost of labour and greater logistical considerations means that ground-baiting would have to be limited to a relatively small land area. As an indication, one full-time person would be required to service the bait-stations within each 10-15 ha of ground-based treatment. With the associated extra supervision and equipment required, ground-based baiting is estimated to cost an additional £300-500 ha^{-1}, depending on the scale of the area and other variables, over and above the cost of treating the same area via aerial drops.

A major downside of potential use of bait-stations is the apparent behavioural interactions between rats and mice. Rats will tend to dominate the bait-stations, and some mice will be prevented or deterred from entering the bait-station, potentially even after the rat(s) has died from the bait, as the rat scent or mouse behavioural inhibition may persist. This has major implications for the probability of achieving mouse eradication.

The use of bait-stations will probably have only relatively minor implications for potential rat eradication, namely:

- Requiring a more lengthy lead-in time to set up bait-stations well in advance of loading with bait, to overcome potential neophobia issues.
- The remote possibility of dominant individuals monopolising the bait stations to such an extent that subservient individuals permanently avoid them.
- The spacing of bait-stations is insufficient in prime commensal habitats - eg food storage or disposal areas such as the rubbish dump, poultry pens and food storage areas, residential food storage areas - to cater for the minimum home range of some individuals.

However, use of bait-stations is likely to substantially reduce (but not eliminate) the chance of successful mouse eradication. Use of bait stations should therefore only be considered with this in mind.

Bait-stations would need to be established on a maximum 25 m x 25 m grid to adequately target mice, meaning that at least 16 bait-stations

ha^{-1} would be required. To cover the Settlement area alone, it is estimated that 500 bait-stations would be required. These could be the commercial variety, which while being more 'secure' are expensive and unproven in eradication operations, or could be, as used in many NZ eradications, a short length of small diameter plastic drainage pipe pegged into position.

To overcome potential neophobia of rats to bait-stations – a behaviour known to occur, all bait-stations should be installed several weeks before baiting commences. This may require a rodent eradication specialist to travel to the island before the main party, to ensure that the laying out, numbering and mapping of the grid system of bait-stations has been completed satisfactorily.

The use of bait-stations would require at least three extra personnel to service them for the duration of the operation, and would require a daily intrusion of these staff though every fenced yard or private surround of every house in the settlement. Despite this, the use of bait-stations within the settlement is a possibility, especially if employed in conjunction with the proposed hand laying of bait within all houses and sheds. Further hand laying of bait in areas largely inaccessible to children or pets (eg within rock walls or in areas of dense flax) could improve the prospect of all mice being able to access and consume a lethal dose of bait.

In view of all this, the use of bait-stations within the settlement is an option, but one which is considered to give a greater probability of operational failure (especially for mice) than an aerial broadcast. Therefore, it should only be considered if the Tristan people consider aerial sowing of bait is unacceptable after full consideration of the pros and cons of both options.

Bait-stations would reduce risk to children, pets and livestock but would not entirely eliminate it, as it would be possible for bait to be manipulated or knocked out of the covers, and it would almost certainly be dragged out by rodents in many instances.

Logistical constraints mean that only a small proportion of the island could be baited by hand, and therefore bait would still be available in aerially-treated areas immediately adjacent to hand-treated areas. Therefore risks from aerial-sown baits could at best be reduced through ground-based baiting, but never completely eliminated.

Dogs and other scavengers would still be at the same level of risk of secondary poisoning from consumption of dead rodents, regardless of the method employed to spread the bait.

It is possible that bait-stations could also be used for areas where livestock are contained, instead of the proposed rotational movement of livestock ahead of aerial sowing of individual paddocks. However, the logistics for such a ground-based operation are formidable. To sustain the entire Settlement Plain livestock population over the duration of the baiting operation would require at least 100 ha of pasture (possibly more), or 1,600 bait stations, each needing to be checked and replenished near-daily over a period of 2-3 months. It is considered that a single fit person

could check a maximum of 200 bait stations per day, meaning that more than 700 additional person-days could be required for just this one area of pasture. If other pasture areas (eg the Caves, Stony Beach) also needed bait-stations, the labour and material costs begin to soar. While most of the work could be undertaken by local labour, it would be very important that an eradication expert is assigned to supervise this 'operation within an operation', and that the PM can completely delegate this task to an experienced and reliable person.

Hand-treatment of any areas also adds operational constraints, because borders between areas of hand- and aerial-treatment need to be very carefully established, ideally with a doubly-treated buffer zone between them to eliminate any temporal or spatial gaps in baiting. Such 'artificial' boundaries would be difficult for pilots to see and/or for the pilots to ensure that the bait coverage gets to, but not over, the boundary.

14 Planning

14.1 INFORMATION FLOW

All team members are to receive regular updates on the project preparation and what is expected of them, from the PM. They are to be aware of their responsibilities prior to departure. If any team members are unsure of anything they are to contact the PM who, if relevant, will then inform all team members of the situation, or if specific to the person concerned will inform just the person involved. Team members will also receive a copy of the operational and safety plans so that they can raise any issues prior to departure.

Major stakeholders will be identified, and will be kept informed of developments in the project via newsletter-type e-mails at regular intervals from the PM.

Updates on the baiting operation will be provided to major stakeholders as as progress is made and/or new information becomes available.

14.2 AUDIT

The IEAG (or similar group of eradication experts) should carry out a review of the Operational Plan. Later, it should also conduct an audit of operational readiness within the two months prior to ship departure. This will double-check that everything that is required for the successful completion of the operation is in place. The results of this audit will be sent to the steering committee as well as the PM, as confirmation that the operation is ready to proceed. If anything is found to be unready, or unsatisfactorily addressed, the IEAG will advise the PM, who will indicate in writing to the steering committee and the IEAG what is to happen to rectify the outstanding issue(s).

The Tristan Government should also appoint representatives to consider the preparedness of the island and islanders for the operation, especially in terms of providing the labour, logistics and general support required for the eradication. They should also ensure all concerns have been addressed in relation to preventative or remedial actions to protect human and animal health.

14.3 LOGISTICS

14.3.1 Work & Logistics in New Zealand

It is probable that some of the project team (especially bait-sowing pilots) will reside in New Zealand. It is also probable that the bait to be used will also be produced in this country. Therefore, much of the pre-operational planning could occur here.

Flights, accommodation, vehicle hire, taxi or mileage will also be necessary for such purposes as:

- Visits to ACP relating to bait production
- Collection and couriering of bait samples to analytical labs
- Meetings with the IEAG
- Meetings with helicopter pilots
- Bait calibration trials.

14.3.2 Work & Logistics in Cape Town

As the probable departure point for Tristan, most aspects of the operation will at some point have to be channelled through Cape Town.

Some requirements are:

- Accommodation for PM and CP while based at Cape Town
- Accommodation for transiting staff
- Selecting and confirming lease of a covered, secure storage area for bait
- Coordinating/supervising the stevedoring, warehousing, security etc of supplies
- Communications/meetings facilities
- Vehicle hire

Some key agencies and stakeholders are located in Cape Town, including:

- Table Bay Marine
- Department of Environment and Tourism (DEAT) and South African National Antarctic Programme (SANAP)
- Premier Fishing
- University of Cape Town

14.3.3 Support in UK

It is presumed that major funding agencies will be based in the UK. As such, it is possible that the Steering Committee and administration for the project will be based there. Key project staff (especially the PM) will occasionally need to meet with funders and UK-based stakeholders.

While it may be possible for the administrative requirements of the project to be undertaken within the existing structure of a stakeholder agency, it is possible that the project would place a significant additional burden on administrative staff. It may be necessary to re-allocate existing duties and/or employ additional staff to ensure the project has the reliable administrative support and the guaranteed priority that it requires.

There will be some requirement for meetings of the Steering Committee and senior project staff, requiring meeting facilities (and/or video conferencing facilities), and local transport and accommodation will be required.

14.3.4 On-island Operational Support Requirements

On Tristan itself, the operation will rely heavily on the co-operation of the local population, for various aspects including:

- Accommodation
- Food and catering
- Helicopter storage, fuel depot and workshop
- Boats (unloading ship, possible transport to remote areas)
- Vehicles and trailers, to transport either or both personnel and equipment
- Heavy machinery, tools
- Office space, office equipment
- Communications
- Labour
- Contingency options

These will be covered in specific sections below.

14.3.4.1 Accommodation

Up to 12 people will need to be temporarily housed on the island. It is important that these, or at least the decision-making team, should be housed together for efficiency of operation (eg co-ordination of meal and work times, briefings etc). The rental of Darwin House or similar is desired.

Some staff (eg the aviculturalist or veterinarian) could be housed separately as their roles are well defined and do not under normal circumstances require a daily co-ordination with the bait team.

14.3.4.2 Food supply

All food will be provided on the ship for the duration of the journeys, as part of the ticket price or contract.

Bulk food for the project team while on Tristan will be purchased in South Africa and sent on the bait ship. This will be co-ordinated by the PM through Table Bay Marine, who are very familiar with supply of such goods for Tristan and other remote islands. Additional items can be sourced as required from the island supermarket.

The use of a large freezer on the island to store bulk frozen goods will be sought.

A cook (or roster of cooks) shall be hired to provide the main (evening) meal each day for the bulk of the team, and also any other catering requirements (eg to make bread).

Any team members boarded privately will have meals provided through that arrangement.

14.3.4.3 Office space and equipment

An effective office and communications room is needed for reliable daily communication with managers and experts on the mainland (eg weather forecasters). The requirements are minor, and can probably be set up in the lounge/living room of the accommodation unit. This would also serve as the team briefing room.

Equipment required includes: one desk-top computer, the PM's and APM's lap-tops, a printer; a large whiteboard or two; office stationery; laminated and paper maps; satellite phone/fax; and VHF radio for communications to helicopters/field staff/ Tristan government officials.

14.4 COMMUNICATIONS

The PM will purchase a laptop capable of receiving global e-mail communication, as from the start of the PM contract. When the PM begins work in Cape Town, a global roaming mobile phone should be available. A satellite phone will be provided for use on the ship and on Tristan.

The APM shall also be provided with a laptop, and all information stored on the PM's laptop will be transferred to the APM's computer as well. Critical data will also have hard and disk copies made.

The satellite phone/fax will be set up in the office. It will be available for other staff on a cost basis. The IT technician is responsible for setting up

the phone/fax. An e-mail modem should also be set up so that the daily weather forecast can be sent this way, rather than by fax.

The PM and the Administrator's office will be provided with a copy of every team member's personal contact details as well as a list of likely emergency contact numbers.

For communication on the island, 4 x Tait Orca or similar VHF hand-held radios will be taken down, if suitable units are not already available on the island. These will have frequencies that allow communication with the helicopters, the ship(s) and the Tristan government. Two headsets will be provided for use by the site controllers for unloading. For bait-loading, each site controller will have a radio, as will the PM and base crew.

A portable mini repeater will taken down (if necessary – this is to be confirmed through testing in the field) to ensure radio communication over the whole island. The frequency that will be used for unloading and for the drop is to be confirmed.

A satellite phone is also available at the Tristan Government offices, in case of loss or malfunction of the project team's phone.

One laptop and the project satellite phone will be available to all team members for personal phone and e-mail communications while on the island, at their personal expense.

It is important for the project's efficient operation that the satellite e-mail system is high speed, capable of receiving sizeable attachments and is reliable. It should also stand alone from the current systems in place on the island so as not to overburden or unduly inconvenience either party.

14.5 FIELD EQUIPMENT REQUIREMENTS

For bio-security reasons, and to ensure adequate quality and quantity of equipment is obtained, all field personnel involved in the project will be provided with new items of field kit considered necessary for the work on the island. This will include wet weather gear, hiking and/or rubber boots, general outdoor clothing, sleeping bags, daypacks, flashlights or headlamps, eating utensils (for camping), Thermos flasks, personal first aid/survival kits, etc. The requirements (quantity/types etc) will be organised by the PM or delegated agent.

Safety clothing and equipment will be provided for all personnel working with the bait or in and around helicopters.

Batteries (possibly rechargeable, with rechargers) will be provided for field use applications (flashlights, GPS units, etc).

At least two hand-held GPS units will be purchased (or made available) for use by ground teams.

Also required will be laminated field maps, field notebooks, and two first-aid field-kits (one for each remote bait-loading site).

Some items potentially necessary for fieldwork are probably available on the island either through the Island Store (eg re-sealable plastic bags, rubbish bags), or through the Natural Resources Department (small gas cookers, camping equipment). It

would be necessary to do a careful audit of these - what is there and what is working well - before making the decision not to bring essential items down on the boat.

14.6 BIO-SECURITY & QUARANTINE

To ensure that the operation itself causes minimal threat to Tristan's bio-security, the transportation of all personnel, equipment and supplies will follow an approved quarantine process. This may be Tristan's own bio-security plan (if prepared and approved by then), but if not then a standard quarantine (bio-security) prescription as laid out in a New Zealand Department of Conservation Bio-security Action Plan (eg the Southland Conservancy Island Bio-security Plan) will be adhered to where relevant. Details will include the briefing of all team members, food and equipment stored in rodent proof containers, bait-stations aboard the ship, etc.

The bait storage shed in Cape Town, and all holds in the ship, are to be fumigated prior to use – protocols to be confirmed but should include spraying with a pyrethrum-based spray between one and four weeks prior to stacking. The ground (concrete) areas on which the full pods will be stored in the warehouse will be sprayed prior to the arrival of the pods. All non-pod pallets will be sprayed prior to loading.

14.7 RUBBISH

Rubbish on ship will be disposed of as per the standard operating procedures for the ship.

Rubbish generated on the island will be incinerated. Bait bags will constitute a major source of rubbish, and will either need temporary covered storage and/or daily incineration.

For the period immediately prior to, and for the duration of, baiting operations, locally generated rubbish should be fully contained until incineration to ensure that it does not provide a rodent food resource. Extreme care should be taken in the disposal of all food waste immediately before and during the baiting operation. Options for food waste disposal are to be discussed with Tristan officials. This may include the provision of a fully sealable plastic bin for every household, and the daily collection of such for appropriate disposal (complete incineration, complete deep burial, or disposal at sea).

14.8 PUBLIC NOTIFICATIONS

14.8.1 Tristan Public Notification

The Tristan public will be kept fully informed as to the state of the operation, and specific requirements for their co-operation, through use of regular verbal updates and/or through posting of notices on the public notice-boards currently in use on the island. The PM or delegated team member will pass on information as and when possible, either via Tristan government officials or through advertised public meetings. Scheduled meetings will be held with key officials and the general public at key points of the operation, eg immediately prior to commencement,

and when baiting is due to occur in or around human-occupied areas.

The Conservation Officer, the Natural Resources Department and the Administrator shall be official conduits of information if necessary, and shall highlight any weakness or failure in the public notification system to the PM, so that it may be rectified.

14.8.2 Notification to Visitors

Entry to Tristan is by permission only, and entry permits should be restricted as much as practical for the duration of the operation.

Information will be provided to tourist operators, researchers and any other visitors about the presence of poison bait on the island and the required precautions. While the bait should have broken down prior to any subsequent tourists visiting the island, information will be provided to tourists, in most cases through the tour operators or local guides, about the operation and informing them of the risk. An information sheet on the risks is to be prepared by the PM.

14.8.3 Media

The potential for positive public exposure is probably as high as any restoration project yet undertaken. The scale, benefits and cost of the project are of such magnitude that information about the project needs to be given to the public in a positive manner. The project will be a showcase of leading edge conservation restoration. Accurate reporting will therefore be of the highest importance. The risk of failure could lead to public criticism, particularly over the use of poisons and any non-target species losses. It is important to have positive media coverage of the project, but at the same time, managers need to be careful not to over-sell the probability of success.

This project has potentially sensitive aspects to it (eg use of aerially-sown toxins in the presence of a human population). It may therefore be more desirable to focus media attention to the project only at a stage when the field operations have been completed and/or when the project has been deemed successful, rather than in the early stages of the project. This would be at the discretion of the major stakeholders in the project. Nevertheless, a Media Spokesperson needs to be appointed from the initial stages of the project to deal with any media interest, negative or otherwise, and to gather and prepare information for later release.

Important background information documents include Angel & Cooper (2006), Brown (2007), Fisher & Fairweather (2005), Tristan NRD/RSPB (2006), IEAG (2005), and Sommer (2006).

Any media releases are to be co-ordinated by the designated Media Spokesperson and approved by the steering committee. The PM shall have the opportunity (before the release of the statement) to view a draft to correct any factual errors or potentially misleading statements.

As the Media Spokesperson receives updates, they are to discuss these with the Steering Committee and decide what they deem newsworthy. They are then to ensure that the information is checked for factual correctness. If

the opportunity arises, (eg fishing vessels departing Tristan), exposed films and video will be sent back to the Media Spokesperson, who will then discuss the suitability of using that material for media releases.

It is unlikely that any media personnel will be present on the island during the operation, and from an operational viewpoint, coping with media requirements would be an added imposition in an already challenging programme. A project team member or Tristanian will be assigned the role of photographer and will be taking photographs of all aspects of the operation. Some video footage should also be obtained, and again, a project team member or Tristanian will be allocated this task.

Fact sheets and press releases will be required at several stages of the project.

The main media opportunities will be:

- Prior to the expedition leaving
- Upon return to Cape Town
- At or after an official debriefing (in the UK?)

The Media Spokesperson is to notify relevant media prior to the expedition departure from Cape Town and/or prior to any other significant events eg upon the team's return. This could be an opportunity for the funding agencies or Steering Committee to introduce the project to the public. The key messages are:

- The benefits to Tristan and the threatened species there
- Opportunities for species' recoveries and re-introductions
- It is one of the largest operations of its kind ever attempted, and possibly the most complex and logistically difficult
- The project is based on sound and proven techniques, with several islands having recently been successfully treated in a very similar manner
- The weather risks are significant; operational risks have been reduced by planning to use three helicopters, a 33% bait contingency, and multiple bait-sowing strategies on this operation
- The team will be guided by advice and staff from New Zealand, which is leading the world in island restoration;
- Undoing the damage caused by rats
- Removing the last mammalian pest species
- A possible focus on some of the personalities involved
- The Tristanians have strongly supported this eradication project
- Support has been received from RSPB, OTEP, University of Cape Town, and others.
- How the toxin works (particularly in relation to non-target species)
- Cost and cost benefits.

When the operation actually begins, there is an opportunity for operational staff to update the Media Spokesperson with the progress of the operation. Key messages could be:

- The island will become one of the largest vegetated areas in the world free of the influence of introduced predatory animals

- The potential short-term negative effect on non-target species will be considerably outweighed by the long-term gains for species and ecosystems
- The ccomplexities and difficulties of weather and other factors on the operation
- The use of modern technology (GPS) in conservation management

Following the conclusion of the baiting (if successful), and return of the team to Cape Town there could be an opportunity for a formal media conference outlining the operation to date. The Media Spokesperson is to notify relevant media prior to return.

Key messages will be:

- Mission accomplished (now it's time to 'hurry up and wait' for confirmation of success)
- The risks to non-targets and what they actually were – if known by then (most should be apparent)
- The safety of the operation.

A further opportunity arises when (if) the eradication is declared successful. This could include a final project update (summarising any noted response of wildlife on the island, and opinions of Tristan islanders). It is also an opportunity for a representative of the funding agency or Steering Committee to formally acknowledge the efforts of the project staff and the Tristan islanders, etc.

The key messages will be:

- That the conservation gains significantly outweigh the cost of the operation (£2 million-plus over several years and the biological cost)
- On-going quarantine is required to protect Tristan and other islands from the effects of rodents and other pest invasives.

A detailed report on the project is required upon its conclusion (ie upon confirmation that the island is rat- or rodent-free). Such a report should be in a published journal to make it accessible to a wide audience.

15 Health & environment

15.1 OPERATIONAL SAFETY

The health and safety of the project staff and residents of the island is a critical concern for the project management team. The isolation of the island means that any risk may be compounded by the time required for evacuation of an injured or ill person. Even minor injuries or illnesses can develop into more serious issues as a result of specialised medical attention not being available.

A Material Safety Data Sheet for Pestoff 20R brodifacoum rodent pellets is available, and copies will be held by the PM and other key staff for dissemination as necessary. More detailed advice is also available for veterinary and medical specialists (eg Shlosberg & Booth 2006).

A Health and Safety plan will be prepared for this project by the PM. It will be approved by the Steering Committee prior to the expedition leaving. The Safety Plan must detail all significant hazards that could cause serious harm.

The following documents that contain health and safety guidelines will be used for the plan:

- New Zealand Department of Conservation's Handling of Pesticides Standard Operating Procedure
- Helicopter Contractor's safety guidelines, or failing that, the New Zealand Department of Conservation's Southland Helicopter Safety Plan
- New Zealand Department of Conservation's Health and Safety Manual.

All team members must be given the plan to read and understand, and must sign that they have done so. A copy of every team members' personal contact details, medical conditions etc will be held by the PM and the Tristan Administrator. At least half the personnel will be required to have a basic outdoor first-aid certificate. The PM will liaise with the Tristan doctor as to the standard emergency procedures on the island, and any special requirements for the project team.

A member of the project team will be designated as Safety Officer, who will be responsible for dealing with any safety issues that may arise on the island.

The daily team briefings will be used to raise and/or resolve any operational safety issues.

Wider safety issues, such as those relating to the Tristan public, will be discussed at scheduled public meetings, and with government and health officials as required. The necessary or desired measures to protect the safety of the Tristan public will be pre-determined and pre-approved by the Tristan public. This is a fundamental pre-requisite for the operation.

As safety is the responsibility of all team members, they must report anything they deem unsafe to either the Safety Officer or PM. The Safety Officer or PM will discuss the issue

and must take appropriate action: either removing or sufficiently reducing the risk, or explaining to the relevant person why they do not believe it is an unacceptable risk. These actions are to be recorded in a log. No significant hazards are to be allowed to continue.

Health and safety requirements include:

- A Health & Safety Plan to be prepared
- The Tristan government and public 'sign off' on the proposed measures and actions to be taken to protect their safety
- Safety Log / Accident Register to be established and kept on site in the Operations Room
- All personal protective equipment purchased
- First-aid kits purchased
- A supply of water, and a barrel containing first-aid kit and basic survival gear - tent, food etc for each remote bait-loading site.

15.1.1 Safety Briefings

Upon arrival at Tristan, there will be pre-departure briefings on the ship for the project team. These are to include the safety issues for the unloading of the ship and likely issues for the first day.

The PM will pre-organise a public meeting, and public information packs, to convey necessary safety information to all Tristan Islanders. Much information will have been pre-circulated amongst the Tristan population as part of the planning and approvals process. Additional meetings will be called, or information sent out, as necessary throughout the operation, as various issues or phases arise.

For the project team (including any Tristan Islanders involved), a safety briefing for bait sowing will be given as part of the operational briefing on the first day, with tasks allocated as per this plan. A debrief will be held after each day's bait sowing, and an additional operational briefing will be held before each day's bait drop.

15.1.2 Safety Equipment

All safety gear supplied, including overalls, rubber boots, facemask, goggles, earplugs and back supports are to be worn when handling bait.

An adequate supply of water will be held at each remote loading site to enable staff to wash prior to eating/drinking. A barrel continuing first-aid kit and basic survival gear - tent, food etc will be held at each remote loading site in case of injury and/or an inability to return to base.

The respective pilot is responsible for briefing those personnel flying around the island by helicopter on their responsibilities (eg refuelling and safety issues).

15.2 HUMAN HEALTH

15.2.1 Brodifacoum Toxicity

The risks of brodifacoum bait to humans are outlined in the Material Safety Data Sheet, and in Fisher & Fairweather (2005).

Brodifacoum is toxic to humans, but in doses much larger than people could feasibly be expected to ingest as a

result of this operation, unless the bait was deliberately ingested in quantity. It is a slow-acting toxin, and usually takes several days to take effect, during which time diagnostic symptoms usually become apparent.

The greatest risk is through ingestion, with secondary risks through inhalation of dust and absorption through the skin. The latter two are only likely to apply to those people repeatedly handling the bait and bait bags (ie the bait loaders) so with protective masks and clothing the risks here can be minimised.

People at greatest risk include those suffering from anaemia, liver disorders, or currently taking prescription anticoagulant medicines (for heart or blood related disorders).

However, with appropriate prior education it is highly unlikely that any cognitive person would encounter enough bait to acquire any ill-effect. The greatest risk therefore occurs to babies and toddlers who may not appreciate the hazards and may intentionally sample the bait. The health risk associated with occasional tasting or 'mouthing' is considered to be relatively low – greater risk would only occur if the baits were actually swallowed, and probably only then if appreciable quantities were eaten. A retrospective review of numerous instances of children aged six or less that unintentionally ingested a single dose of brodifacoum baits found no instances of major effect or death (Shepherd *et al* 2002, cited in Shlosberg & Booth 2006).

A risk factor that applies to all residents occurs through the possibility of consuming meat products that contain residues of brodifacoum. Actions can be taken (eg temporary bans on the killing and eating of local meat after the baiting operation) to reduce this risk avenue to extremely low levels.

There is no clearly defined LD50 (the lethal dose to kill the 'average individual' or 50% of the treatment population) for humans, but figures available suggest an LD50 of 0.25 mg of brodifacoum kg^{-1} of body weight. Therefore, an average 15-kg child would have to consume 187.5 grams of bait within a relatively short time frame (several weeks) to receive such a dose. The longer the timeframe over which the ingestion occurs the more bait would be required to receive a dangerous dose, as natural breakdown of the toxin occurs relatively quickly in the body, and most brodifacoum is excreted in normal bodily processes. The half-life of brodifacoum in blood is 16-36 days for humans. However, brodifacoum can 'bond' to organs and body tissue and persist for some time (several months). This in itself is not significantly harmful unless additional doses re-elevate the quantities to toxic levels.

A small adult of 60 kg would require 750g for an LD50 dose. However, there is apparently a wide variation in susceptibility between individuals. As little as 1-2 mg of brodifacoum (equivalent to 50-100 grams of bait) can produce sub-lethal symptoms in adult humans.

An effective antidote (Vitamin K1, phytomenadione) for brodifacoum exists, but it is not always a simple treatment – it may require repeat doses and regular intensive medical monitoring to 'match' the level of antidote with the level of toxin

present. It appears that some testing for brodifacoum residues is potentially possible on Tristan (further specialist medical/toxicology advice will be required on this), but if feasible, such testing facilities should be on site during and after the operation. The standard test for humans and for animals is 'prothrombin time (PT) testing', which gives a clear indication of the physiological effect of anticoagulants even if clinical signs are not apparent. The PT test is relatively straightforward, requiring standard blood-sampling and laboratory facilities and a centrifuge.

If such detailed testing is not possible on the island, initial Vitamin K treatment can occur there to stabilise an individual while emergency evacuation is arranged.

If ingestion was recent, initial medical treatment can also include gastric lavage (stomach washing), activated charcoal and cathartics to negate the toxic effects and/or reduce absorption into the body.

Brodifacoum has a very low solubility in water. It is extremely unlikely that brodifacoum will be dissolved into water supplies. Numerous tests in actual New Zealand aerial baiting operations of a similar nature have practically demonstrated this. The contamination of water to any significant level is therefore considered to be a fear rather than an actual risk.

It is pertinent to note that anticoagulant toxins for the on-going control of rodents have been in use on Tristan for some years with no apparent ill-effect. However, the quantity present at any one time within the environment has been significantly less. It is also pertinent to note that the concentration of toxin within the Pestoff 20R baits is 20 parts per million (ppm) whereas many commercial forms of rodenticide have the significantly higher concentration of 50 ppm.

15.2.2 Human Health Mitigation Measures

Regardless of the actual risk, the perceived risk should be addressed as far as practical to minimise the concerns of the Tristan people.

15.2.2.1 General education

All people on Tristan (including school-age children) would be fully briefed on the potential hazards relating to brodifacoum use, including the main threat vectors (see Table 4, below) and how to minimise the risk to individuals.

15.2.2.2 Protection of small children

Small children of an age not able to comprehend the risk of handling or eating baits can be protected to some degree through:

- Strict parental supervision during the time period when baiting occurs in the settlement area
- Immediately after baiting occurs in the settlement, the removal of any bait that falls in highly visible areas and/or areas where children have ready access (eg backyards, roads and verges). These baits would have to remain in the immediate area, but can be placed in sites unlikely to be accessed by young

children (eg in rock walls, dense flax or other vegetation, etc).

If these measures are not considered adequate, then consideration could be given to:

- Use of bait-stations rather than aerial broadcast in the Settlement area ('Option 2')
- Addition of a bitter additive - 'Bitrex' - to the bait to deter any mouthing or eating of bait
- Temporarily removing the young children and caregivers from the island while the baiting occurs.

15.2.2.3 Adding Bitrex to bait

'Bitrex' is an additive normally added to rodenticides to reduce the potential for consumption by humans. Bitrex is a compound that is apparently undetectable to rodents but which creates an extremely bitter taste to humans, thereby reducing the possibility of accidental consumption or 'testing' of bait by children especially. It is not normally added to Pestoff 20R baits, at the request of the purchaser, as there has been some debate as to whether it is undetectable to *all* rodents within any population. If some rodents (even a tiny percentage) can detect it and avoid eating the bait as a result, any total eradication becomes less likely. Therefore as a non-essential ingredient from an eradication perspective, its use is normally avoided to minimise such risk, no matter how small this additional risk is considered to be.

However, it is known that some earlier eradications of rodents have occurred in New Zealand with bait incorporating Bitrex, so there is some level of proven success with such bait, though not in more recent, larger-scale operations. Bitrex could therefore be added to any bait destined for Tristan. This would greatly reduce the risk of young children consuming any meaningful amount of bait, but this would be at the unquantifiable (but probably small) additional risk of operational failure through addition of a relatively less proven bait ingredient.

15.2.2.4 Temporary removal of residents

For anyone whose concerns cannot be addressed to their satisfaction (particularly parents of young children, and anyone with a medical condition that may be exacerbated by possible contact with brodifacoum), an option is that they could be offered temporary removal from the island. This would be on the return journey of the ship that delivers the bait and project team, on which they would travel to and stay in Cape Town to return on a later ship. This would be at the project's cost.

15.2.2.5 Option 2 for bait dispersal

The second option for baiting in key areas (ie use of bait-stations) will *reduce* but not *eliminate* the potential for humans to be affected by the baiting through accidental, deliberate or secondary ingestion of toxin. For example, bait may still be attractive and available to inquisitive toddlers.

15.2.2.6 Water supply options

Because of its nature, brodifacoum is unlikely to enter water supplies in any soluble form, but based on experience

in New Zealand the potential contamination of water supplies remains a somewhat emotive area of concern for many people. In acknowledgement of this, some action to protect the 'purity' of water supplies should be considered. If possible, Tristan PWD could adjust the water system prior to arrival of the project ship, to save time and overall costs. Options include:

- Once bait-sowing begins in the Settlement and/or water catchment, supply bottled water or bulk water from ship for drinking/cooking
- Pre-store a bulk supply of water from the normal island source in water tanks, sufficient to meet needs until bait risk is reduced
- Place filters/screens in the intake of the current water supply to prevent bait pellets getting in
- Any person unduly concerned could temporarily vacate the island on the ship returning to Cape Town, for the duration of the baiting operation. Travel to and from Cape Town, and accommodation costs in Cape Town would be covered by the project.

Prior to the commencement of baiting, the Settlement's water collection system will be secured to avoid contamination with bait. This will involve identifying all 'at risk' areas then working out the most appropriate way to protect them, eg covering of open tanks, disconnecting down-pipes that collect rainwater from roofs, temporarily stopping inflow into the storage tanks from catchment areas that may catch and hold baits. These precautions will be put in place when the bait-sowing reaches the vicinity of the settlement or hut site. Once bait has been sown over that area, including the double swath around the coast and the second drop, all relevant roofs will be swept and then left until sufficient rainfall has occurred to wash off any bait residue. The roofs can then be reconnected for normal supply. Water collection systems that collect water from ground run-off (rather than roof collection) may require a longer 'stand-down' period, in order for bait still lying on the ground within the catchment area to decompose or disappear. This may be a matter of some weeks, and can only be judged by observation at the time. As the issue is somewhat subjective, it will be up to the Tristan people to indicate when they are comfortable to have all the systems reconnected. Samples of water can be collected at any time from any source for analysis of brodifacoum content. However, it is unlikely that this process (HPLC, high-performance liquid chromatography) can be conducted on the island, so samples would need to be sent from the island for analysis, with a minimum 'turn-around time' of approximately 20 days for results to be available).

For outlying huts, all water systems will either be disconnected before the drop, and the above procedure followed prior to reconnecting, or they will be visited after the drop - and sufficient rain has fallen - and all water tanks emptied and cleaned before reconnecting.

15.3 GENERAL HEALTH CONCERNS

A full information kit on the potential risks of the bait, poisoning symptoms, etc will be delivered to every household on the island before the operation commences.

The island medical doctor will be provided with as much information as possible, including key contacts. The island's doctor will need to be brought on-board in advance, so that they are fully conversant with the Operational Plan and can say what island facilities (equipment, medicines, etc.) may be lacking (and thus need obtaining in advance or brought on the bait ship).

The island's doctor will need (possibly in conjunction with the project veterinarian) to ensure adequate stocks of Vitamin K are available for all foreseeable needs, and will have the capacity to administer this on the island. They should if possible be familiar with, and able to carry out, the 'prothrombin time test' in order to identify the need for any or continued treatment.

It is also feasible that the project team brings its own doctor or toxicology specialist (with any necessary specialist equipment) to work alongside the island's resident doctor, if this is considered necessary or desirable by any of the major stakeholders. This would be at additional cost to the project.

It is feasible that a representative proportion of the human population is tested on a voluntary basis (by taking of blood samples), both in the pre- and post-operation phases, to detect any changes in relation to possible brodifacoum assimilation.

Full health checks with respect to possible brodifacoum-related ailments should be made available at any time, free of charge, during and after the bait-sowing operation.

Special effort would be made to ensure all school age children are educated about the possible risks of the bait.

There would need to be a self-enforced ban on killing of any stock (including poultry and wild or semi-wild sheep or cattle) for human consumption for up to one year following bait drop. Killing for meat supply should only recommence once analysis has shown that levels have declined to safe levels. Transportation of frozen samples off the island would be required, and samples would need to be forwarded as quickly as possible to analytical laboratories experienced in conducting such tests. One such laboratory with considerable experience in analysis of brodifacoum residue is Landcare Research in Lincoln, New Zealand, where results from samples are usually available 7-10 days after receipt. There are other facilities in the United States and possibly elsewhere.

Table 4. Summary of human health risk factors and possible mitigation

Risk	Level of Risk	Mitigation Options	Residual Risk
Eating bait	Very low for adults & older children	Education	Very low
	Much higher for toddlers, though still considered unlikely to cause any serious health effect	Confinement and parental supervision, and removal of visible/accessible bait	Moderate-low
		Temporary removal of young children from island	Very low
		Addition of 'Bitrex' to bait	Very low
Absorbing toxin through inhalation	Very low for residents	Avoidance of bait-loading & storage areas	Very low
	Higher for bait handlers & loaders, but still low	Protective facemasks & clothing	Very low
Absorbing toxin through skin	Very low for residents	Avoidance of bait-loading & storage areas, & avoidance of handling bait without gloves	Very low
	Higher for bait handlers & loaders, but still low	Protective facemasks & clothing	Very low
Contamination of water supply	Low	Pre-storage of water, provision of bottled water, temporary disconnection of catchments, &/or filtering of water Regular testing of water	Very low
Residues of toxin in livestock/meat	High	Stocking up of meat supplies prior to bait drop; Temporary bans on consumption of local meat after bait drop; Regular testing of livestock samples; Restricting access of livestock to bait as far as practical	Low
General health effect of all the above	Low for most people, may be elevated for some 'at risk' individuals	Regular health testing during & after operation, blood samples for toxin, Possible Vitamin K treatment	Very low risk for most people, may be elevated for some 'at risk' individuals

15.4 PETS & LIVESTOCK

A summary of knowledge on effects of brodifacoum on livestock can be found in Fisher & Fairweather (2005).

In single instances in New Zealand, wild pigs and domestic sheep have been killed through ingestion of brodifacoum baits. These cases appear to have been where large quantities of bait have been available (eg in a series of bait-stations) and the animals have learnt to seek out the bait.

It is possible that some lethal or sub-lethal poisoning of livestock or pets could occur on Tristan, particularly where they have free range to access baits or dead or dying rodents affected by the bait. Risks would undoubtedly be reduced through appropriate mitigation and protective measures, but to some degree the actual effect is unquantifiable, as this scenario (of deliberate baiting in and around areas occupied by large numbers of livestock) has not occurred before.

Available information (see Table 5 below) suggests that for most species appreciable quantities of bait would need to be eaten. Such quantities could only be accumulated if the animal had free range to seek out bait (or in the cases of dogs, pigs and chickens consume rodents that had themselves accumulated a high dose of the toxin).

There are reported instances of sub-lethal poisoning causing abortion of foetuses in pregnant cattle and also in dogs and sheep. It is unclear what the level of risk is to cattle on Tristan, and LD50's for cattle have not been established.

Table 5. Estimated toxic doses of brodifacoum for livestock species

Species	Estimated average body mass (kg)	LD50 (mg kg^{-1})	Amount of bait required to receive an LD50*
Dog	8 kg	0.25	100g
Pig (large sow)	120 kg	0.5	3,000g
Sheep	50 kg	1.1	2,750g
Chicken (large breed)	0.9 kg	10	450g
Duck	1.1 kg	4.6	250g
Cattle		unknown	unknown

* Each pellet of Pestoff 20R has an average weight of approximately 2 grams.

N.B. An LD50 is the lethal dose to kill the 'average individual' or 50% of the treatment population. Some individuals may be more susceptible than this.

Brodifacoum can be excreted from the body in a relatively short time frame; the half-life (time taken for half the initially present quantity to disappear) in dog blood for example ranges between 1 and 10 days.

However, some brodifacoum can 'bond' to tissue in organs such as the liver, and is relatively stable in this situation, taking long periods, for example >250 days in sheep liver, to

break down and eventually be excreted. Therefore, there is a risk of secondary intake of brodifacoum through human consumption of sheep or cattle meat, especially liver. This 'bonding' of brodifacoum is known through extensive testing to occur in liver, but may equally occur in other organs and tissues, including kidneys, pancreas and muscle tissue, to a similar or lesser degree; information from clinical trials is limited.

Information on the effect of aerial bait-sowing over areas inhabited by livestock is very limited. One of the most relevant examples, although on a much smaller scale, comes from three islands in the Seychelles, where there was no reported effect on or loss of pets or livestock, which were all penned or confined during the poison-baiting operations (Merton 2001).

15.4.1 Pets & Livestock Mitigation Measures

Vitamin K treatment can be given to any animal suspected of brodifacoum poisoning. Tests are available to detect anticoagulant effect in animals, eg prothrombin time testing for live animals and high-performance liquid chromatography (HPLC) for tissue taken from any dead animal.

It is likely that prothrombin time tests could be carried out on the island by medical or veterinary staff. However, HPLC tests require more technical and expensive equipment, and even in established laboratories, quality assurance is a factor – it is unlikely that this could be achieved on the island.

Pregnant or lactating animals may require special attention, as foetuses or nursing young may be at elevated risk.

15.4.1.1 Dogs

Dogs will be at risk both through direct consumption of bait and through consumption of poisoned rodents (and to a lesser extent through consumption of any affected non-target species of wildlife or livestock).

Islanders are to determine the best situation for their own dog, the options for which include:

- Aversion training to baits
- Keeping the dog indoors or on a leash during and following treatment of Settlement areas (possibly for several weeks)
- The dog being temporarily removed from the island onto a ship
- No specific measures taken, but train the dog to avoid the bait, and monitor their health and behaviour, with treatment implemented for any suspected poisoning.

15.4.1.2 Poultry

All poultry are to be fully contained within pens during and following treatment of the settlement area, until it is apparent that most if not all bait has been taken by rodents and/or degraded by weather. Even with aerial-sowing, very few pellets will fall within poultry pens, and while it is conceivable that a few individual birds could be affected there should be no significant risk to the poultry population while penned.

This confinement may be a period of several weeks if not months. The exact duration of confinement would be determined by the rate of decay of any bait left uneaten by rodents. Once bait has degraded to a point where it would not be recognised as food by the poultry - most likely when the pellet has entirely disintegrated - the poultry could be released from confinement. Therefore, consideration should be given prior to the baiting operation to either improving captive conditions or to substantially reducing the poultry population through culling, to ensure the pens are adequate for the numbers of birds and potential duration of confinement.

A greater risk will arise if poultry are released from their temporary confinement before most bait in the surroundings has disappeared.

If desired, eggs or poultry meat can be periodically analysed for brodifacoum residue as part of a health screening process following the baiting operation.

A ban on the consumption of poultry should be considered if initial blood or tissue testing or field observation shows that poultry have accessed bait. If the poultry have been confined this is unlikely to be the case, but should not be ruled out.

15.4.1.3 Pigs

All pigs on Tristan are normally confined within pigsties, and this should alleviate most if not all concerns with regard to this species. Any bait falling into such enclosed spaces will almost certainly be insufficient in quantity to cause any detectable effect on the animal's health or on any human subsequently consuming meat from the animal. For even greater security all sties could be checked immediately after aerial bait-sowing has occurred over the site, and any baits seen within the pens removed.

Any pigs not closely confined are likely to seek out bait and/or dead rodents, and would be at appreciable risk of acquiring lethal or sub-lethal doses of the toxin.

15.4.1.4 Livestock (cattle, sheep & donkeys)

Protective action to reduce (but not entirely eliminate) the chance of livestock consuming bait would occur through containment of the Settlement Plain animals within predetermined fenced pastures at Burntwood end of the plain while baiting occurs at the other end (or vice versa). Stock would then be moved toward the Settlement/Pigbite end after several days, by which time most bait should have been removed by rodents in the pasture areas first treated. Movement of animals to new pastures would need to progress repeatedly and relatively frequently to allow for aerial sowing of baits to occur behind the stock rotation (remembering each pasture would need to have two applications of bait).

While the Settlement Plain livestock would never have access to freshly sown bait, it is inevitable they will encounter some bait remaining in pastures some time after treatment, when stock rotation through the individual pastures dictates they use previously treated areas again. However, the amount of bait they encounter is likely to be significantly

lower (due to consumption of bait by rodents) than would be expected in freshly sown pastures.

Livestock protection will require a rotational grazing pattern to be established beforehand. The Burntwood pastures will need to be closed well before the operation begins, to allow for sufficient grass growth to sustain all livestock for up to three weeks during the baiting operation.

It should also be noted that longer grass would reduce the chances of stock ingesting bait through 'close-cropping' of pasture, which occurs in times of lower food availability. It will be important for the island's stock population to be reduced and maintained to a level where grass growth can be maintained at a reasonable grazing height.

15.4.1.5 Remote cattle herds

As there are currently no fenced pastures in the areas where the 'remote' cattle herds occur, there is no possibility of rotational grazing to reduce the level of contact between cattle and freshly sown bait. If the cattle are left *in situ* there is an appreciable risk of ingestion of significant quantities of bait. Losses of individuals, or appreciable health effects could be expected in such circumstances.

Options include:

- Leave as is, and hope for the best
- Construct holding yards, muster cattle into these immediately before bait treatment of the area, and supplementary feed them for up to several weeks until most bait in the area has been consumed by rodents or degraded
- Complete removal of cattle (either temporary or permanent) from these areas
- No killing for consumption for up to one year post-baiting (subject to laboratory sampling)

The preferred situation from an operational perspective would be the removal of the cattle from these areas.

15.4.1.6 Feral sheep

As with the remote cattle herds, the feral sheep would have free access to freshly sown baits.

- Options include:
- Leave as is, and hope for the best
- Substantial reduction in numbers (>50% reduction) or even complete eradication, prior to the baiting operation
- No killing for consumption for up to one year post-baiting (subject to laboratory sampling)

The preferred option operationally speaking would be the complete removal of feral sheep from the unfenced Base area of the island.

15.5 NON-TARGET WILDLIFE

Fisher & Fairweather (2005) document a wide range of wildlife species that have been affected by brodifacoum baiting. In most cases, the effect has been the loss of individuals of a species, but the population has not been significantly affected. Indeed, in many if not most cases, wildlife populations have responded strongly

and positively to rat removal, to a point where the population has within a short space of time exceeded the pre-operation population.

However, on Tristan there are species of considerable conservation importance. Angel & Cooper (2006) have identified the Tristan thrush *Nesocichla eremita* and the Gough moorhen *Gallinula comeri* as being at significant risk, the former through consumption of bait, the latter through both bait consumption and potentially also through consumption of rat carrion. Both species are endemic to the Territory of Tristan da Cunha. The thrush is found on Nightingale and Inaccessible Islands (in far greater numbers) as well as on Tristan. The Gough Moorhen is found on Gough Island in addition to Tristan. The population on Tristan is thought to derive from a deliberate human introduction of birds from Gough, the original, single-island endemic Tristan Moorhen *Gallinula nesiotis* having gone extinct. However, this remains unconfirmed. There is a remote possibility that the Tristan birds are in fact surviving Tristan moorhens, or hybrids. Tristan thrush is designated 'near-threatened' and Gough moorhen 'vulnerable' by IUCN.

The [Tristan] southern skua *Catharacta antarctica* population (and any vagrant kelp gulls *Larus dominicanus*) could feasibly be at risk (through consumption of poisoned rodents), though they are reputedly largely absent from the island during the winter period, when baiting will occur. It is extremely unlikely that any other seabirds (albatrosses, penguins, etc) will be affected. They do not feed on land, and are unlikely to deliberately ingest bait. Accidental consumption is highly unlikely to be sufficient for toxic doses to be acquired. Consequently it is considered that the only risk may be through disturbance at nesting or roosting areas by helicopter activity. While this cannot realistically be avoided, the effects, based on prior experience from New Zealand, are likely to be minor and temporary in nature.

Should any non-target animals be found dead following the bait-sowing, they will be collected and returned to base for autopsy and collection of samples for baseline disease screening prior to disposal by burying. Samples will be taken for toxin assay. The responsibility for this should lie with the Conservation Officer.

15.5.1 Wildlife Mitigation Measures

15.5.1.1 Southern skua

The baiting operation will target the non-breeding period for southern skua, when most if not all birds will be absent from the island. Some loss of individuals could be expected, but the population should not be at significant risk. In the extreme unlikelihood of a worst case scenario occurring, a skua population will self-reintroduce themselves from the larger populations on nearby Nightingale and/or Inaccessible.

15.5.1.2 Tristan thrush & Gough moorhen

Options:

- Do nothing – it is probable that some thrush and moorhen will survive, and rapidly re-establish

populations. In the worst case scenario (the entire population is affected) birds could be re-established by transfer from Nightingale (thrush) and Gough Island (moorhen)

- Captive holding of a small number of birds of each species to ensure a core breeding stock and some genetic diversity remains. Birds would be released back into the wild once baits have degraded and the risk is considered minimal.

Small populations of Rallidae have been extirpated on small islands where ground-based rodent eradications have occurred (using baits with higher toxin loadings than proposed here), but there are no known instances where populations of Rallidae or passerines have been extirpated as a result of aerial-sowing of brodifacoum. There are however several instances where populations have been temporarily affected at a significant level.

In consideration of the global importance of the populations, and the slight doubt that remains about the genetic provenance of the Gough moorhens, a small number of pairs (or mixed sex groupings) should be captured prior to the bait drop and established in pre-constructed aviaries. The capture and care of the birds will be the responsibility of the specialist aviculturalist, supported by local conservation staff. Precise numbers of birds to be held will be a balance between practical considerations and ensuring that reasonable genetic diversity is maintained. This will need to be established by relevant experts prior to the operation.

16 Worst case scenarios and contingency actions

16.1 WEATHER

This is an appreciable risk to the operation. Tristan is well known for its strong winds and low cloud, both of which can delay the spreading of bait. Less than six days of fine weather is required to drop each of the two rounds of bait (assuming no re-treatment of areas is required following delays), and the field team will be in place for at least two months. It is considered that in normal winter conditions experienced on Tristan that the operation can comfortably be accomplished. However, it is remotely possible that extreme weather is persistent or regular enough to make it impossible to drop all the bait, causing the failure of the operation.

The PM should gather and assess relevant climate data in the preparatory phase of the operation, in order to better gauge the expected weather patterns, and to be better prepared to take any alternative actions that may be necessary to successfully conclude the operation.

Potential options in the event of severe weather-induced delays are:

- Stay longer. This is feasible, but not without significantly increasing the budget, and it could only be achieved if the helicopters and pilots are available for longer, and the ship is available at a later date. A longer operation also raises risks of a spring/summer operation, as outlined below.
- Do the operation during the summer. Nearly all previous island eradications have been carried out during the winter, since this is when rat numbers are lowest, alternative food is in shortest supply and the rats are not breeding (which reduces the risk of a young rat not having access to bait). To change to an eradication in summer would require considerable preparatory trials, which may or may not show that such a move is possible.

16.2 BAIT

It is feasible that demand for the bait will exceed production capabilities in any given year, as other major operations could be underway (eg Macquarie Island, South Georgia). However, the bait production company should have considerable advance warning of production requirements, and early placement and confirmation of the bait order should alleviate this potential problem.

If manufacture of the full consignment is delayed (eg major breakdown of equipment) then consideration may have to be given to either proceeding with the operation with smaller amounts of bait available, delaying the operation up to the limit of 31 July, or postponing for a year or more.

If all containerised bait does not arrive safely in Cape Town (or does not arrive in time), an assessment will be required to gauge what quantity is missing. It is considered feasible for

the operation to continue if at least 110 tonnes of bait is available for departure on the ship, but only if guarantees are received that the missing or replacement bait would be in Cape Town within two weeks of the departure of the first ship. This amount would enable the first baiting run to be completed with sufficient contingency. Bait for the second round could, if necessary, be brought down on a slightly later ship (eg aboard one of the fishing vessels, specially commissioned for the purpose if normal sailing dates do not coincide with requirements).

In the event of a delay in bait arriving at Cape Town, consideration would have to be given to air freighting any additional/replacement bait required from the factory, but this would be at considerable additional expense.

All precautions with bait during transport will be taken, including checking the bait prior to leaving the factory, again at the point of departure and ongoing monitoring on the island. The best practical bait storage options will be chosen wherever possible. Key issues include:

- The appropriate storage of the bait (avoiding any physical damage to pallets, bags or bait)
- Avoidance of moisture absorption, leading to development of mould or other degradation of bait
- Avoiding contact with or proximity to any materials that may contaminate the bait and make it less palatable to rodents (eg fuels, oils, volatile compounds).

Other relevant factors include good security while also permitting easy access by project staff to inspect the bait. All options for bait storage should be examined, and the most appropriate practical option selected by the PM.

Regular inspections of bait quality will be made wherever access to the stored bait is practical, particularly in storage at Cape Town and in transit on the ship to Tristan. Anti-moisture techniques will be employed where necessary (use of dehumidifiers, etc). Any evidence of bait decay will be treated urgently by removing affected bait and drying out the rest and considering using backup storage or protection options.

16.3 MECHANICAL BREAKDOWN

With three helicopters operating on-site for several weeks, it is probable that a mechanic will be required on site to service and maintain the machines, and therefore a suitably skilled helicopter mechanic will be a required component of the field team. The successful helicopter company will be required to provide this person as part of their overall package. Skilled mechanics and engineers capable of making/ assisting with basic repairs to machinery are present on Tristan. At least four bait-buckets shall be taken to the island, along with the spare parts required to make basic repairs or adjustments.

The bait-sowing helicopters and/or Tristan barges could be used in the event of the main lifting helicopter breaking down during unloading of the bait-ship.

The possibility of helicopter failure during bait-sowing is covered as well

as possible by having at least two helicopters. In the event of a breakdown, bait-sowing can continue using the other helicopter. If feasible, the larger support helicopter could be considered as another bait-sowing option. It is considered that a single operational helicopter could still complete the bait-sowing operation albeit at a much slower rate, and at a consequently greater risk of complications arising through inability to react quickly to weather windows, and larger proportion of time spent re-treating buffer zones, etc. In such an event, the overall baiting strategy would probably remain unchanged, but would be discussed between key team members in consultation with appropriate experts such as the IEAG.

At least one spare bait-bucket as well as a range of spare parts will be taken down.

In case of a forklift breakdown, other mechanical options would be considered (eg manual pallet trucks, or tractors with hydraulic lifting arms, etc), and failing that, the 25 kg bait bags can be moved by hand.

16.4 SHIP

If the ship charter expires or the ship otherwise becomes unavailable before baiting is complete, a skeleton crew (including a helicopter mechanic) may be asked to remain on Tristan with one helicopter. This would be at considerable extra expense, as the options for returning the helicopter to South Africa could be limited, and penalty hire rates could accrue. This helicopter may need to be loaded as deck cargo or similar on any smaller vessel available at any time after the conclusion of the operation.

16.5 KEY STAFF

Where possible, all key staff (eg PM, Chief Pilot, IT technician) will have a replacement identified who is familiar with the project and the requirements of the position.

16.5.1 Effects of Bait on Humans

Minor health issues through any anticoagulant poisoning for humans can be addressed through the medical facilities on the island. No significant effects on humans are known to have occurred during any aerial bait application of brodifacoum bait for eradication purposes, but the data is very limited, as most prior eradication work has occurred on unpopulated islands.

Accidental consumption of rodent baits (particularly by children) has been known to occur in rodent control operations. With appropriate safety procedures and parental supervision, such problems are not anticipated to occur at any significant level, and should not threaten the successful accomplishment of the operation.

It is highly unlikely that serious human health impacts would occur, given adherence to adequate safety procedures. However, if they do manifest in any way, the health of the human population would be of the highest priority, and if such issues could not be satisfactorily avoided or remedied, then the operation would have to stop immediately.

16.5.2 Effects of Bait on Livestock or Wildlife

Many Tristan people have already indicated a willingness to accept losses of livestock in order to facilitate the removal of rats. However, losses could be far greater than anticipated, if for example, some individual livestock actively seek out the baits, and/or more bait than expected remains uneaten by rodents and available to stock returning to the area and/or Tristan livestock are genetically predisposed toward being badly affected by brodifacoum. The precise effects are hard to gauge, as individuals or herds may act differently in relation to a wide variety of factors including local conditions such as availability of natural food resources. However, it is considered probable that livestock would eat bait (particularly fresh bait) that they encounter, and therefore the situation must be managed to minimise the quantity of bait available to any livestock, as far as is practical without unduly jeopardising the likely success of the rodent eradication.

A vast range of experience has accumulated on the effects of the bait on wildlife. It is very unlikely that any events will occur that have not been foreseen as possible. However, if effects reach an unacceptable level, the project may be halted on the recommendation of the funding and/or technical advice bodies.

16.5.3 Obvious Failure of Baiting Programme (Surviving Rodents)

If it becomes apparent that rats and mice have survived the baiting operation in large or widely distributed numbers, there is nothing that can feasibly be done to alleviate this – effectively, the project has failed. All that could be done is a thorough evaluation of the possible reasons, to prevent a similar situation happening here or elsewhere in future.

Contingency operations may be feasible if surviving mice or rats are detected only from within the settlement or another defined pocket(s). Depending on the circumstances, this may promote an active contingency response, if it is felt that there is a reasonable chance that the surviving pocket can be effectively targeted and eradicated. This would be decided by the decision-making team, but would probably involve the use of a wider range of rodent toxins, traps, and detection devices. Most if not all of this equipment should already be in place on the island as part of the established pest quarantine/prevention system, and the practical application of efforts in such a contingency should also be largely pre-established as part of this system.

17 Post-operational requirements

17.1 RODENT MONITORING

No formal monitoring of the rodents will occur during or immediately after the aerial bait-sowing stage of the operation. The chances of finding a single or small number of surviving rodents over an island of this size is so remote that even a huge effort would not give confidence in a negative result. It is standard procedure that confirmation of success for such operations occurs two years after the operation, by which time, if rodents have survived, their numbers would have recovered to a point where they would be easily detectable.

The Tristan people are all too familiar with rodent sign. The public will be relied upon to bring to the project team's attention any possible rodent sign detected after the conclusion of the baiting operation.

In autumn/early winter two years after the bait drop, a field team (at least four personnel, including at least one acknowledged expert in detecting rodent sign) will spend time on the island searching for any sign of rodents and confirming the success of the operation.

Sign will be searched for; including predated or scavenged seabird carcasses, footprints in soft mud or peat, and droppings. Active detection methods include non-toxic 'indicator' baits (chocolate, butter, and new specially designed 'wax tags'), tracking tunnels, sticky hair-traps, and trap lines (snap-traps, Fenn or DoC 150-type traps). Monitoring should cover most of the island but should focus on areas favoured by rats, such as around seabird colonies and sheltered coastlines.

Trained rodent-tracking dogs would be an advantage in such monitoring, as presence of rodents can be relatively easily detected through their scent, even if in such low numbers as to be undetectable in traps or tracking-tunnels. Although some such dogs are available in New Zealand, there are considerable logistical problems in getting them to Tristan da Cunha.

17.2 RADIO TRACKING RATS

A small sample of rats could have radio collars attached prior to the bait drop. This would largely be for PR reasons rather than an operational necessity. However, they might be able to provide a few more clues as to rodent behaviour, especially in potentially 'tricky' areas such as where ground-based bait-stations are used, or around settlement, horticultural or livestock areas.

If used, the collared rats should be located within a readily accessible distance from the settlement, and would be monitored both before and after bait is dropped in those areas. While far from being definitive, the subsequent death of transmitter-carrying rats does indicate that the operation is going as planned, and it is a morale booster for the team and gives a positive story for line managers and as a potential press release, providing it is put in correct context.

Use of radio-collars would have an obvious additional cost to the project.

17.3 HUMAN HEALTH MONITORING

The requirements for human health monitoring should be determined by appropriate medical experts, on the basis of evidence obtained during the operation. Blood samples and medical examinations could be carried out if necessary.

17.4 LIVESTOCK MONITORING

A contract veterinarian will be responsible for monitoring effects on livestock during and immediately after the bait drop. Any major effects should have manifested within a month of the conclusion of the second bait drop. Once any serious effects (if any) have been treated (or accepted as untreatable), the veterinarian may depart.

Further livestock monitoring would be of the potential risk to humans through consumption of meat and/or offal that possibly contains brodifacoum residues. Based on published information, residues may persist for a year or more. Therefore, sampling (through culling) of a small number of representative stock should occur on a three-monthly basis from six months post-drop. Samples will be of meat, body fat, and liver (or as otherwise requested) and if they cannot be tested on-site (unlikely to be possible), they will need to be frozen as soon as possible and for the duration of transportation to the testing laboratory. Testing procedures for residues of brodifacoum and other toxins are well established in New Zealand, both within the meat industry and as a consequence of non-target issues relating to conservation pest control.

17.5 WILDLIFE MONITORING

All project team members and Tristanians will be asked to make anecdotal observations of any wildlife effects noted during the first bait application. All freshly dead wildlife (or in the cases of large numbers, a representative sample) will be returned to the Settlement for examination by the veterinarian and the taking of samples for analysis.

The Conservation Officer or delegated assistants will undertake more extensive surveying two weeks after the first drop, and again a similar period after the second drop.

17.6 BAIT WEATHERING

Bait weathering trials may also be carried out to confirm the life of the bait after the drop. This has implications both for operational review and for public and animal health reasons. Protocols for this will be set by the PM but will probably consist of putting samples under rat proof covers (usually wooden frames covered with a fine wire mesh, securely pegged down) at a range of sites as bait is dropped at those sites.

The relative continued risk to livestock and poultry through direct consumption of bait could be established by measuring decay of the baits remaining in pasture areas, as set out in Day (2004) and Epro (2006).

18 Risk assessments

18.1 PUBLIC INTEREST - *LOW RISK*

There is likely to be a high level of media interest in this project given the uniqueness of the area, the difficulties of the operation, and that the operation will be the largest of its kind ever undertaken world-wide. There may be some concerns at the operational cost and use of toxins, but the conservation benefits of eradication (a one-off operation) should be stressed. A media strategy will be written to cover this

18.2 CONSERVATION IMPACT - *SIGNIFICANT RISK*

Potential negative impacts on conservation values are generally low but there is a likelihood of significant losses of some important species, which to some extent will be mitigated through captive holding. However, the potential conservation gains are very high. The short-term negative effect on non-target species will be considerably outweighed by the long-term gains for species and ecosystems. The island will become one of the largest vegetated areas in the world free of the influence of introduced predatory pest animals.

18.3 VISITOR SATISFACTION - *LOW RISK*

The limited numbers of visitors that visit the island annually are likely to experience a heightened appreciation of the unique flora and fauna of the island. No visitors are anticipated during the operational period.

18.4 ISLAND RESIDENTS - *MODERATE RISK*

The potential benefits to the island residents are enormous, but there are some potential concerns with regard to their health. Many of these can be prevented, mitigated or remedied, so the overall risk to most members of the population is considered very low. However, certain at-risk individuals (eg with blood-related disorders) or age groups (eg toddlers) may be at an elevated risk, and because of the limited amount of directly relevant previous experience the precise degree of risk is difficult to quantify. In this respect, there are still some unknown or untested factors in relation to this operation, and this needs to be acknowledged

Very few aerial drops of brodifacoum bait has occurred over a resident human population, one of the few examples known being in the Seychelles (Merton 2001), where no known effect occurred, though the precaution was taken to remove any young children from the islands prior to the bait drops.

18.5 STAFF SAFETY &POTENTIAL LOSS OF KEY STAFF - *LOW RISK*

The health and safety issues encountered by the project team are fairly routine and should not pose a difficulty to the project management team. The island is extremely isolated, meaning specialist medical attention is

a considerable distance away, though general medical care is available on the island.

The winter climate is also a concern, with possibilities of hypothermia occurring. Steep cliffs and strong winds mean serious falls are possible. All staff will be experienced in such field conditions and many will be trained in outdoor first-aid. Strict safety procedures will be enforced with regard to such issues as use of toxins, working around helicopters, minimum size of field parties, intended routes and return times when travelling, flying conditions for helicopters, etc. All parties travelling away from base will be issued a VHF radio for emergency use, and a hand-held GPS (with safety routes uploaded) will be issued to each field team, with laminated maps issued to each person.

A specific Safety Plan will be produced and one team member will have a specific responsibility for safety issues.

This project is a once in a lifetime event and the staff selected should undertake this project to the highest levels possible. Key members of the staff will have considerable experience in similar work. Back-up staff for each key position will be identified.

18.6 OPERATIONAL RISK - *MAJOR RISK*

This operation would be one of the largest and probably the logistically most difficult rodent eradication ever undertaken. While Tristan da Cunha is an order of magnitude larger than most islands treated to date, it is comparable in size to Campbell Island, from which Norway Rats *Rattus norvegicus* have been eradicated, and similar strategies apply. The project is based on sound and proven techniques, with several islands having recently been successfully treated in a very similar manner. However, it pushes the boundaries of rodent eradication technology by its sheer size and remoteness, while also introducing significant 'new' factors such as a relatively large human population, plus associated livestock and poultry. This therefore increases the opportunity for errors and the risk of not achieving eradication.

However, if the operation is planned and implemented correctly, the risk of failure will be minimised to an acceptable level. Beyond receiving adequate funding, the success of the operation will lie with careful, peer-reviewed planning, and adherence to the predetermined options when putting the plans into practice. Likely problems will be identified in advance, and contingency options will be developed. With such a large project, extra problems may arise, and accommodating these will require some flexibility. It is critical that a core of expertise is available to review and advise on response options. The team's response to weather conditions will be a significant factor, in particular the ability to maximise the number of hours when helicopters can spread bait in suitable weather. Other critical factors are: helicopters; pilots; bait storage and conditions; and checking bait spread by DGPS. Prior experience has demonstrated the suitability of the bait, both in terms of longevity in the field and palatability to rats and mice. Operational risks have been reduced by planning to use

several helicopters, a 33% bait contingency, and multiple bait-sowing strategies.

Effectively there is only one option for the transport of helicopters, bait and bulk supplies to the island. If this vessel becomes unavailable at short notice, there will be major problems, which may or may not be surmountable. There are two options if this does occur:

- Charter another ship from Cape Town – this will create costs in excess of the current option and would depend upon availability
- Use the MV Kelso and/or MV Edinburgh – this would require more than one trip to get all the supplies and staff to the island and these vessels probably could not transport the helicopters safely. It would also cost more than the current option. The practicality of this would need to be explored at the time ie it would probably delay bait-sowing and would increase helicopter costs. It would also depend upon availability of the vessels.

To minimise the risk of this event occurring, a comprehensive contract should ideally be signed with the shipping agent a year before the operation, and absolutely no later than March of the bait year. There is little planning that can be done for a short-notice problem of vessel availability, except making enquiries as to the potential alternatives likely to be available at the required time.

Helicopter operations and safety are the responsibility of the contractors and the best possible pilots will be selected for the operation. Helicopter operations on Tristan can be considered to be at the high end of the risk scale due to weather conditions and the amount of heavy load lifting. If a serious accident occurs, it is possible that the remaining helicopters may not be in a position to finish the bait-sowing (eg fewer helicopters may mean the extension of the timeframe necessary to complete the project to beyond the budget capabilities). The risk has been reduced by planning to use several helicopters in the operation, thus reducing the numbers of hours worked for any one pilot or helicopter – planning for overcapacity in respect to helicopter numbers is operationally safer than planning to use the minimum necessary. Full safety briefings on operations around helicopters will be held for all team members.

While it is necessary for practical reasons to keep the team as small as possible, there will be sufficient capacity to cover for reasonable illness or injury. In the event of a major illness affecting most staff there is very little that can be done, and the future of the operation would be in jeopardy.

The Chief Pilot is to nominate a replacement lead pilot if for any reason he is unable to continue in that role. Having two compatible bait-sowing helicopters and three-four pilots on the island gives a high level of back-up. The ground team on the island will include experienced staff to replace the PM if required. The size and skills of the field team provide sufficient backup should a predictable number of personnel be unavailable for work due to illness or injury.

Long periods of non-flying weather are catered for by the baiting regime. The operation is scheduled for mid-

winter but could acceptably continue well into spring if necessary, with no reduction in chance of success, though potential for non-target impacts could increase significantly. Approximately 33% extra bait is being taken down to allow for likely overlaps required by prolonged breaks, washouts etc.

Other unforeseen operational issues could consist of something as basic as the supplier not being able to provide the helicopter fuel when it is needed. In such complex logistical exercises, the smallest omissions or errors can create major problems. The best way to ensure that the project is not jeopardised by any minor unforeseen problems is through forward planning, having reviews or audits by other experienced people, and by having contingency options in place. This is dealt with as well as possible by having a PM with as much time allocated as required, a back up for that person, and all stages of the planning process regularly peer reviewed. The possible consequences of failure are greater than simply not eradicating the rodents from Tristan. A greater risk is that there may be a loss of political and public goodwill towards future operations and that funding may not be forthcoming for such operations. All risks will be updated, minimised, and as far as possible quantified, as the planning for the operation proceeds.

There is significant financial risk associated with the project, as it is effectively an all-or-nothing operation. If the operation is unsuccessful, very few conservation gains will have been made despite the expenditure. To minimise the operational and financial risks, the project has to be funded to allow for the highest levels of quality control systems, technical expertise and resources that will maximise the chances of successful eradication.

19 Workplan & timeframe

PHASE	TIME	TASK	RESPONSIBILITY
PRECURSOR	Completed	Rodent eradication feasibility study	D Brown (RSPB contract)
	Completed	Rodent distribution & ecology study	E Sommer (RSPB contract)
	As soon as practical	Risk analysis documentation collated/developed & presented to Tristan people & key stakeholders. Public discussion & decision on Tristan.	Contractor / Tristan Government
	ASAP	Undertake monitoring of burrowing seabird, thrush & moorhen populations on Tristan	Conservation Officer supported by RSPB
	ASAP	Determine genetic status of Tristan thrush & moorhen populations	RSPB / UCT ?
	ASAP	Confirm whether captive holding of thrush & moorhen will occur, & set guidelines (minimum number of pairs required, etc)	RSPB / UCT ?
	ASAP	Pest quarantine procedures established on island & staff member appointed	Tristan Government
	ASAP	Livestock issues resolved (what to do with remote cattle & feral sheep, rotational grazing pattern established for Settlement Plain livestock, etc)	Tristan Government
	ASAP	All other pre-identified tasks (improvements to rubbish disposal, sewage treatment, etc) completed to satisfactory standard.	Tristan Government
PLANNING	Completed	Development of draft Operational Plan	Contractor (D. Brown)
	Sep 2007	Further consultation with Tristan people	Contractor
	Sep 2007	Initial investigations, helicopter options & flying/operation conditions	SA Agulhas helicopter pilots?
	Sep 2007	On-site investigations/consultations, Tristan – bait storage buildings, etc.	Contractor
	Oct 2007	Revise plan on basis of Tristanians' decisions	Contractor

PLANNING	Jan-Feb 07	Peer-review of draft plan	UCT / IEAG
	Mar 2007	Finalise plan	Contractor
		Establishment of an initial steering committee (may be modified later as major stakeholders, eg major sponsors, are identified)	Controlling Agency
	From Mar 2007	Seek & obtain full funding for operation	Controlling Agency / Steering Committee
		Complete Environmental Effects Assessment ?	
PRE-OPERATIONAL	**2 Years before Bait Drop**	Advertise for & appoint PM	Controlling Agency
	Following PM selection	Advertise for & appoint Chief Pilot	Controlling Agency / PM
	At least one year prior to operation	Advertise for & appoint aviculturalist	Controlling Agency / PM
		Develop & advertise tender or specification documents for helicopter, shipping, bait, bait storage, etc	PM (CP to assist with helicopter issues)
		Determine successful tenders, & set required delivery & lead-in times & details	Controlling Agency / PM
		MOU developed with Tristan Government regarding use of facilities, equipment, staff	Controlling Agency / PM
		Non-toxic bait production	ACP
	Jan - May of bait year	Bait production	ACP
	Jan of bait year	Book bait quality assays, & collect bait samples	PM
	Jan - May of bait year	Conduct bait quality assays	MAF (Wallaceville), LandCare (Lincoln)
	Aug - Oct Y-1*	Design, purchase materials, travel to Tristan, supervise construction of aviaries (*for SA Agulhas trip, later options on fishing boats are also possible)	Aviculturalist
	Jan - May of bait year	Land transport of bait to port of export	ACP
	Apr - May of bait year	Initial bait-bucket calibrations (in NZ?) using non-toxic bait	CP and PM

PRE-OPERATIONAL	Apr - May of bait year	Land transport of bait-sowing buckets & related equipment to port of export	Chief Pilot
	Apr - May of bait year	Shipping of bait to Cape Town	ACP / designated shipping agent
	Jan of bait year	All pilot contracts (incl. replacement/standby) to be confirmed by Chief Pilot	Chief Pilot
	Jan of bait year	Advertise & appoint APM(s)	PM
	Jan of bait year	Advertise & appoint IT technician	PM
	Jan of bait year	Appoint toxicologist (off-island contract advice or on-island support), & pre-book on-going analyses of meat samples	PM
	Jan of bait year	Advertise & appoint veterinarian	PM
	By May of bait year	Health & Safety plan developed	PM
	By May of bait year	Information pack prepared for all Tristan residents	PM
	Jan of bait year	Tristan Administrator to provide list of shipping movements to Tristan to PM	Tristan Administrator
	Jan of bait year	Map of houses and owners to be updated	Tristan Administrator
	Before travel to Cape Town	Field staff to undertake outdoor first-aid training (if necessary)	Designated members, project team
LEAD-IN	**By May of bait year**	All pilots to obtain all required certification for flying of helicopters in SA and Tristan	Chief Pilot
	By Jan of bait year	Confirm all rodent baiting on Tristan has ceased	PM / Tristan Administrator
	May/June of bait year?	Operational Readiness Check, by IEAG or similar body	Steering Committee or PM
		Confirm arrival of bait & bait-buckets to Cape Town	PM
		Customs clearances?	
	From arrival to loading	Bait quality monitoring in storage	PM or delegate
		Loading of ship	Ship's Captain, in consultation with PM, CP, port authorities.
	Prior to ship departure	Confirmation that all supplies & equipment has been received & loaded.	PM (general equipment & supplies) Chief Pilot (helicopter equipment)

OPERATION	20 Jun of bait year	Transport personnel, bait, helicopters & all equipment and supplies to Tristan	SA Agulhas??
		Unload all at Tristan	Agulhas crew / PM / support pilot
		Final check of precursor requirements – rubbish disposal, fish & offal disposal, dead stock, etc.	
		Brief operational field teams & Tristan Heads of Department & other key people. Specific tasks allocated to individuals/departments & lines of communication confirmed	PM
		Preparation for aerial operations – testing of helicopter equipment, set up of DGPS, 'boundary-mapping' flight.	Chief Pilot & PM
	As soon as possible after arrival (target date 1 July)	1st round-island baiting run	PM / Bait pilots
	Coinciding with aerial baiting in adjacent areas	Hand-treatment areas	PM & local team
	A minimum of 10 days after same areas were treated in 1st run	2nd round-island baiting run	PM /bait pilots
		'Surplus' bait use	PM /bait pilots
		Return of ship with helicopters, most personnel & equipment to Cape Town	SA Agulhas?
		Transportation of equipment (eg bait-buckets) back to origin	PM
POST-OPERATIONAL		PM written report to steering committee on baiting operations	PM
		Debrief with steering committee & eradication experts	Controlling Agency / PM
	On-going as necessary	Periodic sampling of meat samples from livestock for brodifacoum residues	Agriculture Dept / vet / toxicologist
		Determination of safe time for resumption of local livestock killing for meat consumption	Toxicologist / Island doctor
		Develop contingency plans for any rodent invasion of islands within the Tristan da Cunha group.	Contractor & local Conservation and/or Biosecurity officers

POST-OPERATIONAL		Design & implement permanent trap & bait station network around wharf/settlement	Contractor & local Conservation and/or Biosecurity officers
	2 years post bait-drop	Conduct rodent detection monitoring across entire island, 2 summers after baiting operation. May also include audit of quarantine system.	Contract rodent expert, supported by local Conservation staff
	Following successful 2-year monitoring	Publish post-operational report	PM
	To coincide with completion of post-op report	Media release statement	Controlling Agency / PM
		On-going monitoring of wildlife response, etc	Tristan Conservation Officer, supported by OTEP, RSPB

20 Budget

ITEM	DETAILS	ESTIMATED COST (GBP)
PREPARATORY ACTIVITIES:		
Improvements to rubbish disposal systems	Expert advice required	£unknown
Improvements to sewage disposal systems	Expert advice required	£unknown
Development of quarantine/bio-security measures	Expert advice required – contract specialist to visit, prepare report & initiate action in co-operation with Tristan government	£5,000
Collation & presentation of all available information to Tristan people & government on issues, risks & potential mitigation for bait drop	Specialist contract toxicologist to prepare background information, travel to island to present this, receive & respond to questions & issues raised	£5,000
BAIT PRODUCTION & DELIVERY:		
Non-toxic bait for bucket calibrations – production, plus freight, travel & labour	1 tonne @ NZ$3,400 tonne^{-1}, plus freight 2x2 person-days, travel costs	£2,500
Bait production	210 tonnes @ NZ$3,400 tonne^{-1}	£300,000
Contract &/or transport costs – monitoring of production	NZ contractor	£3,000
Bait insurance		£3,000
Road/rail transport of bait to port	NZ$1,200 per container	£13,000
Road transport of bait buckets & other supplies to port		£500
Shipping of bait (& other equipment)	NZ$5000 per 20 ft container 8 tonnes per container, = 27 containers	£55,000
Assays	25 samples @ NZ$250/sample	£2,500
Customs costs, South Africa		£unknown
Storage, Cape Town	Warehouse rental (minimum 400m^2) for up to three months, plus any bait protection (environmental & security) costs	£10,000
STAFF:		
Project Manager	Part-time 6 mths equiv from July Y-1, full-time 6 months.	£60,000
Assistant Project Manager	Part-time 3 mths, full-time 6 mths	£40,000

ITEM	DETAILS	ESTIMATED COST (GBP)
Chief Pilot	Part-time 6 mths, full-time 6 mths	£60,000
Contract pilots	Full-time 6 mths, plus any prior training	To be included in helicopter contract?
Helicopter ground staff	Full-time 6 mths, plus any prior training	To be included in helicopter contract?
IT technician	DGPS training, then full-time 6 mths	£30,000
Aviculturalist	3 mths full-time in year prior, then 6 mths full-time	£50,000
Veterinarian	Full-time 6-8 mths	£50,000
Toxicologist	Possibly full-time 6 mths	£50,000
Local staff hire – cook(s) & cleaner	Roster for daily duties, 2 people for up to four months @ £32 p d	£7,680
Local staff hire – field assistants	1,800 person-days @ £ 32 p d	£57,600
Weather forecasting contract	Up to 4 months @ £ 50 p d	£6,000
Other staff costs – expert consultants, administrative costs, etc		£unknown
Cape Town logistic support	As required over full term of project	£10,000
Post-eradication follow-up – specialist (rodent monitoring, quarantine procedures)	Two years after operation (to incl travel costs, accommodation, salary)	£15,000
FLIGHTS & TRANSPORT:		
PM from home to UK &/or South Africa – planning stages	4 return flights & accommodation	£5,000
Planning visit to Tristan by PM & CP	2 return air tickets to Cape Town & Agulhas tickets to Tristan, year prior	£5,000
Various staff to Cape Town	10 return flights	£12,000
CAPE TOWN:		
Accommodation & meals	100 person-days @ £50 p d	£5,000
Vehicle hire or taxis		£1,000
Bait pod construction	16 pods @ £150 ea	£2,400

ITEM	DETAILS	ESTIMATED COST (GBP)
Accommodation of any Tristan residents (eg young children & caregivers) temporarily evacuated from island during bait drop	unknown person-days @ unknown p d	£unknown
HELICOPTERS:		
Hire of helicopters & associated personnel & equipment	2 x Bell 206 Jet Rangers 1 x Bell 205/212 or AS Squirrel	£500,000
Bait buckets, DGPS ground station, VHF ground station		To be included in helicopter contract?
Jet A1 Fuel	Sufficient for 300 flying hours (= 180 x 220-litre drums)	£30,000
Fuel & containers, for bait-bucket spinners	*ca*. 300 litres petrol – available on island?	£1,000
Tie-down system installation, or storage facility costs, Tristan	Unknown at this stage – to be determined by PM & CP	£unknown
SHIP		
Hire of ship, all-up cost per day	Estimated 50 days @ £12,000 p d	£600,000
Loading – stevedoring costs		£unknown
Passenger fares – project team	12 return tickets @ £ 1000?	£12,000
Passenger fares – residents	Unknown return tickets @ £unknown	£ unknown
HUMAN HEALTH ISSUES		
Water supplies	Measures yet to be established	£ unknown
Health screening	Blood sampling, analyses, possible specialist support	£ unknown
First-aid kits		£600
Antidote (Vitamin K)	For all human, pet, livestock & wildlife requirements	£ unknown
WILDLIFE		
SA Agulhas tickets, Aviculturalist	Year prior to bait operation	£1,500
Tristan accommodation, aviculturalist	3 weeks @ £25 p d	£600
Aviary construction (materials & local labour)	9 person-weeks @ £250 per week	£2,250
Avicultural supplies	(incl. bird food, capture nets & traps, transport boxes)	£1,500

ITEM	DETAILS	ESTIMATED COST (GBP)
Collection & analysis of non-target kills	Collection, storage, transport & analytical costs	£1,000
LIVESTOCK		
Cattle-yard materials & construction	3 x yards, plus water supplies	£5,000
Supplementary livestock feed	For *ca*.120 cattle, remote areas, four weeks feed	£2,000
Antidotes & equipment		£2,000
Sample analyses	Collection, storage, transport & analytical costs (*ca*. £80 per sample)	£5,000
ACCOMMODATION, TRISTAN		
Main accommodation	Hire of 1-2 visitor houses £250 per week	£4,000
Additional board	240 person-days @ £25 p p p d	£6,000
FIELD & OFFICE EQUIPMENT		
Laptops x 2		£2,000
Desktop PC x 1		£1,000
Printer/photocopiers x 2		£1,000
General office stationery		£500
Satellite phone (& calls)		£5,000
Whiteboards	X 2	£200
VHF radios	4 radios @ £300, plus spare batteries, charging unit, 2 x headsets.	£1,500
Field equipment	(tarpaulins, ratchet tie-downs, water containers, waterproof plastic bins, etc)	£1,000
Outdoor clothing & camping equipment for ground-team		£4,500
Safety clothing & footwear (bait-loading/handling staff only)	20 sets coveralls, rubber boots, eyewear, hard-hats plus disposable face masks, earplugs	£2,000
Cordless drills	3 @ £40	£120
Basic tool kit	hammer, screwdrivers, wire-cutters, etc	£100
Hand-held GPS units	2 @ £100	£200
Hand-operated pallet truck		£500

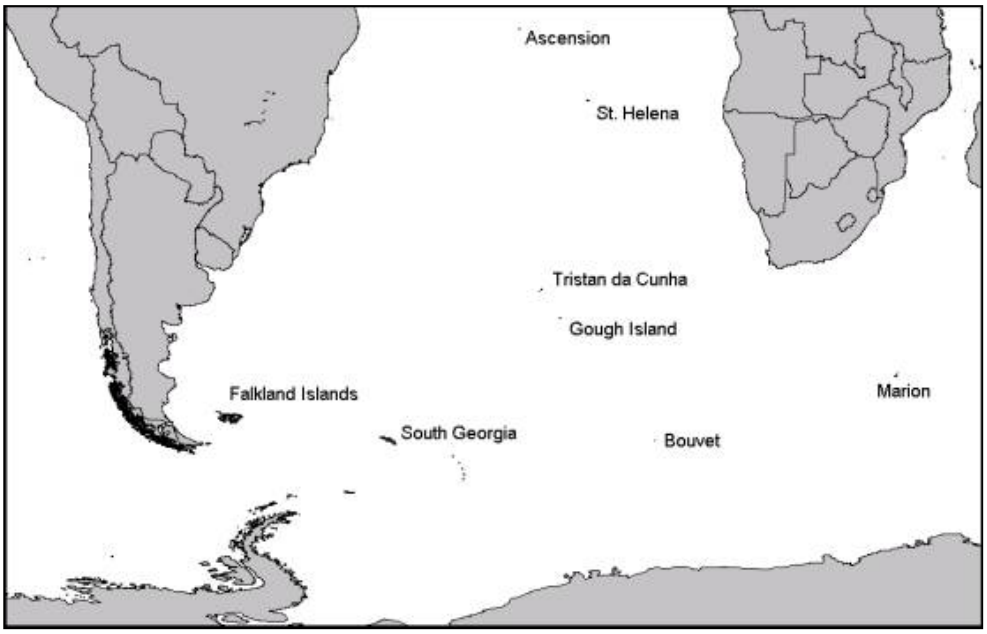
ITEM	DETAILS	ESTIMATED COST (GBP)
POST OPERATION:		
Return of bait-buckets, etc to location		£2,500
Airfares, etc for debriefs		£2,500
POST-OPERATIONAL MONITORING		
Tracking-tunnels	50 @ £5 ea	£250
Snap traps & covers	50 traps & 25 covers @ £4 ea.	£200
Wage costs, rodent monitoring	Local staff, 2 x 50 days, plus field allowances @ £50 p d	£5,000
POST-OPERATIONAL PREVENTION		
Permanent bait stations	50 @ £ 15 ea	£750
Tristan Biosecurity Officer	Permanent part-time position	Costs to be covered by Tristan Government?
On-going bait replacement, other field costs	Estimated to be *ca*. £200/year	Costs to be covered by Tristan Government?
ADDITIONAL COSTS IF 'OPTION 2' IS SELECTED		
Bait stations & wire	Up to 1,000 bait stations	£5,000
Additional labour to run bait station operations	1 x skilled supervisor, 5 x local labour for 3 months	£40,000

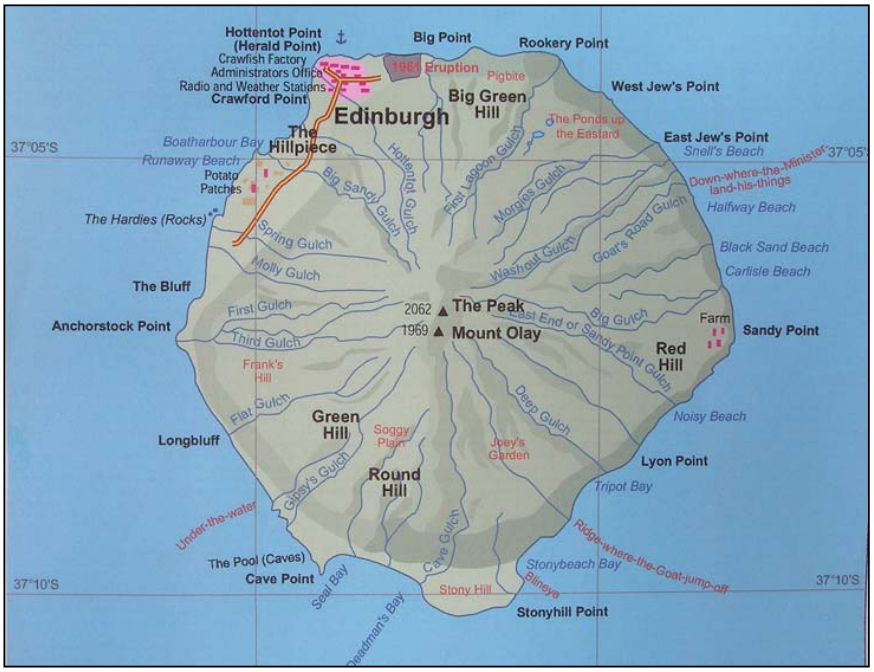
Approximate Total £ 2,113,950

Plus contingencies and currently uncosted items

Estimated Budget for Total Project: £2,500,000

21 Map


Ascension
St. Helena
Tristan da Cunha
Gough Island
Falkland Islands
South Georgia
Bouvet
Marion


Hottentot Point
(Herald Point)
Crawfish Factory
Administrators Office
Radio and Weather Stations
Crawford Point
Big Point
Rookery Point
1961 Eruption
Pigbite
West Jew's Point
Big Green Hill
Edinburgh
The Ponds up the Eastard
East Jew's Point
Snell's Beach
37°05'S
Boatharbour Bay
Runaway Beach
Potato Patches
The Hillpiece
Hollentot Gulch
Big Sandy Gulch
First Leggon Gulch
Morgies Gulch
Down-where-the-Minister-land-his-things
Halfway Beach
The Hardies (Rocks)
Spring Gulch
Molly Gulch
Washout Gulch
Goat's Road Gulch
Black Sand Beach
Carlisle Beach
The Bluff
First Gulch
2062
The Peak
1969
Mount Olay
Big Gulch
East End of Sandy Point Gulch
Farm
Sandy Point
Anchorstock Point
Third Gulch
Red Hill
Frank's Hill
Flat Gulch
Deep Gulch
Noisy Beach
Green Hill
Soggy Plain
Joey's Garden
Longbluff
Lyon Point
Round Hill
Tripot Bay
Gibby's Gulch
Under-the-water
Cave Gulch
Ridge-where-the-Goat-jump-off
The Pool (Caves)
Cave Point
Stonybeach Bay
Blineye
37°10'S
Seal Bay
Stony Hill
Stonyhill Point
Deadman's Bay

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23 Appendix 1. Key contacts

Tristan satellite phone no

Project satellite phone number:

Role	Name	Work	Home/ Mobile	e-mail
Project manager				
Assistant PM				
2nd APM				
Chief Pilot				
Bait pilots				
Support pilot				
IT Technician				
Veterinarian				
Aviculturalist				
Shipping Agent contact	Sam Oosthuizen	Tel: +27 21 405 9406 Fax +27 21 405 9424	+27 83 627 0213	soosthuizen@deat.govt.za

Role	Name	Work	Home/ Mobile	e-mail
Captain, SA Agulhas				
1st Officer				
Purser				
Ovenstone Agencies Ltd (MV Kelso & MV Edinburgh)		Tel: +27 21 421 6169 Fax: +27 21 421 6177		
Fishing Company manager, Tristan				
CHC, Helicopters, Cape Town		Tel: +27 21 934 0560		
Table Bay Marine		Tel: +21 531 4700 Fax +21 531 4794		t_b_m@mweb.co.za
University of Cape Town	John Cooper			John.Cooper@uct.ac.za
	Peter Ryan	Tel: +27 21 650 2966 Fax: +27 21 650 3295		Peter.Ryan@ uct.ac.za
	Ross Wanless			rwanless@botzoo.uct.ac.za
	Andrea Angel			AndreaAngel@gmail.com
RSPB, UK.	Sarah Sanders	+44 (0)1767 693257		Sarah.Sanders@rspb.org.uk
	Geoff Hilton	+44 (0)1767 693292		Geoff.Hilton@rspb.org.uk
	Clare Miller	+44 (0)1767 693015		Clare.Miller@rspb.org.uk

Role	Name	Work	Home/ Mobile	e-mail
	Richard Cuthbert	+44 (0)1767 693085		Richard.Cuthbert@rspb.org.uk
Administrator, Tristan da Cunha		Tel: +871 682 087 155 Fax: 871 682 087 158		tristandcadmin@gmail.com hmg@cunha.demon.co.uk
Island Council				
Island Doctor				
Head, Agriculture & Natural Resources	James Glass			Tristannrd@uuplus.com
Conservation Officer	Trevor Glass			Tg.conservation@gmail.com
Public Works (Carpentry)	Herbert Glass			
Public Works (Electrical/ Plumbing	Stanley Swain			
Public Works (Transport)	Terence Green			
Public Works (Mechanical)	Joseph Green			
Education	Anne Green			
Island Store	Judy Green			

Role	Name	Work	Home/ Mobile	e-mail
Weather forecaster				
Trimble (GPS)				
Av gas supplies				
Bait Supply	Bill Simmons (ACP Wanganui)	Tel + 64 6 3445302 Fax + 64 6 3442260	025 7980028	Simmo@pestoff.clear.net
	Kevin Jeffery (Storeman)	Tel + 64 6 3445302		
Bait assay	Lynette Dey MAF (Wallaceville, NZ)	Tel + 64 4 5280718 Fax + 64 4 5281375		
Bait assay, toxicology	Geoff Wright, Landcare Research (Lincoln, NZ)	Tel + 64 3 325 6700 Fax + 64 3 325 2418		Wrightg@landcareresearchco.nz
Toxicology	Penny Fisher, Landcare Research (Lincoln, NZ)	Tel + 64 3 321 9665 Fax + 64 3 325 2418		Fisherp@landcareresearch.co.nz
Toxicology lab or expert, South Africa	?			
IEAG (technical support)	Keith Broome			Kbroome@doc.govt.nz

24 Appendix 2. Buildings and other sites for hand bait spread

Locations	Date baited (dd/mm/yy)	No. of bait stations	Person responsible
Edinburgh Settlement			
All residential houses and associated sheds and garages			
Administrator's Residence and outbuildings			
All temporary accommodation units			
Government buildings: Administration/treasury Agriculture Mechanical Medical Natural resources Police Post & telecoms Public works			
Supermarket (all buildings and attic spaces)			
Disused glasshouses and associated buildings			
Around outside of all poultry pens (in rock walls, etc)			
Wharf buildings and containers			
Fish factory and outbuildings			
School (all classrooms, storerooms, kitchen etc)			
Buildings elsewhere			
Potato Patches sheds and cribs			
Administrator's hut			
Sandy Point hut			
The Caves huts			
Stonybeach huts			

Locations	Date baited (dd/mm/yy)	No. of bait stations	Person responsible
Islets			
Hillpiece Hardies			
Potato Patch Hardies			
Sailshardy rocks?			
Caves			
Hottentot Cave GPS ref S37.07600° W12.30750°			
Devil's Hole (Knockfolly Ridge) cave GPS ref S37.08200° W.1230850°			
Hillpiece Cave GPS ref S.3707750° W.1232450°			
Cave N of Round Hill GPS ref S.3713979° W.1229462°			
Between Cave Gulch and Round Hill GPS ref S37.13819° W12.28935°			
Between East Castle and Nellie's Hump GPS ref S37.09812° W12.30512°			
Any other			
[state location:]			

The Royal Society for the Protection of Birds is the United Kingdom charity working to secure a healthy environment for birds and wildlife, helping to create a better world for us all. The RSPB belongs to BirdLife International, the global partnership of bird conservation organisations.

www.rspb.org.uk

The Tristan Agriculture and Natural Resources Department is responsible for biodiversity conservation on Tristan da Cunha. It works in partnership with organisations from around the world, specifically in the UK and South Africa, to reduce the rate of biodiversity loss on the Tristan Island group.

The Percy Fitzpatrick Institute of African Ornithology is part of the Department of Zoology at the University of Cape Town. Its mission is to promote and undertake scientific studies involving birds that contribute to the conservation of biological diversity and the sustained use of biological resources.

www.fitzpatrick.uct.ac.za

The Avian Demography Unit is a research unit in the Department of Statistical Sciences at the University of Cape Town. It contributes to the understanding of bird populations, especially population dynamics, and thus provides input to their conservation.

www.aviandemography.org.za

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