DARTMOOR NATIONAL PARK AUTHORITY

Moor than Meets the Eye

Lidar Survey 2013

CONTRACT

THIS CONTRACT is made this 29th day of January 2013

BETWEEN

FUGRO-BKS LIMITED (a company registered in Northern Ireland under company no. NI005303) of Killeague House, Knocklynn Road, Coleraine, Northern Ireland BT52 1WW ("the Contractor")

and

DARTMOOR NATIONAL PARK AUTHORITY of Parke, Bovey Tracey, Newton Abbot, Devon TQ13 9JQ ("the Authority")

Background and Purpose

1 The Authority, working with the Forestry Commission (FC), Natural England and the Woodland Trust, wishes to commission a LIDAR Survey as part of the development phase of the Authority's HLF Landscape Partnership programme of work: *"Moor than meets the Eye – the story of people and landscape over 4000 years on Dartmoor"*. The survey will form a major part of delivering the objectives for the archaeology of a number of identified sites, as described more fully in the Authority's Invitation to Quote ("the Invitation").

The Service

2 The Contractor will undertake a LIDAR survey, including waveform data, of the Fernworthy, Bellever, Soussons and East Dartmoor NNR, as specified in the Invitation. The Contractor will then produce Elevation Models and all other data required by and in accordance with this Contract, the Invitation and the Contractor's quotation. The Authority acknowledges and agrees the final deliverables set out in part 6.1.1 of the Contractor's quotation and these are incorporated into the Service ("the Deliverables").

The Contract Price

3 The total price agreed for the satisfactory completion of the Service is £23,000 excluding VAT. This comprises the quotation of £19,750 for the agreed survey work, together with the quotation of £3,250 for the Deliverables, both excluding VAT.

Timescales and Contract Period

4 Timely provision of the Services shall be of the essence of the Contract. In particular, satisfactory completion of the Service is required on or before 4pm on 28th February 2013 ("the Completion Date").

5 The Completion Date may, at the Authority's absolute discretion, be extended in the event that adverse weather conditions are acknowledged and accepted as the main factor in preventing completion of the Service by the Completion Date.

Contract Performance

6 The Contractor shall perform the Service in accordance with:

a) this Contract;

b) the Invitation (incorporating the Specification and the Authority's General Conditions of Contract) (Annex 1 hereto); and

c) the Contractor's quotation (Annex 2 hereto)

7 In the event of any discrepancy or dispute between this Contract and the documents listed above, the conditions and provisions shall apply in the order of precedence a) to c) above.

8 The Contractor warrants that the Contract will be performed with all due skill, care and diligence, and in accordance with good industry practice and legal requirements.

9 The Contractor and the Authority may agree that the Service is further refined or better performed by such written or oral instructions as may be from time to time given by or on behalf of the Authority.

Contract Management

10 The Contract shall be managed –

a) on behalf of the Authority by:

Stephen Scoffin, Moor than Meets the Eye Project Officer,
mailto:sscoffin@dartmoor.gov.uk
tel: 01626 831026

b) on behalf of the Contractor by:

Mervyn Adams, Production/Project Manager,
mailto:madams@fugro-bks.com
tel: 028 7035 2311

Payment

11 The Authority will pay the Contractor the Contract Price, excluding VAT but including all costs, expenses, disbursements and contingencies in respect of the satisfactory completion of the Service. The full Contract Price shall be paid in accordance with the Authority's General Conditions of Contract.

General Conditions of Contract

13 The Authority's General Conditions of Contract are incorporated into this Contract and are reproduced as Appendix 3 to the Invitation to be found at Annex 1 hereto.

Notices

14 All or any notices to be given under this Contract shall be given in writing and sent by Royal Mail first class "signed for" post or another carrier or courier where a signature or proof of delivery is required. Notice shall only be given and accepted by these means.

15 For the purpose of ongoing performance of the Contract or advance warning, there is nothing to prevent advance copy of such notices being sent by electronic means to either party's contract manager, but the date any notice takes effect shall be calculated only be reference to the date is delivered by the means described in clause 14.

Disputes

16 The parties hereby declare and affirm that if any dispute shall arise between them in relation to this Contract, they will endeavour to resolve the matter through discussion and negotiation.

English Law

17 This Contract shall be governed and construed according to the laws of England and each party submits to the exclusive jurisdiction of the English courts.

AS WITNESS the hands of the said parties:

For	FUGRO-BKS Ltd	**For**	Dartmoor National Park Authority
Signed		**Signed**	
Name	Robert Loughran	**Name**	STEVE SCOFFIN
Position	EUROPEAN SALES MANAGER.	**Position**	MORE THAN THE EYE PROJECT MANAGER

heritage lottery fund

Forestry Commission England

Dartmoor National Park Authority

LIDAR SURVEY CONTRACT

INVITATION TO QUOTE

1. **Background**

Dartmoor National Park Authority, working in partnership with the Forestry Commission (FC), Natural England and the Woodland Trust wishes to commission a LIDAR Survey as part of the development phase of the Authority's HLF Landscape Partnership programme of work: *"Moor than meets the Eye – the story of people and landscape over 4000 years on Dartmoor"*.

The survey will form a major part of delivering the objectives for the archaeology of a number of identified sites, which are to:

- improve the visibility and the interpretation of the archaeological sites
- rediscover those sites which has been lost or obscured by tree planting
- restore sites to their age old natural settings
- produce new material for interpretation, education and publication purposes
- assist the Forestry Commision in the refinement of future forest plans and operational assessments to ensure that accidental damage to archaeological sites does not occur during forestry operations
- engage volunteers in the management of archaeological sites
- identify and map large canopy trees and likely veterans that can assist with identifying potential bat roosts, and likely concentrations of lichen assemblages.
- assist with the mapping of invasive evergreen species, such as holly, rhododendron, and regenerating conifer

2. The Sites

(a) Fernworthy

Fernworthy forest is owned by the Duchy of Cornwall and covers an area of 5.72sq km. The major afforested area is leased to the Forestry Commission, whilst the area immediately around the reservoir is leased to South West Water. The terrain is varied, with contours of up to 500m and ranging from areas of rough boulder-strewn ground, brash covered compartments and large areas of densely planted sitka spruce, of varying ages. It is interspersed with a number of water courses and the whole site is crossed by hard surfaced forestry tracks. It contains a large number of visible archaeological sites set within clearings within the forest.

(b) East Dartmoor NNR

East Dartmoor NNR is just a stone's throw from the iconic Haytor Rocks, and straddles both the high open moors and lower wooded valleys. It's made up of three joined but distinct areas; Yarner Wood, Trendlebere Down and the valley of the River Bovey, and in all covers over 345 ha of some of England's most dramatic scenery.

The reserve is internationally important for its extensive ancient upland oak wood, heathland and mires. These habitats support a great range of plants and animals; from abundant species like the great-spotted woodpecker to the rare blue ground beetle and Barbastelle bat. The NNR is legally protected as a Special Area of Conservation and Site of Special Scientific Interest.

The Bovey Valley Woods comprise four separate woodlands Higher Knowle Wood (10.01ha), Pullabrook Wood (19.98 ha), Hisley Wood (42.02ha) and Houndtor Wood (24.19 ha). The woodlands comprise stands of mature native species, interspersed with pure blocks of conifer established in the 1960s. The ground is often steep and rocky with a complex terrain of deep river valleys. Hisely Wood is classified as a SSSI for its lichen assemblages and Higher Knowle for the site geology. Hisley Wood contains two former farmsteads Boveycombe and Vinnecombe believed to be medieval in origin and in the case of Boveycombe farmed up until the 1920s.

(c) Bellever

Bellever forest is owned by the Duchy of Cornwall and covers an area of 5.26 sq km. The main afforested area is leased to the Forestry Commission; the Dartmoor Pony Heritage Trust have grazing rights over the unplanted areas and currently have a Higher Level Stewardship agreement with Natural England.

The terrain is varied with the afforested contours of up to 425m. It has areas of densely planted sitka spruce of varying heights, boulder strewn and brash covered ground which are the results of recent storm damage and clear felling. The main area of Lakehead Hill, in the centre of the plantation, has remained unplanted because of the density of archaeological sites which are located there, it is important that this area is included in the survey. There are many other archaeological sites within the afforested areas The plantation is interspersed with streams and hard surfaced forestry tracks. The River Dart forms part of its eastern boundary.

(d) Soussons

Sousson forest is owned by the Duchy of Cornwall and covers an area of 2.14 sq km, the afforested area is leased to the Forestry Commission.

The terrain is varied with contours of up to 420m and ranges from areas of recently felled compartments, brash covered compartments and large areas of densely planted sitka spruce, with stands of varying ages.
There are a number of archaeological sites ; the area was the focus of intensive tinworking activity up until the twentieth century which has resulted in a number of shafts and spoil heaps associated with these situated within the afforested area.
There are a number of water courses, some which have been used for alluvial tin streamworking. The Golden Dagger mining complex is on the eastern side of the forest and although no longer part of the afforestation should be included in the Lidar survey

3. Project Requirements

Undertake a LIDAR survey and production of high quality Elevation Models, in accordance with the specification set out at Appendix 1, including a Digital Terrain Model (DTM) of afforested parts of the landscape, in the survey areas specified in Appendix 2.

A shapefile containing polygons of the survey area(s) will be supplied. Metadata on survey parameters and vegetation removal processes will also be provided.

The contractor will be required to:

- provide four hill-shaded images (in a GIS ready format) of each DTM from at least four different compass settings, in a spatial resolution that can be analysed in GIS format.
- supply the data as an arcGIS project
- present the information in a map book (1:5000 scale approximately) and DVD format for use by subsequent field based work
- provide maps of vegetation height
- present the findings of the survey at a seminar attended by project partners and other invited guests

4. Timing

The analysis, survey work and reports must be completed and the reports submitted by 28 Feb 2013.

Time is of the essence in this contract.

In the event of prolonged adverse weather, the completion date may (at the Authority's absolute discretion) be extended by agreement.

5. Quotations

Quotations must be submitted in writing, marked CONFIDENTIAL – TENDER addressed to C.R.Walledge, Head of Legal & Democratic Services and should be sent either electronically to tenders@dartmoor.gov.uk or by post to Dartmoor National Park Authority, Parke, Bovey Tracey, Newton Abbot, TQ13 9JQ, together with supporting information, to arrive no later than **2pm on Tuesday 4 December 2012**

Contractors are requested to provide **two** fixed price quotations on the following basis:

Locations (see Appendix 2)	**Approx area**	**First Quotation**	**Second Quotation**
		Point clouds & DEMs	**Point clouds & DEMs plus Waveform data**
Fernworthy and the NNR	9.84 km^2	£	£
Fernworthy, Bellever, Soussons and NNR	17.24 km^2	£	£

6. Selection of Contractor

The contract will be awarded on the basis of confidence in the contractor achieving a high standard of work, completing the work in accordance with an agreed written scheme of investigation and delivering good value for money.

Selection criteria will include:

- methodology – approach to task; data validation and checking process
- evidence of successful delivery of comparable LIDAR survey work
- evidence of successful delivery of comparable LIDAR analysis
- resilience – ability to deliver in the event of unplanned unavailability of key staff etc
- value for money

Criteria will be scored in line with the following:

Criteria	**Potential score**	**Weighting**	**Max score**
Methodology	1-5	x1	5
Evidence of successful delivery of comparable LIDAR survey in wooded and afforested areas	1-5	x3	15
Evidence of successful delivery of comparable LIDAR analysis in wooded and afforested areas	1-5	x3	15
Resilience – ability to deliver in the event of unplanned unavailability of key staff etc	1-5	x1	5
Value for money	1-5	x2	10
TOTAL			**50**

7. Contract Award

Please note that any costs incurred in preparing your quotation are entirely at your own risk. The Authority reserves the right not make any appointment and not to accept the lowest quotation.

The successful Contractor will be invited to enter into a formal contract with the Authority in the terms of this invitation to quote, the submitted quotation and the Authority's standard conditions of contract (at Appendix 3) . Until the formal contract has been completed, the successful quotation together with the Authority's written acceptance will form a binding agreement between the Authority and the successful Contractor based on the terms specified in this invitation to quote.

The details and timings of payment(s) will be discussed with the selected contractor and specified in the contract.

8. Intellectual Property Rights

It is the Authority's intention that all raw elevation and derived data, text, illustrations, information, correspondence and all documents acquired, created or otherwise obtained in any work under this Contract shall be the sole property of the Authority and shall be free to use such material or any part thereof as it sees fit.

9. Freedom of Information

Contractors should be advised that information relating to any contract or procurement exercise to which the Authority is party, including information about price and performance, is covered by the Freedom of Information Act 2000 (the Act). The Authority is under a legal obligation to disclose such information if requested unless an exemption under the Act applies.

Any person submitting a quotation or entering into a contract with the Authority should, as part of the contract process, inform the Authority of any information which it regards as being eligible for a claim for exemption from disclosure by the Authority under the Act. The final decision as to what information can be disclosed rests with the Authority

Appendix 1

Survey Specification

1. Project requirements

The following project requirements are proposed. Your quotation should;

(a) confirm whether you can deliver these requirements; and

(b) indicate whether you believe them to be appropriate requirements and in particular whether in your opinion there may be a more effective, reliable or efficient method of delivering the project

- a project manager and day to day point of contact must be clearly identified
- surveys shall be flown between mid December and mid February
- surveys must not be undertaken if deep or drifted snow is lying on the survey site (a light dusting can be tolerated providing it does not mask the terrain)
- regular updates will be required on progress with data capture and any change in the condition of the on-site vegetation (i.e plants coming into leaf)
- deployment of a field team to the survey areas should be avoided if possible, or if absolutely necessary it should be limited to the minimum necessary to secure useable data
- Deliverables from the survey to be provided no later than 28 February 2013.
- an archive copy of all raw and processed data shall be retained by you until 28 February 2019

2. Survey requirements

The following survey requirements are proposed. Your quotation should;

(a) confirm whether you can deliver these requirements; and

(b) indicate whether you believe them to be appropriate requirements and in particular whether in your opinion there may be a more effective, reliable or efficient method of capturing the data

- Data is to be captured at a minimum resolution of 2 hits per square metre (or higher if more practicable
- A class 4 laser shall be used to increase the chances of receiving a signal reflected from the forest floor
- Ground truth surveys for the checking of LIDAR height accuracy to be carried out within each flight
- The ability to record subtle changes in resulting elevation models is essential. Relative changes in elevation are therefore more important than obtaining absolute

vertical accuracy. ALTM calibration on a known target area is expected, as is the use of OS base stations.

- The **maximum** angle of scan from vertical (half-scan angle) shall be 15 degrees and swath widths shall be of 600m or less (equating to a 15 degrees and maximum survey height of 1000m AGL)
- A 55% overlap of adjacent swaths shall be used to further reduce the effects of the laser striking trees side-on at the edge of the swath
- Full waveform data to be collected and provided *(Quotation 2 only)*

3. Deliverables

The following deliverables are proposed. Your quotation should;

(a) confirm whether you can deliver these requirements; and

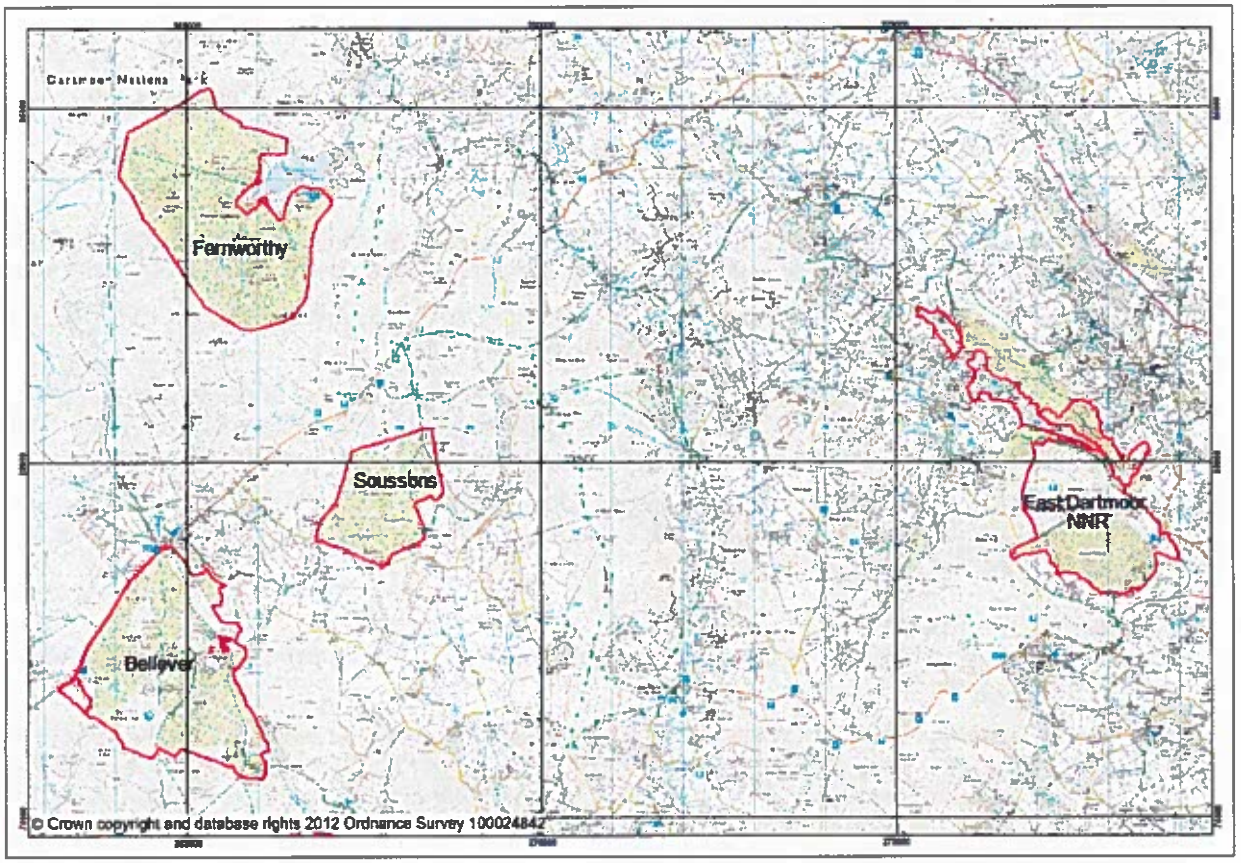
(b) indicate whether you believe them to be appropriate deliverables and in particular whether in your opinion there may be a more effective, reliable or efficient method of delivering the required outcomes

- Point cloud data (first pulse X,Y,Z,I and last pulse X,Y,Z,I) to be provided, geo-referenced to the British National Grid. Data to be supplied as 1x1 Km areas and as ASCII, LAS and CSV / TXT files. Inclusion of intermediate returns and/or point classification is preferred, unless it increases project costs.
- Separate DEMs to be provided as a single raster for the extent of each survey polygon
- Provision of geo-referenced First Return DSM in .IMG format with a 0.5m cell size. Interpolation to populate empty cells where necessary.
- Provision of geo-referenced DTM (with the same cell size and format as the DSM) following vegetation removal. – Vegetation removal should result in the highest quality DTM possible, using waveform or intermediate return data to help determine ground points if practicable. However, filtering should not be too extreme to reduce the risks of potential features of interest from being removed. Where dense vegetation prevents the vegetation removal process from determining a confident ground, gaps should be left within the DTM, rather than forcing a surface to be filled in or smoothed over.
- Data supplied is to be accurate to a DMSE of +/- 15cm.
- A quality control report to be supplied by 28 February 2013, to include:
    - A plot of all data indicating polygon coverage and aircraft navigation lines
    - A copy of the flight log for all polygons
    - Data processing procedures
    - A report on comparison of survey data with ground truth data
- Waveform data to be provided in TXT or similar ASCII format and in files no greater than 1.0 Gb in size. *(Quotation 2 only)*

Appendix 2

Survey Area Specification

The survey areas are set out below:



Appendix 3

General Conditions of Contract

1 **Definitions**
In these General Conditions of Contract the following terms shall have the following meanings:

"Authority"	Dartmoor National Park Authority
"Contractor"	.....
"Contract"	The contract for the provision by the Contractor of services to the Authority
"Contract Brief"	The invitation to quote issued by the Authority on .....

2 **Provision of the Services**
The Contractor shall perform work under the contract in accordance with the Contract Brief together with such written or oral instructions as may from time to time be given by or on behalf of the Authority.

The Contractor warrants that the Contract will be performed with all due skill, care and diligence, and in accordance with good industry practice and legal requirements

Any failure to provide correctly formatted, accessible copies of reports, text, drawings, illustrations, plans and other documents in a Microsoft Office compatible electronic format capable of further editing (not read only) shall be taken to be a failure to deliver proper performance under this contract.

Where any conflict arises between these General Conditions of contract, the provisions of the Contract, the Contract Brief, or the Contractor's quotation, the provisions shall apply in the order of precedence specified in the Contract

3 **Quality and Description**
The Contractor's work shall conform as to the quantity, quality and description with the particulars stated in the Contract;

The Authority reserves the right to amend the contract specification including the substitution, deletion and addition of conditions and requirements, **PROVIDED ALWAYS** that no amendment shall be made without the Contractor first being afforded the right to make representations to the Responsible Officer **AND** also given the opportunity to indicate whether there will be a supplemental charge in respect of any additional work consequent upon the proposed amendment which the Contractor believes was not in the contemplation of the parties at the date of signing this contract

4 **Invoicing & Payment**
Unless otherwise agreed in writing, payment will be made upon satisfactory completion of the work, as specified in the Contract, within 30 days of receipt of a written invoice.

It shall be open to the Authority to agree other arrangements for invoicing and payment, for example: to provide for an inception payment, stage payments and/or retentions.

5 **Confidentiality**
The Contractor shall not disclose to any person, firm or company any information of a confidential nature obtained in any work under this Contract and for the avoidance of doubt this obligation of confidentiality shall continue beyond the termination of this contract, without limit of time.

6 **Assignment or Sub-Contracting**
The Contractor shall not assign, sub-rogate or transfer the Contract or any part or parts thereof to any other person, firm or company, except with the prior written consent of the Authority

7 **Intellectual Property Rights**
For the avoidance of any doubt it is hereby agreed and declared that all data, text, illustrations, information, correspondence and all documents acquired, created or otherwise obtained in any work under this Contract ('the work') shall be the sole property of the Authority who shall be free to use the work as it sees fit

The Contractor agrees and undertakes that the Authority's organisational name, logo or other identifying mark shall not be used without prior written approval from the Responsible Officer.

8 Data Protection Act 1998

In respect of any "personal data" which may come into its possession through its work on this contract, the Contractor shall comply in all respects with the provisions of the Data Protection Act 1998 and will indemnify the Authority against all actions, costs, expenses, claims, proceedings and demands which may be brought arising from the use, disclosure, transfer or other processing of personal data by the Contractor or any person employed by the Contractor or acting on the Contractor's behalf (whether with or without the knowledge of the Contractor)

9 Freedom of Information

This Contract shall be subject to the provisions of the Freedom of Information Act 2000 and the parties acknowledge that the Authority shall comply in all respects with the provisions of the Act and in particular shall communicate to any persons making a request under the Act all and any information contained in or relating to this Contract where required by and in accordance with the provisions of the Act

10 Health & Safety at Work

The attention of the Contractor is directed particularly to the responsibilities of employers under the Health and Safety at Work Act 1974 (as amended) and Codes of Practice issued by the Health and Safety Executive. The Contractor shall at all times be responsible for ensuring safe systems of work, suitable and safe equipment and a safe working environment for all activities coming under the scope of this contract.

11 Bankruptcy/Liquidation etc.

In the event of the Contractor becoming bankrupt or making a composition or arrangement with its creditors or having a proposal for a voluntary arrangement for a composition of debts or scheme or arrangement approved in accordance with the Insolvency Act 1986, the Authority shall be at liberty to cancel the Contract by notice in writing without compensation to the Contractor.

12 Corruption

The Authority shall be entitled to cancel the Contract and to recover from the Contractor the amount of any loss resulting from such cancellation if the Contractor shall have offered or given or agreed to give any person a gift or consideration of any kind as an inducement or reward for doing or forbearing to do or for having done or forborne to any action in relation to the obtaining or execution of the Contract or any other Contract with the Authority or for showing or forbearing to show favour or disfavour to any person in relation to the Contract or any other contract with the Authority or if the like acts shall have been done by any person employed by him or acting on his behalf (whether with or without the knowledge of the Contractor) or if in relation to any contract with the Authority, the Contractor or any person employed by or acting on its behalf shall have committed any offence under the Bribery Act 2010, Prevention of Corruption Acts 1889 & 1916 or shall have given any fee or reward the receipt of which is an offence under Section 117(2) Local Government Act 1972

13 Force Majeure

Neither the Authority or the Contractor shall be liable to the other for any delay or failure by either party to perform its obligations under the Contract if any such delay or failure arises from any cause or causes beyond the reasonable control of either party, including, but not limited to lightning, earthquakes, riots, acts of terrorism, regulations or orders of any Government, agency or subdivision thereof

14 Variation of Contract

The Contract and its provisions shall only be capable of amendment by a written agreement signed by the parties.

15 Termination

This Contract may be terminated at any time, without cause, by the Contractor or the Authority serving 30 days notice in writing on the other party.

The Authority reserves the right to terminate the Contract forthwith if at any time it considers that the Contractor is in material or serious breach of his obligations under the Contract or that any terms and conditions of the Contract are not being performed in a proper and businesslike manner or to the true intent and meaning of the same.

The termination of the Contract shall have no effect upon the accrued legal rights and obligations under this Contract between the parties.

FUGRO-BKS LIMITED

Dartmoor National Park Authority

LiDAR Survey Contract

Tender Response by Fugro-BKS Ltd

CONFIDENTIAL

Contents

1. Background

Fugro-BKS understands that Dartmoor National Park Authority working with other responsible Stakeholders wish to increase their knowledge of the archaeology across Dartmoor particularly that which may now be occluded by tree planting. To achieve this aim there is a need to better understand the landscape and topography of the Moor.

One the key survey tools for collecting accurate topography over wide areas is airborne laser mapping or LiDAR. The system works by pulsing a light beam from an emitter which travels to the ground, were it strikes an object and returns to the sensor. As the speed of light is known and also the location of the aircraft through GPS and IMU recordings a very accurate x,y,z co-ordinate can be produced for each of the pulses. As the sensor fires thousands of pulses a second the pulse returns begin to build a 3D point cloud of the survey area's topography and once processed can be used to produce Digital Terrain and Surface models.

A key advantage that LiDAR has over say an aerial photography generated DTM is the fact that it can return pulses from underneath vegetation. LiDAR is an active system unlike a camera which is passive. Each pulse is capable of striking objects and returning up to four times this allows the pulses to travel 'through' vegetation and reach the ground. The result is a more accurate surface topography particularly under dense vegetation.

This tender submission has been produced in response to Dartmoor National Park Authority's request to collect new airborne LiDAR data for four sites totalling 17.24km².

2. Introduction

This proposal is submitted by Fugro-BKS Ltd., a company incorporated in the United Kingdom and a wholly owned subsidiary of Fugro NV and part of Fugro Geospatial Services Group.

Fugro NV is a public company listed on the Amsterdam stock exchange with 275 offices, 13,000 employees located throughout the world and an annual turnover in excess of 2 Billion Euro.

Fugro-BKS brings extensive experience, technical and commercial knowledge and financial strength that will provide significant benefits to Dartmoor NPA in relation to this airborne LiDAR project. It is accepted that other organizations may be capable of completing this project. However the advantages which Fugro-BKS brings translates into the following direct benefits:

- Aerial LiDAR and photography expertise with systems operating on a day-to-day basis as our core business.
- In depth understanding of LiDAR specifications from work with Local Authorities and Government Agencies.
- Previously worked with the Environment Agency, Forestry Commission, Coillte (Irish Forestry), The Forestry Service, Office of Public Works and the Rivers Agency on airborne LiDAR data collection. In total Fugro-BKS has collected over 12,000km² of LiDAR data through the United Kingdom and Ireland.
- Have a current Framework with the Northern Ireland Environment Agency which involves LiDAR acquisition over archaeological sites across Northern Ireland. Due to Northern Ireland's terrain most of the prehistoric site acquisition is over moorland.
- Have completed airborne LiDAR surveys for archaeological purposes for Historic Scotland (including St Kilda & Orkney), The Discovery Programme, University College Cork, University of Notre Dame and University College Dublin.
- Proven track record of producing LiDAR terrain products that meet nationally recognised standards: RICS, APRS, TSA.
- Direct access to the knowledge and technical expertise required to successfully complete this project to the highest standards.
- Extensive software development teams that design and build software solutions that are intrinsic to Fugro's day-to-day survey activities and can be brought in at any time.
- Robust commercial and technical reporting systems that come from being a Private Limited Company.
- Robust Project Management, HSE and QA systems that are being constantly improved by more than 13,000 staff.
- Access to the global Fugro secure ICT network that allows the transfer of highly confidential information in a secure environment.

COMPANY BACKGROUND AND ORGANISATIONAL STRUCTURE

The company is organized into three Divisions (Survey, Geotechnical and Geoscience Services) and within this divisional structure; there are a total of eight global Business lines, of which Geospatial Services is one.

Fugro Geospatial Services is comprised of 15 established survey companies (with more than 30 offices) operating on a global basis, some of which have been in operation for over 50 years. Today,

Fugro Geospatial Services operate more than 20 survey aircraft on a global basis and employ over 1400 highly qualified and experienced geospatial engineers. Two of the Geospatial Operating Companies will combine their experience, expertise and resources to provide a complete geospatial data solution for this project.

Fugro-BKS Ltd.
Killeague House
Knocklynn Road, Coleraine
Northern Ireland, BT52 1WW
T. 028 7035 2311
F. 028 7035 7637
W. www.fugro-bks.com

Fugro-BKS is one of UK's most experienced and respected suppliers of airborne and terrestrial survey services including the provision of aerial photography, LiDAR and topographical survey for a range of engineering based applications where resolution, precision and accuracy are of paramount importance.

QUALITY

Fugro-BKS is ISO18001, 14001 and 9001:2008 accredited and have implemented an Integrated Management System based on these accreditations. We understand the importance of having an implemented quality testing and acceptance program for all project phases. Testing will be conducted in each phase to ensure products meet the specified criteria. A software based tracklng and quality assurance tool will be utilized to ensure that uniform quality standards are adopted throughout all datasets.

The following tender presents the objectives of the project, the technical advantages of the Lite Mapper system, the technical approach, the product deliverables, staff/project experience and our financial tender.

F-BKS confirm that we will deliver the final survey datasets to Dartmoor on or before 28th February 2013.

The point of contact for this proposal is:

Chris Boreland

Business Development Manager

E: cboreland@fugro-bks.com

T : 028 7035 2311

F : 028 7035 7637

3. Project Objectives

Fugro-BKS Limited is pleased to provide this proposal to Dartmoor NPA for the capture of LiDAR data for sites with the National Park. Our understanding of the project requirements is as follows:

- Acquire airborne laser data for 4 sites notably Fenworthy, Soussons, Bellever and East Dartmoor NNR.
- Surveys will not be carried out when the ground is covered with snow or during a flood event.
- The minimum point density will be 2 point per m².
- The maximum angle of scan from vertical will be 30°.
- A 55% lateral overlap between swaths shall be used.
- Full waveform data to be collected and provided *(Quotation 2 only)*.
- The grid resolution of the LiDAR DSM/DTM is to be a maximum of 0.5m.
- The overall height accuracy of data shall be ±0.15m RMSE in open unvegetated areas.
- All final datasets are to be delivered before the 28th February 2013.

FUGRO-BKS APPROACH

Fugro-BKS propose to use a twin engined fixed wing aircraft with a Reigl LMS-Q680i laser sensor installed. The survey will be flight planned to acquire a minimum of 7.5 point per m² (ppm) over each of the sites at an altitude of 500m.

The lower flight altitude will also increase the point density. Having reviewed the sites some of the Highland areas cover significant commercial forest plantations. With our experience acquiring LiDAR for Coillte (Irish Forestry Commission), The Forest Service (NI) and The Forestry Commission we have found that a higher point density helps to ensure that enough ground returns are collected under these dense plantations.

We will use virtual stations instead of the traditional surveyor manned base stations. The time stamped GPS data will downloaded from the OSGB CORS Network and used to control the LiDAR data.

For quality control purposes Ground Control Areas will be established at each of the survey locations. The GCAs will ensure that the accuracies stipulated in the Specification are achieved.

After pre-processing the LiDAR, virtual base station, aerial GPS and iMU datasets to produce a geo-referenced point cloud. F-BKS's technicians will conduct an automated process using bespoke software to create the required gridded terrain models. Prior to delivery to the client these models will be manually verified to make sure they meet the client's specification. This process will involve the utilisation of the GCAs and were possible existing terrain datasets from our archive.

4. Method of Undertaking Research

4.1 Project Appreciation

To collect the required terrain data for this project in an adequate manner, a combination of airborne LiDAR and ground based control methods will be the best option.

Fugro-BKS have been involved in the acquisition of airborne LiDAR for archaeological purposes in England, Scotland, Ireland and Northern Ireland. So understand the processes involved in the collection of airborne LiDAR data and the production of the associated terrain datasets on this scale. These proven steps and methodologies will be used on this project to achieve datasets that are fit for purpose.

F-BKS propose to use a laser mapping sensor installed in a fixed wing aircraft to collect 3D height information for the sites. The survey will be flight planned in accordance with the tender specification and the sites will collected in late December/early January. The collected data will be processed to produce DSM/DTM products.

The following technical approach has been developed through extensive project experience and is structured to address the points outlined in your specification.

4.2 Raw Data Acquisition System

The survey will be planned at an altitude of approximately 500 metres AGL, which will realise a minimum LiDAR point density of approximately 7.5 points per m² over each project area. The vertical accuracy will be equal to or better than ±15cm and horizontal accuracy equal to or better than ±20cm.

Data will be collected using a fixed wing platform, Piper Aztec – similar to that shown in Figure 1. The laser scanner will be a Riegl LMS-Q680i sensor with a pulse repetition rate of up to 400,000Hz and full waveform digitisation. Navigation will be carried out using dedicated flight navigation software, which uses GPS to aid the pilot in following the planned flight lines.

NOTE: The Riegl LiDAR system is one of the most up to date systems on the market. Older systems such as the Leica ALS-50 and Optech Gemini scanners use oscillating mirrors which can produce 'noise' at the end of the swath. To limit this noise the scan angle was reduced to 30° (15° half scan angle). The new Riegl systems operate a rotating polygonal mirror which do not suffer from this problem so a wider field of view can be utilised.

For LiDAR data acquisition, the aircraft will only gather data when the predicted GPS Positional Dilution of Precision (PDOP) is less than 3. Notification of the correct functioning of the GPS equipment will be made in the flight report within one week of the final flight.

The following table lists the airborne LiDAR hardware that will be used for carrying out the work on the project:

4.2.1 Airborne Laser Altimetry System (LiDAR)

Hardware	Purpose
Riegl Scanner LMS-Q680i	Airborne Laser Scanner with full waveform signal capture
Scanner Type	4 Faced Polygon Rotating Mirror

Scan Direction	Parallel Scanning Lines
Scan Speed	10 to 200 lines per second (154 for this project)
Scan Angle	60°
Sensor Accuracy (flat surface parallel to beam)	20mm
Pulse Repetition rate	266,000Hz (240,000Hz for this project)
Maximum number of returns	Unlimited
Ground Sample Spot Diameter	0.15m (@ 500m AGL)
Surface Point Accuracy (vertical/horizontal) excluding GPS errors	0.04m/0.08m (1 sigma) @ 500m AGL

Calibration procedure:

After installation of the LIDAR within the aircraft, the offsets of the GPS antenna to the common reference point (CRP) will be determined. As the aircraft GPS antenna mount is directly above the scanner the offsets are relatively small and any error in these offsets will have minimal impact on the final data accuracy.

Fig 1 : Survey Aircraft

4.3 Flight Parameters

IGIPlan© Mission Planning software has been used to calculate the flight plans for each of the Work Packages. This software is specifically designed for the Riegl LiteMapper laser sensors.

4.3.1 Work Package – All Sites

Proposed flight window: December 2012 to January 2013

- Planned flight lines, including cross lines:
  - flight lines including cross lines: 24
  - Total flying kilometres: 100
- Flight elevation, flight speed, width of scan, and overlaps with adjacent lines and previous flights
  - Elevation: 500 metres above mean sea level (approx. 1,640feet)
  - Flight speed: 110kts
  - Width of scan: 577m (including overlap)
  - Overlaps with adjacent lines: 40% overlap
- Scan frequency and laser footprint to be achieved
  - Scan frequency: 240 kHz (PRR), 154 scan lines per second
  - Laser footprint (spot diameter) 15 cm

4.3.2 Proposed Flight Lines (Figure 2)

A tabular and digital copy of the individual flight lines can be provided on request.

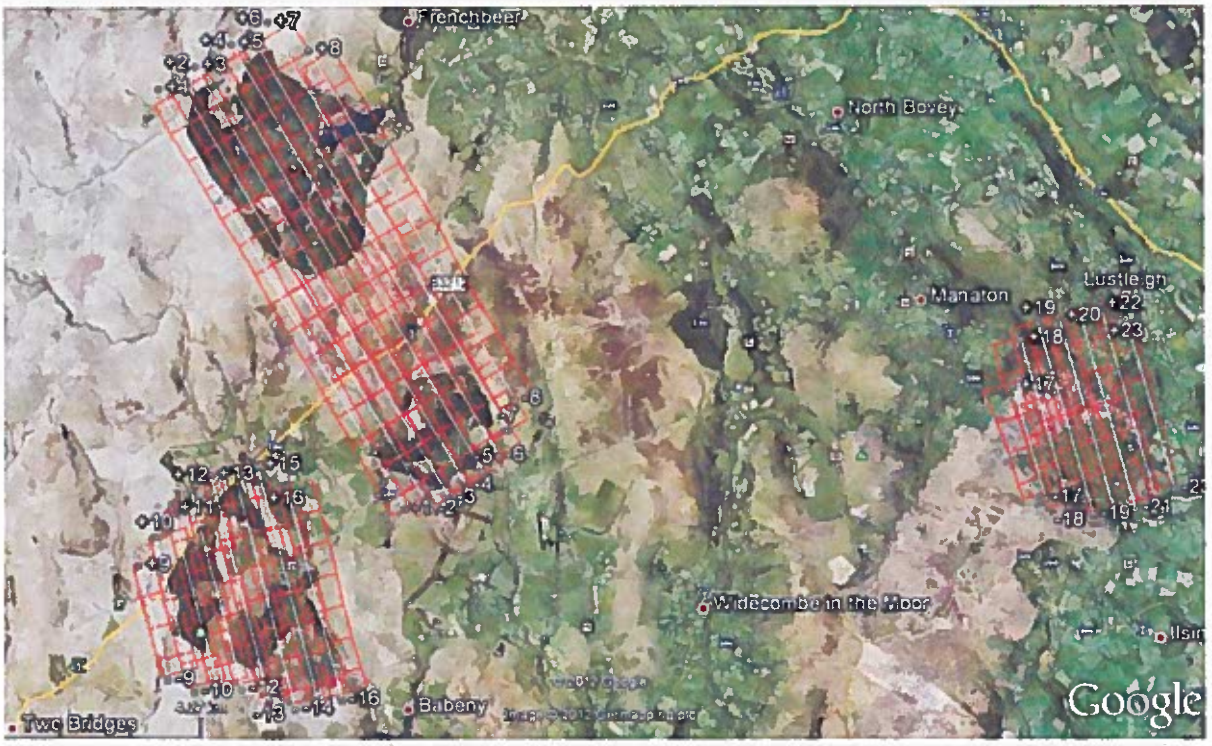


Figure 2 – Proposed Flight Lines (NOTE: The scanner will remain on between the Soussons and Fernworthy sites so additional LiDAR data will be available and can be processed at a later date for a small charge).

4.4 Navigational Systems

4.4.1 Airborne GPS System/Inertial Navigation Unit (IMU)

Hardware	Purpose
IGI *LMcontrol*©	Sensor Management System onboard the aircraft
IGI *CCNS4*© Computer Controlled Navigation System	Guidance and Positioning System
IGI *AEROcontrol*© Dual Frequency GPS Receiver	Records GPS data during acquisition
IGI *AEROcontrol*© IId 256kHz IMU	Records angular rotations during acquisition

Software	Purpose
Novatel GrafNav	GPS post processing
IGI *AEROoffice*©	IMU processing
Post Processing Workstations	For post processing raw LiDAR data

4.4.2 Processing

The airborne GPS readings are processed using Novatel GrafNav software. The accuracy of the collected data will be to centimetre level. The IMU readings are processed using the IGI AEROoffice and then combined with the GPS readings using the same software suite.

IMU Accuracy Statement;

- Manufacturer: Phi/Omega 0.004 deg, Kappa 0.01 deg
- Typically: Phi/Omega 0.003 deg, Kappa 0.004 deg

4.4.3 Calibration Procedures

No specific calibration of GPS units is required. All GPS units are serviced when required.

IMU Calibration Procedure;

- Boresight calibration
- IMU unit recalibrated every other year by the manufacturer

4.4.4 Base Stations/Ground Control Areas

Hardware	Purpose
2 x Leica 530 GPS Dual Frequency Receivers	To observe the GCA points

Software	Purpose
Leica Geo-Office Pro	Processing of the GPS readings and GCA points
Trimble VRS	Download and process the 1-arc second RINEX data

Fugro's continuing research into improving our LiDAR sensors and GNSS Augmentation have allowed us to move away from the need to install manned base stations during a LiDAR survey while at the same time achieving the maximum available accuracy. For this project we intend to use downloaded GPS data from the 1-arc second OSGB active GPS Network and Trimble's VRS Network.

The ground based GPS readings will be computed using Leica Geo-Office Pro software.

No specific calibration of GPS units is required. All GPS units are actively collecting 24 hours a day all year round. As a control measure should 1 station malfunction our Survey Manager is alerted by email within 1 hour.

With regard to the GCAs the plan will be to install at least 1 GCA per survey area, the locations of each will be submitted prior to survey commencement.

The location of the GCA is selected to incorporate topographical features that can be identified on the LiDAR data (intensity). A typical location would be a road intersection where we would survey an average of 30 air-visible detail points XYZ eg road markings/kerb lines/road signs etc in a flat area.

4.5 LIDAR Data Processing

The data processing involves 4 key steps in the flow of production for generating the final deliverables. These steps are:

- Pre-processing
- Classification of pulse data
- Post Processing Automated Filtering
- Post Processing Manual Filtering

Software	Purpose
Novatel GrafNav	GPS post processing
IGI *AEROoffice©*	IMU processing
TerraSolid TerraScan	Manipulating, viewing and classifying LiDAR data
3 x Post Processing Workstations	For post processing raw LiDAR data

4.5.1 Pre-Processing (Novatel GrafNav and AEROoffice)

Pre-processing is the conversion of raw LiDAR, IMU, and GPS data into XYZ points and data pre-processing algorithms use the sensor's complex set of electronic timing signals to compute ranges or distances to a reflective surface. The ranges must be combined with positional information from the GPS/IMU system to orientate those ranges in 3D space and to produce XYZ points. As with any such electronic measuring system, systematic errors can be introduced from a variety of internal and external sources – instrument timing errors, effects of the atmosphere, initialization errors and so on. However, strict calibration and testing procedures are used to make sure that systematic errors are detected and eliminated. Parameters used in pre-processing and the results of quality control checks are archived in the project database for future reference. The overlapping pre-processed data is merged and clipped into a seamless coverage for DTM/DSM production.

4.5.2 Classification of Pulse Data (TerraScan Software)

For the DTM (Digital Terrain Model) deliverable, the pulse data shall not contain water or raised objects on the ground, including vegetation, buildings, and other above-ground objects. A combination of automated and manual filtering will be used to produce this bare earth model, which will be gridded at 1m as the final deliverable.

In the DSM (Digital Surface Model) deliverable, the pulse data shall contain all features captured during the acquisition, these will include all buildings, vegetation, bridge spans, water etc. A combination of automated and manual filtering will be used to produce this surface model, which will be gridded at 1m as the final deliverable.

4.5.3 Post Processing Automated Filtering (TerraScan Software)

Fugro have developed a unique time efficient and cost effective method for automatic processing of LiDAR data to identify either ground or above ground features. The algorithm for filtering the data points has been designed specifically to process large amounts of elevation point data in batch mode. Conceptually, the goal of automated processing is to remove as many features (trees, buildings etc)

as possible automatically, thereby reducing the amount of manual editing that is required to produce a LIDAR derived bare earth surface.
Automated LiDAR filtering depends on mathematical filters to evaluate the LiDAR return data, removing points that are most likely to be non-bare earth points and creating the DSM and DTM products at the same time. Parameters are set in the software to control the size of the filter neighbourhood and the aggressiveness with which it removes points that appear to be mathematically above the bare earth surface. The filter settings are optimised for the particular terrain type and land cover apparent within a given flight line.

Determination of filter parameters can be automated to some extent by statistically characterizing the LIDAR data itself. A skilled operator can also contribute his own judgment and experience by testing small samples before letting the filters run on the entire flight line. The LiDAR analyst selects representative areas and establishes the appropriate parameters for effective processing based on terrain and vegetation type. For example, very aggressive parameters are applied to wooded areas with thick under-storey; moderate parameters for wooded areas with clear ground, and very conservative parameters for relatively clear areas. For archaeological projects these parameters are used selectively across all the sites to ensure no loss of detail.

This initial processing run re-classifies 90-95% of points falling on vegetation. The algorithm also re-classifies the points falling on the edges of hard features including structures, elevated roadways and bridges.

Once the automated filtering has been completed, the files are run through a visual inspection to ensure that the filtering was not too aggressive or not aggressive enough. In cases where the filtering is too aggressive and important terrain features (such as embankments or flood walls) have been filtered out, the data is either run through a different filter or is corrected during the manual filtering process.

4.5.4 Post Processing Manual Filtering (TerraScan Software)

Vegetation and features remaining after automatic data post-processing are removed manually through interactive editing. The data is re-processed interactively to re-classify the remaining points falling on vegetation and points falling on other above ground structures. Lone LiDAR points may be difficult to interpret based only on a TIN or shaded relief view of the LiDAR data. For example, a lone high point in the TIN could either be a tree or a rocky outcrop in rugged terrain. For this reason, it is considered "best practice" to reference aerial photography to identify and edit as necessary any remaining features in the post-processed terrain model.
Our experience on similar projects indicates that monoscopic viewing of aerial imagery or comparing the terrain data to previous DTM/DSM datasets is a cost-effective way to ensure the most accurate interpretation and editing of the LIDAR data.

For this project no new aerial photography is to be collected over the survey areas. We would plan to utilise Google Earth's imagery and potentially OSGB's MasterMap 10k raster (if the client can supply it) as the visual assessment tool.

Software visualization tools enable the analyst to quickly scan through a deliverable sector, identify areas where additional points or features need to be removed and reclassify them in the database. The surface is then redrawn allowing the analyst to immediately see the result of the edit and make further corrections, including 'undoing' previous steps if necessary. Removed points are stored in the database where they may be retrieved at a later date, if required. The final result of interactive data post-processing is the bare earth DTM deliverables in 1m grid resolution and the DSM in a 1m grid resolution covering the project areas.

4.6 Accuracy Assessment

The Quality Control measures will ensure the following:

- ✓ Our RMSE in the 95 and 99 percentile values for vertical position will not exceed 15cm;
- ✓ Our RMSE in the 95 and 99 percentile values for horizontal position will not exceed 20cm;

These accuracies apply to all hard and soft topographic features except water were the pulses will have been absorbed and no returns recorded.

4.7 Quality and Accuracy Assurance

At an operational level, Fugro-BKS and Fugro Pacifica run quality management systems that are accredited to BS EN ISO 9001:2008. These quality systems contain individual working practices that best suit the companies at an operational level and which are well-integrated into the business processes.

4.7.1 LIDAR Data Acquisition QC

During data acquisition the operator continuously monitors the following:

- Aircraft GPS. Number of satellites being received and Positional Dilution of Precision (PDOP) value.
  Range signal. Check the flying height is correct and stable from the range distance being recorded by the laser.
- Dropout rate – this ideally should not exceed 20% unless acquiring data over large bodies of water.
- Check that the laser is firing continuously throughout acquisition and that data is being recorded to the hard drive storage (from LED indicators).
- Roll and yaw of the aircraft. Roll ideally should not exceed 5° and yaw 10° during an acquisition line.

At the end of the survey day the airborne data is collected in the field office where data processors shall make back-ups of all data, perform quality control and pre-process the flight path. The quality controls are carried out to judge whether the collected data meets the project specifications or whether there are areas that will require repeat data acquisition.

4.7.2 Instrument Calibration

The LIDAR system is calibrated when installed in the aircraft and at regular intervals.

4.7.3 Flight Planning QC

Flight plans will be submitted for approval with the relevant authorities (both civil and military) upon award of contract. Prior to any survey flight Fugro-BKS will notify the relevant ATC authorities.

LIDAR flights can utilise all flight windows irrespective of lighting conditions, as the laser sensor is an active system. The survey sites will however be free of smoke or haze, snow or large areas of standing water. All inter-tidal areas will be collected at Low Water ±2 hours.

Suitable GPS conditions will be predicted using a current GPS Almanac the constraints being a period when the PDOP is less than 3 and 7 or more satellites visible.

Long range weather forecasts can be obtained for periods more than 5 days ahead. For closer periods of 1 to 5 days the Met Office or local providers will be used with local airfield forecasts and reports being used up to 18 hours in advance.

4.7.4 Ground Control Areas

Ground Control Areas (GCA's) will be used to provide the control against which an assignment area of Point Cloud Data, can be compared to determine the level of accuracy of the data collected. The location of the GCA is selected to incorporate topographical features that can be identified on the LiDAR data (intensity). A typical location would be a road intersection where we would survey an average of 30 air-visible detail points XYZ eg road markings/kerb lines/road signs etc in a flat area.

4.7.5 Processing QC

When gathering data within the specified survey area the PDOP must be less than 3 and the position standard deviation less than 0.05 metres. A GPS Almanac will used at the planning stage to identify predicted periods of suitable PDOP. After the acquisition if high PDOP or higher standard deviation values are identified, during processing in Novatel GrafNav, the GPS data are further processed to try and affect a better solution. Failure to meet the required target values will result in a re-fly.

Once the laser data have been processed into points the data will be viewed in TerraScan software and successive lines compared to assess areas of overlap in the data. A series of profiles are created across the data in unambiguous areas, i.e. no dense vegetation or buildings, and the differences between the co-incident points on subsequent lines of data are compared. Where unacceptable differences are observed, relative to the client specification, adjustments can be made in offsets and the data are reprocessed to produce the best possible comparison within the dataset. This is an interactive process. Failure to create a product with an overlap error in z less than the client's specification will result in a repeat survey being commissioned.

If stripes are found in the coverage plot the operators will assess their size or the differences and determine if the data should be reprocessed or if a re-fly would be preferable. Stripes in the data at this stage are normally associated either as a period of reduced accuracy in the GPS solution or a period of reduced accuracy in the POS. If the data fails at this stage it will normally necessitate a re-fly although reprocessing the data using different scale factors may be tried initially. Areas of overlap between lines are visually checked for obvious anomalies or stripes greater than +/- 20cm. A JPEG image is produced at this point to show the quality of the data, which will be provided with the Report of Survey.

Prior to transformation to the local co-ordinate system a comparison will be made against the ground control areas to ensure that the datasets are within the client's specification. All laser measurements within 40 centimetres plan of a ground truth point are compared for height. If the root mean square error (RMSE) between the laser and ground points is less than 15cm (in accordance with the client's specification) then the datasets are accepted. If the RMSE is greater than 15cm then further re-processing will be carried out or the data reflown.

4.7.6 LiDAR Data Output QC

Following the transformation the laser data is compared to a TIN model created from ground survey data acquired by the surveyors. The TIN model is compared to the LiDAR data and a report is generated specifying the accuracy of the LiDAR data represented as RMSE.

4.8 Risk Register

Please find below a risk management plan for this project, with the corresponding countermeasures.

Risk No:	Risk Description:	Impact:	Likelihood:	Countermeasures:	Ownership:
1	Technical failure of aircraft / LiDAR system	High	Low	Regular maintenance of aircraft in accordance with CAA regulations. Regular maintenance of LiDAR equipment by Riegl factory engineers. Backup aircraft and LiDAR equipment.	Aircraft Operations Manager
2	Adverse weather conditions	High	Medium	Regular monitoring of long range weather forecasts. Flights conducted during the summer months. Have additional aircraft and sensors available should programme become critical	Project Manager/Aircraft Operations Manager
3	Loss of GPS Data / Observations	High	Low	Daily back-ups	Field Operations Manager
4	Loss of data in transit	High	Low	Use of courier services with tracking capability on all consignments.	Aircraft Operations Manager
5	The information being captured is corrupted	High	Low	Regular back-up routines established. Anti-virus measures in place.	Project Manager
6	Staff Shortages	High	Low	Fugro have a large offshore production facility approx 180 staff that could be utilised for this project. A number of smaller production departments within the Group that could also be utilised.	Project Manager
7	Loss of captured information – Digital	High	Low	Regular back-up routines established. Secure storage facilities conforming to industry standards for data storage.	Project Manager / Team Leaders
8	Loss of information – Raw materials	High	Low	Secure storage of all materials.	Project Manager / Team Leaders
9	Loss of materials in transit to / from client	High	Low	Copying of original materials and final datasets by the dispatching partner. Use of courier service with tracking capability of all consignments.	Dartmoor NPA/BKS
10	Loss of power to capture stations	Low	Low	Existence of a dedicated back-up generator on site.	Facilities Manager
11	General Health & Safety Issues / Acts of God	Medium	Low	Company Health & Safety procedures and mechanisms relating to evacuation and danger recognition / control.	Facilities Manager
12	Illness in team	High	Medium/Low	Access to Company Doctor facilities. Expansion of team from wider workforce. 'Work shadowing' for key success factor activities.	Production Director

5. Dissemination

5.1 Overview

This section provides a brief dissemination of the project equipment/personnel utilisation. This section outlines the corporate capacity of Fugro-BKS and similar projects that the company have been involved in over recent years. Please note all equipment listed is owned by the Fugro Group, no equipment will be hired.

5.2 Data Capture Systems

For the acquisition stage of this project Fugro-BKS plan to use the following equipment;

Hardware	Purpose
1 x Riegl Scanner LMS-Q680	Airborne Laser Scanner with full waveform signal capture
1 x Piper Aztec PA23	Twin engine survey aircraft

Should the project time line slip due to poor weather or technical failure Fugro-BKS have another 2 aircrafts and 2 LiDAR systems that can be tasked onto the project.

For the GCA capture stage of this project Fugro-BKS plan to use the following equipment;

Hardware	Purpose
2 x Leica 530 GPS Dual Frequency Receivers	To observe the GCA points

5.3 Processing Capacity

As part of the Fugro Group, F-BKS are able to draw on the expertise of additional data capture and processing capacity as and when the need arises. Our plan will be to utilise our own LiDAR processing technicians based in our office in Coleraine. However should the project time line slip we can utilise the Group's offshore production capacity, Fugro Pacifica. Fugro-BKS will also complete the Quality Assurance of the processed data prior to it being sent. The table below lists the required processing hardware and software for this project.

Hardware/Software	Purpose
3 x LiDAR Processing Workstations	Workstations to process the LiDAR data
3 x TerraSolid Software Packages	Software for manipulating, processing and QA of the LiDAR data

Based on the timeframe for the completion of the project the Table below provides an indication of the staff resources that we believe will be required from each Fugro company over the lifecycle of the contract.

Dartmoor Project	Fugro BKS
Managers	1
Team Leaders	1
LiDAR Operators	1
QA Technicians	1
Totals	4

The base-level experience/qualifications required for staff required in relation to this contract are as follows:

Managers:
Min. 10 Years professional experience
8 years project management experience

Team Leaders:
Min. 6 Years professional experience
5 years digital capture experience and QA of geometry and attribution
Range of mapping scales – planimetric and topographic compilation

LiDAR Operator:
Min. 3 Years professional experience
2 years digital capture experience
Range of mapping scales – planimetric and topographic compilation

QA Technicians:
Min. 6 Years professional experience
2-3 years QA experience of geometry and attribution of data including visual checks
Range of mapping scales/software platforms

We have sufficient capacity, technology and overall resources to undertake this contract within the required timescale of this project. The annual LiDAR production capacity of Fugro Pacifica and Fugro-BKS is over 150,000 hours which equates to a total of 50 staff. Based on similar projects we will be able to process up to 200km² per day with the number of staff detailed in this response.

Fugro takes account of known and anticipated impacts from other projects and we are aware that the time schedule for this contract is critical. Should Fugro be awarded this project, we would confirm that

with the current work commitments at Fugro-BKS and Fugro Pacifica we can guarantee that we have the capacity to undertake and complete this contract by the end of February 2013.

5.4 Project Experience

Please find below a table of similar projects that have been completed by Fugro-BKS in the last 2 years.

Project Name/Location	Client	Award Date	Sector	Services
Sniffer Phase 2 LiDAR Survey/Scotland	Sniffer (Scottish Government)	Oct-12	Environment (Flooding)	LiDAR Acquisition & Processing
NIEA LiDAR Framework/Ireland	Northern Ireland Environment Agency	Sept-12	Archaeology	LiDAR Acquisition & Processing
Forestry Areas/Ireland	Coillte	Aug-12	Forestry	LiDAR Acquisition & Processing
Altikeeragh Wind Farm/Ireland	Renewable Energy International	July-12	Renewable	10cm F&P, LiDAR Acquisition & Processing
York Street Interchange/Ireland	URS Infrastructure & Environment (UK) Ltd	June-12	Infrastructure	5cm F&P, LiDAR, Mapping, Orthos
Altikeeragh Wind Farm/Ireland	Renewable Energy International	June-12	Renewable	LiDAR Acquisition & Processing
CFRAM LiDAR Survey (additional sites)/Ireland	Office of Public Works	May-12	Environment (Flooding)	LiDAR Acquisition & Processing
Ballylin & Baltinglass/Ireland	University College Cork	April-12	Archaeology	LiDAR Acquisition & Processing
OKLNG Pipeline/Nigeria	OKLNG	March-12	Oil & Gas	10cm F&P, LiDAR, Mapping, Orthos
NIEA Archaeological Sites(Addtional Sites)/Ireland	Northern Ireland Environment Agency	Feb-12	Archaeology	LiDAR Acquisition & Processing
CFRAM LiDAR Survey (additional sites)/Ireland	Office of Public Works	Feb-12	Environment (Flooding)	LiDAR Acquisition & Processing
4 Forestry Sites/Scotland	Forestry Commission	Feb-12	Forestry	LiDAR Acquisition & Processing
Mountstewart & Slane/Ireland	AFBI	Feb-12	Agriculture	LiDAR Acquisition & Processing
Illegal Waste Sites/Ireland	Northern Ireland Environment Agency	Feb-12	Environment	LiDAR Acquisition & Processing
Caithness (Whaligoe)/Scotland	AOC Archaeology Group	Feb-12	Archaeology	LiDAR Acquisition & Processing
A9 LiDAR/Scotland	URS Infrastructure & Environment (UK) Ltd	Feb-12	Infrastructure	LiDAR Acquisition, Processing & Topographic Mapping
FLIP7 Data Transfer/Scotland	Network Rail	Feb-12	Infrastructure	LiDAR Processing
Maghera/Ireland	Carntogher Community Centre	Jan-12	Archaeology	LiDAR Acquisition & Processing
Huyton Junction/England	Network Rail	Jan-12	Infrastructure	LiDAR Processing & Topographic Mapping
Severn Trent Catchment Area Flood Hazard Mapping/England	Severn Trent Water	Jan-12	Environment (Flooding)	LiDAR Acquisition & Processing
Cavan/Ireland	SSE Renewables Development (UK) Ltd	Jan-12	Renewable	LiDAR Acquisition & Processing
NIEA Archaeological Sites/Ireland	Northern Ireland Environment Agency	Dec-11	Archaeology	LiDAR Acquisition & Processing

Alvsbyn/Sweden	Metria	Nov-11	Forestry	LiDAR Processing
ACP LiDAR Survey/Ireland	Teagasc	Nov-11	Agriculture	LiDAR Acquisition & Processing
Great Western Rail Line/England	Network Rail	Oct-11	Infrastructure	LiDAR Quality Checks
3 HV Routes/Scotland	Scottish Power	Oct-11	Utilities	LiDAR Acquisition & Processing
CFRAM Aerial Survey Flood Hazard Mapping/Ireland	Office of Public Works	Aug-11	Environment (Flooding)	LiDAR Acquisition & Processing
Caithness/Scotland	AOC Archaeology Group	May-11	Archaeology	LiDAR Acquisition & Processing
Derrybrien/Ireland	ESBI	May 11	Renewable	LiDAR Acquisition & Processing
Plymouth Breakwater/UK	Babcock	Mar 11	Environment	LiDAR Acquisition & Processing
4 Windfarm Sites/Scotland	RES UK & Ireland Ltd	Mar 11	Renewable	LiDAR Acquisition & Processing
A27 Antwerp/Netherlands	Fugro Aerial Mapping BV	Feb 11	Environment	LiDAR Processing
Hallaryd, Ronneby, Falkenberg/Sweden	Metria	Oct 10	Forestry	LiDAR Processing
KLT & KTGOK Kenya/Kenya	Digmap Consultants	Oct 10	Infrastructure	LiDAR Acquisition & Processing
Network Rail/UK	Fugro Aerial Mapping BV	Aug 10	Infrastructure	LiDAR Processing
8 Windfarm Sites/Ireland	ESBI	April 10	Renewable	LiDAR Acquisition & Processing
Flood Hazard Mapping/UK	Rivers Agency	Jan 10	Environment (Flooding)	LiDAR Acquisition & Processing
Six Sites/Scotland	Historic Scotland	Dec 09	Archaeology	LiDAR Acquisition & Processing
Newcastle Metro/UK	Bridgeway Consulting	Nov 09	Infrastructure	LiDAR Acquisition & Processing
NRA Noise Mapping/Ireland	National Roads Authority	Nov 09	Environment	LiDAR Acquisition & Processing
N3 Edenbury to Cavan Bypass/Ireland	Cavan County Council	Nov 09	Infrastructure	LiDAR Acquisition & Processing
A30/A38/UK	Enterprise Mouchel (Highways Agency)	Oct 09	Infrastructure	LiDAR Acquisition & Processing
A5 Western Transport Corridor/UK	Mouchel	July 09	Infrastructure	LiDAR Acquisition & Processing
Three Sites, Dundalk	Stratascan	July 09	Environment	LiDAR Acquisition & Processing
ESB 100kV & 400 kV Lines/Ireland	ESBI	June 09	Utilities	LiDAR Acquisition & Processing
M60 Junctions 12-15/UK	Highways Agency	May 09	Infrastructure	LiDAR & Ground Survey
In Salah Gas JV/Algeria	Fugro Geoid	May 09	Oil & Gas	LiDAR Acquisition & Processing
Carraig Gheal/UK	Mott MacDonald	April 09	Renewable	LiDAR Acquisition & Processing
Dunluce & Linford/UK	Northern Ireland Environment Agency	April 09	Archaeology	LiDAR Acquisition & Processing
Three Power Line Routes/Ireland	ESBI	Nov 08	Utilities	LiDAR Acquisition & Processing

Bremore/UK	Margaret Gowen & Co Ltd	May 08	Archaeology	LiDAR Acquisition & Processing
Welwick & Chowder Ness/UK	ABP Marine Environmental Research	May 08	Environment	LiDAR Acquisition & Processing
5 Sites/UK	Northern Ireland Environment Agency	May 08	Archaeology	LiDAR Acquisition & Processing
3 Routes/Ireland	ESBI	May 08	Utilities	LiDAR Acquisition & Processing
AHN 2 Parcel 2/Netherlands	Rijkswaterstaat	Jan 08	Environment	LiDAR Acquisition & Processing

5.5 References

The following two references can be contacted with regard to similar projects we have completed.

5.5.1 Reference 1

Name:	Colm O'Kane
Company:	Coillte
Email:	colm.okane@coillte.com
Tel:	+353 91 787 565
Project Synopsis:	Forestry Sites. Fugro-BKS acquired new airborne LiDAR for more than 120km² of commercial forest area across Ireland. The LiDAR data was acquired to assist Coillte with their felling plans. Deliverables included DTM/DSM and tree height datasets.

5.5.2 Reference 2

Name:	Claire Foley
Company:	DOE Northern Ireland Environment Agency
Email:	claire.foley@doeni.gov.uk
Tel:	028 9054 3025
Project Synopsis:	Framework for LiDAR acquisition of archaeological sites across Northern Ireland. Fugro-BKS have been the incumbent service provider since the commencement of the first framework 3 years ago and are currently halfway through the 2nd three year Framework. Services provided are new high resolution LiDAR acquisition (approximately 30ppm), 0.25cm grid DTM/DSM creation and hillshade modelling.

6. Deliverables & Outputs

After the completion of the acquisition and processing the following datasets will be delivered. From previous experience these datasets are appropriate and once produced into hillshade models will be ideal for landscape analysis.

6.1.1 Final Deliverables

The final deliverables will be supplied in OSGB in the following formats and file sizes;

DTM and DSM gridded data shall be delivered as:

- Tab-delimited ESRI ASCII files in ".txt" file-type, containing three headed columns (Easting, Northing, elevation).

Other LiDAR datasets will include;

- Filter mask layers including feature layers (identifying the areas removed between the DSM and DTM datasets)
- Point cloud data (first pulse X,Y,Z,I and last pulse X,Y,Z,I) geo-referenced to British National Grid supplied as 1x1km tiles.

At the end of the project a detailed Survey Report will be compiled including;

- Flight map/log detailing actual flight lines and weather conditions for each sortie
- Flight Coverage Map
- Diagrams showing GNSS GDOP during each sortie
- Statistical analysis of LiDAR against the Ground Control Areas
- Description, coordinates of base stations
- A completion report

Other Deliverables (P.3 of Specification)

- Although not detailed under the final deliverables section of the specification. Fugro-BKS can deliver four hill-shade images (in a GIS format) of each DTM from at least four different compass points.
- Supply the data as an ArcGIS project
- Provide maps of tree heights
- Present the information in a map book (1:5000 scale).

The extra over price to deliver the above datasets is.....£3,250.00 (excluding VAT).

7. Timescales

7.1 Programme

We have assumed for the purpose of this project that the start date is 10th December 2012 and the end date for delivery of all final data the 28th February 2013.

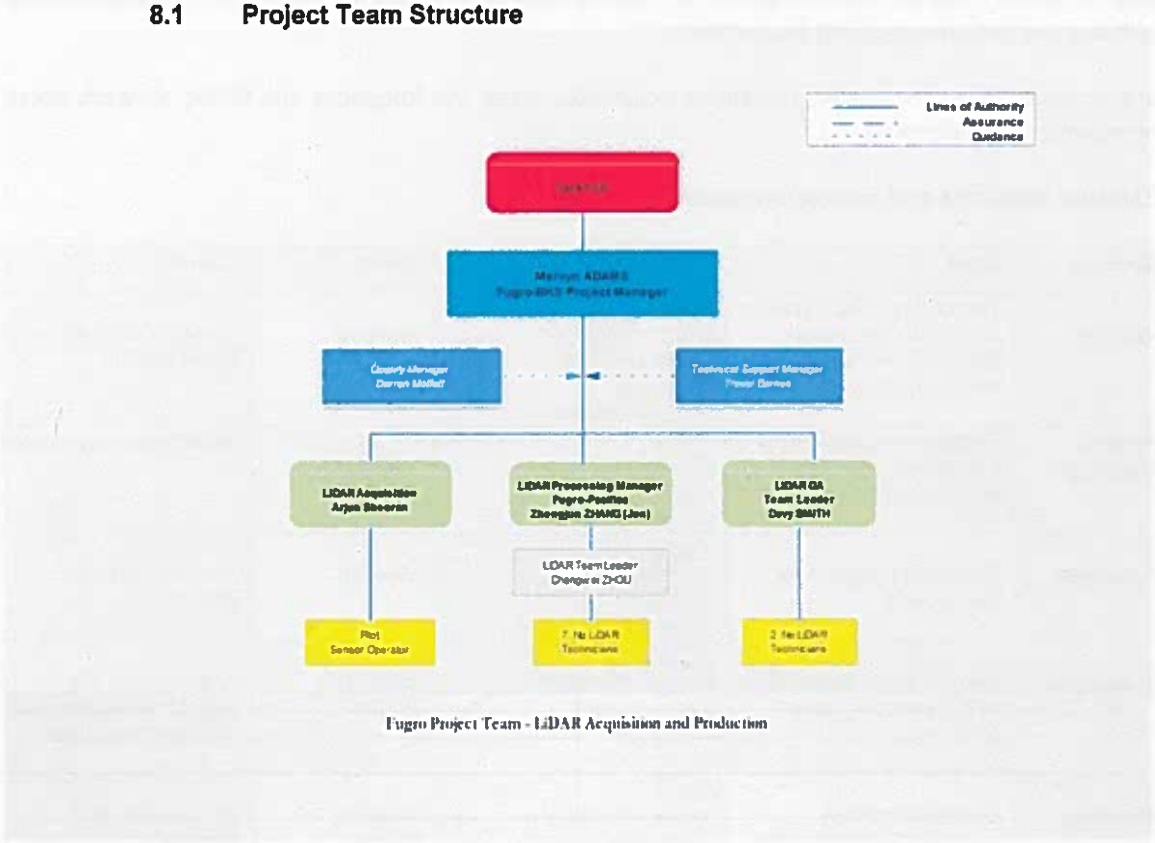
7.2 Implementation Plan

Our implementation plan based on the Project Milestones are listed in the table below along with the number of days and our innovations for each task.

Milestone	No. of Days without PM days	Innovation
Ground Control Areas	3	We will not be using manned base stations to control the LiDAR acquisition, this will come of the OSGB Active GPS Network. This means that there will be no delays in the field with equipment failure/comms failure as the air crew and surveyors will be work separately. The GCAs can be installed before, during and after the LiDAR acquisition. It also helps to reduce our overall costs as we do not need to have base stations or surveyors on the ground during the acquisition.
LiDAR Acquisition	2 (including standby)	Although the request is for a minimum of 4ppm, this could be acquired at a high flying height. However due to the acquisition period running through winter we expect to encounter adverse weather conditions. Therefore we intend to fly at 500m to ensure even on days with low cloud there will be opportunities to get up an fly between gaps or below the cloud cover.
Processing LiDAR Data	10	The Fugro Group has an offshore processing facility in China, Fugro Pacifica. With 180 operators we can easily upman our processing should our programme slip due to poor weather.
QA and Delivery of Datasets	5	As a market leader in LiDAR acquisition/processing, Fugro have developed a number of automated QA software tools which will highlight any errors without the need to manually check each file. This reduces our overall time/costs at the QA stage. We also supply the client with initial datasets prior to final delivery to allow the data to be reviewed and any issues reported. These can then be fixed prior to final delivery. To speed up delivery we can utilise our Secure File Transfer system.

8. Project Management and Relevance of Staff

8.1 Project Team Structure



Fugro Project Team - LiDAR Acquisition and Production

8.2 Communication with Dartmoor NPA

Fugro believes that good external and internal communication is essential to the success of any project and will formulate a Project Plan, produced in close co-operation with Dartmoor NPA, that will specify all aspects of communication for the life-cycle of the project. The Project Plan will define both external and internal lines of communication.

The Plan will address communication issues relating to the Project ranging from the overall direction and management, measured performance, progress reporting, day to day project management and liaison, risk management pertaining to programme and cost, quality control and project specification and change control.

8.2.1 External communications (FUGRO and Dartmoor NPA).

To ensure effective external communication, Fugro believes that several types of meetings should take place with Dartmoor NPA during the life-cycle of the contract in order to ensure the smooth running and ultimate success of the project.

The first point of contact for all commercial, technical and quality questions for Dartmoor NPA will be the Fugro Project Manager. However, Fugro will also provide Dartmoor with a named list of nominated key contacts and their defined responsibilities enabling the client to directly contact the most appropriate person to deal with any technical or quality matter.

Likewise, Fugro would seek a list of suitably qualified and named contacts from Dartmoor defining their individual roles and responsibilities, so that the most appropriate person can be contacted to deal with any queries arising during the contract.

It is proposed that the following meetings would take place, the frequency and timing of which would be agreed with Dartmoor NPA.

External meetings and correspondence:

Meeting	Goal	Participants	Form	Interval
Kick-off	Discussion of all aspects relating to the project (planning, activities, limiting factors, etc.)	Fugro Project Manager Team Leaders Dartmoor Project Manager	Meeting	Once, at the beginning of the project
Project Meetings	Discuss the progress of the project, any issues arising & provide updates	Fugro Project Manager Dartmoor Project Manager	Meeting	Dependent on progress
Progress	Checking progress for this project	Fugro Project Manager Dartmoor Project Manager	Meeting	Half way through project
Evaluation	Review of the description of the services to be provided	Fugro Project Manager Team Leaders Dartmoor Project Manager	Meeting, E-mail	At the end of the project, when the final data are submitted
Planning	Discussion of any questions relating to the delivery schedule	Fugro Project Manager Team Leaders Dartmoor Project Manager	Meeting, E-mail	As necessary/ Monthly
Ad hoc	Discussion and resolution of any questions arising during the project	Fugro Project Manager Team Leaders Dartmoor Project Manager	Meeting, E-mail	As necessary

At the scheduled meetings there is a fixed agenda for each ongoing project with the following points

- Work progress
- Issues encountered and suggestions for solution
- Other business

Unscheduled meetings
Should Dartmoor NPA identify any problems with data or issues with the workflow/methodology then these are reported to Fugro's Project Manager who passes the information to Fugro-BKS' team. An unscheduled phone meeting will be arranged with relevant staff who then will work on a solution. If the topics discussed is judged to affect the time schedule the client is informed by the project manager.

The problem identified and the proposed solution will be made available to all people involved in the project mainly by updating the procedural manuals for the project and providing all relevant staff with

an updated copy. If further instruction is necessary web-meetings allowing MS PowerPoint presentations to be conveyed will be held allowing for an interactive creative solution of the problem.

8.2.2 Internal communications (FUGRO ONLY)

The architecture of the Project Management system will define an organisation structure that will comprise a dedicated Fugro Project Manager, with a strong technical background who will govern the major planning and objectives of the project and will be the primary point of contact for Dartmoor NPA. Including the management of time, cost and quality.

The Project Manager, supported by team leaders, shall be responsible for overseeing the design and implementation of the components, processes and techniques necessary to realise the project requirements. This will include additional elements such as planning, risk assessment and quality assurance techniques. The team leaders will report to the Project Manager on at least a weekly basis to update progress and highlighting any foreseen problems. The Project Manager in turn will be responsible for providing the Team Leaders with the necessary decisions for the project to overcome any problems encountered.

Communication between key personnel in the various technical disciplines within the Fugro Team shall be in accordance with the decision lines depicted in the organigram under 8.1 of this proposal.

Communication may occur in the form of face-to-face meetings, telephone exchanges, written reports, email and web enabled reporting. Fugro is actively enabling the use of on-line progress and project management tools and information and the use of internet conferencing.

Internal communications will consist of progress and status reports submitted to the Project Manager. These communications will be produced at regular intervals, as dictated by project specifications and requirements of the Fugro Project Manager. Several types of internal meetings will be scheduled:

Internal meetings and correspondence:

Meeting	Goal	Participants	Form	Interval
Kick-off (Fugro Only)	Discussion of all aspects relating to the project (Planning, activities, limiting factors, etc.)	Project Manager Team Leaders LiDAR Operators QA Technicians	Meeting / minutes	Once, at the beginning of the project
Project	Discussion of all aspects relating to the project (Planning, activities, limiting factors, etc.)	Project Manager Team Leaders LiDAR Operators QA Technicians	Meeting / minutes / E-mail Webinar	Weekly
Project team	Discussion of all aspects relating to the project (Planning, activities, limiting factors, etc.)	Team Leaders LiDAR Operators QATechnicians	Meeting / E-mail Webinar	Weekly
Ad Hoc	Discussion of any problems which may arise during the project	Project Manager Team leaders	Meeting / E-mail Webinar	Ad hoc

Toolbox	Discussion of all technical aspects of the project – technological progress	Project Team	Meeting / E-mail Webinar	Monthly

8.3 Staff Overview

At F-BKS we pride ourselves in developing close relationships with our clients so as to fully understand the project requirements. We encourage our clients to become an integral part of our project team. We can therefore develop innovative and pro-active bespoke solutions to suit the most demanding and complex projects. We would like to think that this team approach has been admirably demonstrated during previous contracts for Government Agencies in the UK and Ireland.

The following staff are the key technical and managerial specialists who will be responsible for the management and execution of the project.

8.4 Senior Project Staff

MERVYN ADAMS – Production Manager/Project Manager
Qualifications: Post Graduate Diploma in Mathematics, Statistics & Computing (1982)
Project Management: Prince 2 (2007)
Number of Years of Relevant Experience: 10 years (Senior Management),15 years (Project Management)
Office Location Address: Killeague House, Knocklynn Road, Coleraine, BT52 1WW

Mervyn Adams is F-BKS's Production Manager and is responsible for co-ordinating the contract management, project planning, scheduling and daily production operations of 60 people. This includes resource allocation, quality control compliance and project status monitoring. With over 25 years experience in the survey and mapping, he will be available to deal with any technical or commercial issues that may arise over the life-cycle of the contract. Recent projects on which Mervyn has acted as Project Manager/Director include:

- Office of Public Works CFRAM National Airborne LiDAR Contract
- Rivers Agency Winter LIDAR Programme
- NRA LiDAR Contract for all National Roads
- Office of Public Works Slaney River Tullow Flood Relief Scheme
- Environment Agency North East Region Flood Embankment LiDAR Survey
- RWS AHN 2 National LiDAR Survey
- Various LiDAR projects for The Discovery Programme
- Various LiDAR projects for NIEA
- Roads Service A5 LiDAR Project
- Network Rail LiDAR Survey – Great Western Line

DAVY SMYTH – LIDAR Team Leader
Qualifications: Fugro Project Management Courses (2008 & 2010)
Number of Years of Relevant Experience: 36 years (Data Processing) 12 years (LiDAR Processing)
Office Location Address: Killeague House, Knocklynn Road, Coleraine, BT52 1WW

One of Fugro-BKS's Senior LiDAR Processing Technicians, Davy has over 12 years experience in LiDAR processing. He will be responsible for the everyday management of the QA Team at Fugro-BKS's office. He will report directly to the Project Manager through weekly progress reports and will be responsible for the delivery of the final datasets after the QA is complete.
Major projects completed include:

- Office of Public Works CFRAM National Airborne LiDAR Contract
- Rivers Agency Winter LiDAR Programme
- NRA LiDAR Contract for all National Roads
- Office of Public Works Slaney River Tullow Flood Relief Scheme
- Environment Agency North East Region Flood Embankment LiDAR Survey
- RWS AHN 2 National LiDAR Survey
- Various LiDAR projects for The Discovery Programme
- Various LiDAR projects for NIEA
- Roads Service A5 LiDAR Project
- Network Rail LiDAR Survey – Great Western Line

8.5 LiDAR Processing and QA Staff

8.5.1 LiDAR Processing and Quality Assurance Technicians

ARLENE CROWE – LiDAR QA Technician
Element of the Service: LiDAR QA
Grade/Level within Organisation: Data Engineering Technician
Qualifications: BSc (Hons) Computing/IT (2001), Diploma in Computing (1997)
Number of Years of Relevant Experience: 21 years (Data Engineering) 10 years (LiDAR Processing)
Office Location Address: Killeague House, Knocklynn Road, Coleraine, BT52 1WW

MARK GIFFIN – LiDAR QA Technician
Element of the Service: LiDAR QA
Grade/Level within Organisation: LiDAR Processing Technician
Qualifications: BSc Earth Science (2003) PgDip in GIS (2005)
Number of Years of Relevant Experience: 6 years (LiDAR Processing)
Office Location Address: Killeague House, Knocklynn Road, Coleraine, BT52 1WW

Arlene and Mark are responsible for the Processing and Quality Assurance of final DTM/DSM data for this project. Prior to dispatch the processed datasets supplied by will be Quality Checked for completeness and accuracy using the GCAs.

8.6 Business Continuity

Business Continuity Management is reviewed as part of monthly 'Senior Management Team Meeting' and the company's IMS system is reviewed via internal audits (monthly), external audits by BSI (bi-annual), departmental IMS team meetings (monthly) and IMS Board meetings (quarterly).Business Continuity Management identifies critical functions and then reviews the affect on service and the resource requirements to recovery. The responsibility for assessing the way forward following the incidents that materially affect the ongoing business, will fall to the Senior Management team under the Chairmanship of the General Manager.
The various core activities will be apportioned as follows, although in practice there will be a great deal of cross fertilisation in both understanding the problems and formulating plans to address these:General Manager - Business Impact and Priorities, Technical Support Manager - Data Recovery and Systems Establishment, Production Manager - Manpower and Hardware and Financial Controller - Insurance, Logistics and Facilities.

Business Continuity Management is carried out using the undernoted stages:
1) The Incident Stage: This will determine the nature of the response. Much of what is needed is documented as part of the company's Integrated Management System (IMS), which provides policies and procedures for quality, health, safety and environment issues and encompasses all operations from survey works to finance. At this initial stage the top team will have a Critical Function Priority List and a timescale against which to operate.

2) The Recovery Stage: The type of plans that will be developed will look at issues such as:
What Work In Progress has been disrupted?; Staffing - the impact of the incident on staff; Loss of business communications and the wider customer confidence impact; Corruption of data/Status of material backed-up and arrangements to access it; Facllities status and alternative premises availability; Access to equipment, computers, stock, documents, personnel records, etc. Precautionary measures are carried out and reviewed at half yearly management meetings including a review of Insurance Documentation/Policies to ensure adequacy of cover, for example, medical/travel insurance for survey teams working away from office. This will be done in conjunction with the Fugro NV Insurance staff.

3) The Continuity Stage
This stage will be to look at the steps necessary to re-establish the business now that the immediate crisis has been addressed, and how to best harness the changed circumstances that the Company is working in.

9. Price Schedule

Our completed Price Schedule is detailed below.

Locations	Approx Area	First Quotation	Second Quotation
		Point Clouds & DEMs	Point Clouds & DEMs plus Waveform data
Fernworthy and the NNR	9.84km²	**£15,750.00**	**£16,750.00**
Fernworthy, Bellever, Soussons and NNR	17.24km²	**£18,750.00**	**£19,750.00**

NOTE: Due to the relatively small survey areas there is limited price difference between the costs in the table. The reason is the aircraft still needs to spend approximately the same amount of time on both projects so the only real saving is in the processing time.

10. Appendix 1 – Environmental Policy

Environmental Policy

FUGRO-BKS Limited is involved in the provision of geographic information products and services including photography, mapping and surveying. The company recognises that good management includes all environmental matters and will ensure that environmental protection and the prevention of pollution are part of all decisions, policies and practices. The Company shall endeavour to work towards the following objectives:

- Comply with relevant environmental legislation, regulation and other applicable requirements.
- Provide for the publication of the Environmental Policy internally, by displaying the document in the Company and externally to all interested parties, on request.
- Provide for the setting and achieving of environmental objectives and targets for the Company, to reduce the impacts of it's identified Significant Aspects and secondly for the publication of the environmental objectives and targets to all employees.
- Maintain efforts to achieve continual improvement in the environmental performance of the Company, the starting point is to comply fully with the requirements of ISO14001:2004.
- Ensuring that operations at the FUGRO-BKS site are carried out with full control on all aspects, which may have an environmental impact e.g. atmospheric emissions, water and energy usage.
- Foster openness, dialogue and discussion with employees, customers, suppliers, contractors and all interested parties regarding the environmental performance and related issues including this policy and the environmental objectives and targets of the Company.
- Measure environmental performance by conducting regular environmental audits and assessments of compliance with the Environmental Policy, relevant environmental legislation and the targets and objectives of the Company.

Alan Campbell

20th January 2012

General Manager **Date**

Certificate of Registration

ENVIRONMENTAL MANAGEMENT SYSTEM - ISO 14001:2004

This is to certify that:

Fugro-BKS Limited
Killeague House
Unit 17 Sandel Village Centre
Knocklynn Road
Coleraine
BT52 1WW
United Kingdom

Holds Certificate No: **EMS 545588**
and operates an Environmental Management System which complies with the requirements of ISO 14001:2004 for the following scope:

Digital and conventional data products embracing: Aerial photography, Aerial survey and mapping related services, Digital imagery and related services, Data conversion, Data audit and consultancy, LIDAR Data, Topographical ground surveying, Cartographic services, BLPU Data creation.

For and on behalf of BSI:

Gary Fenton, Global Assurance Director

Originally registered: **31/07/2009** Latest Issue: **20/07/2012** Expiry Date: **31/07/2015**

11. Appendix 2 – Health and Safety Certificate

Certificate of Registration

OCCUPATIONAL HEALTH & SAFETY MANAGEMENT SYSTEM

This is to certify that

Fugro-BKS Limited
Killeague House
Unit 17 Sandel Village Centre
Knocklynn Road
Coleraine
BT52 1WW
United Kingdom

Holds Certificate No: **OHS 568674**
and operates an Occupational Health and Safety Management System which complies with the requirements of BS OHSAS 18001:2007 for the following scope:

Digital and conventional data products embracing: aerial photography, aerial survey and mapping related services, Data conversion, Data Audit and Consultancy, LIDAR Data, Topographical ground surveying, Cartographic services, BLPU Data creation.

For and on behalf of BSI:

Chair, Certification Body Management Committee

Onginally registered: **18/02/2011** Latest Issue: **20/10/2011** Expiry Date: **18/02/2014**

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12. Appendix 3 - Fugro-BKS Quality Management System

The quality policy within Fugro-BKS is to ensure that customer' standards and specifications are met. FUGRO-BKS Limited recognises its responsibility in terms of safety performance, environmental sustainability as well as the delivery of high quality services to its clients. In order to manage the quality, safety and environmental performance of our business, the company has implemented an Integrated Management System, to meet the requirements of ISO9001:2008, 14001:2004 and OHSAS 18001:2007.

Certificate of Registration

QUALITY MANAGEMENT SYSTEM - ISO 9001:2008

This is to certify that

Fugro-BKS Limited
47 Ballycairn Road
Coleraine
BT51 3HZ
United Kingdom

Holds Certificate No: FS 12145

and operates a Quality Management System which complies with the requirements of ISO 9001:2008 for the following scope:

Digital and conventional data products embracing Aerial photography. Aerial survey and mapping related services. Digital imagery and related services. Data conversion. Data audit and consultancy. LiDAR Data. Topographical ground surveying. Cartographic services. BLPU Data creation

For and on behalf of BSI:

Managing Director, BSI Kitemark

Originally registered: 19/04/1991 Latest Issue: 25/11/2008 Expiry Date: 06/01/2012

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An internationally recognised certification body will assess the company for compliance with the international standard ISO9001:2008, ISO14001:2004 and OHSAS 18001: 2007 in order to demonstrate the effectiveness of our Integrated Management System to meet the needs of our customers, employees and interested third parties.

This Management System has been established and is maintained as a means of providing a structured process for the achievement of continual quality, health & safety and environmental improvement. The company has prepared and effectively implements documented procedures in accordance with the requirements of the Integrated Management System (IMS). The IMS documentation is structured in three main levels, and illustrated below.

LEVEL 1- Integrated Policy Manual
This manual demonstrates how the company meets the requirements of the Integrated Management System. It includes the policy, responsibilities, and acts as a signpost to related system documentation.

LEVEL 2- Integrated Procedures Manual and Work Instructions
Procedures have been prepared to cover situations where their absence could lead to deviations from the company's policy statement and the set improvement objectives & targets. Procedures have been developed on two levels, General Departmental Operating Procedures and Specific Departmental Operating Procedures.

LEVEL 3 - Supporting Documentation
This includes the Register of Legislation, Legal compliance check, Regulation and other Policy Requirements, Register of Environmental Aspects, Risk Assessments, Management Programmes, and any other documentation and records related to the operation of the IMS.

Quality System
Quality encompasses several goals, including delivery-to-Program, accuracy, completeness and data structure. It is measured through a system of audits and process reviews to monitor, measure and

analyse the effectiveness of these procedures and processes and are used to implement a process of continuous improvement across the organisation.
Data quality can be measured in a number of ways, including the physical testing of data and seeking customer feedback. Fugro-BKS follows internationally recognised procedures and processes to collect, process and deliver geographic data.
Built in to these procedures are requirements for independent checks on the data throughout the collection and computation processes. Such checks comprise of both visual and automated processes, which are undertaken at the end of each project stage and are aimed at identifying quality issues prior to embarking on a new process.

The Fugro-BKS documented management system comprises:

- **Quality Policy:** defines the company's approach to quality, mandatory for all staff.
- **Quality Manual:** identifies the processes required for the management system, and their application throughout the organisation. It identifies the sequence and interaction of these processes.
- **Quality Assurance Procedures;** identifies in detail the procedures used to comply with the requirements at a managerial level and determines the methods needed to ensure that both the operation and control of these procedures are effective.
- **Quality Control Procedures;** contain detailed work instructions.
- **Quality Records:** ensure consistency of delivery

Quality Testing and Acceptance
Fugro-BKS understands the importance of having an implemented quality testing and acceptance program for all project phases. Testing will be conducted in each phase to ensure:

- Products meet the specified criteria;
- Identify and resolve any potential discrepancies; and
- Ensure all products are fully operational and tested before official handover to the end client

Acceptance criteria will be based on the following criteria:

- Functional correctness and completeness
- Accuracy
- Data integrity
- Data conversion
- Backup and recovery
- Usability
- Performance
- Reliability and availability
- Maintenance and service
- Timeliness
- Compliance
- Scalability
- Documentation and training requirements

In all phases testing and acceptance will be carried out by independent professionals not directly related to the phase of the project. Detailed reports will be generated that will discuss summary, variances, results, evaluation, recommendations and approval.
Project Quality Management
Developed by the Quality Systems Manager and endorsed by company management, a Project Plan will be developed to ensure that the client receives quality, reliability and integrity in the products and

services that Fugro-BKS will provide, and that needs and requirements are met at each stage. The system calls for strict adherence to specifications, as well as industry and quality requirements.