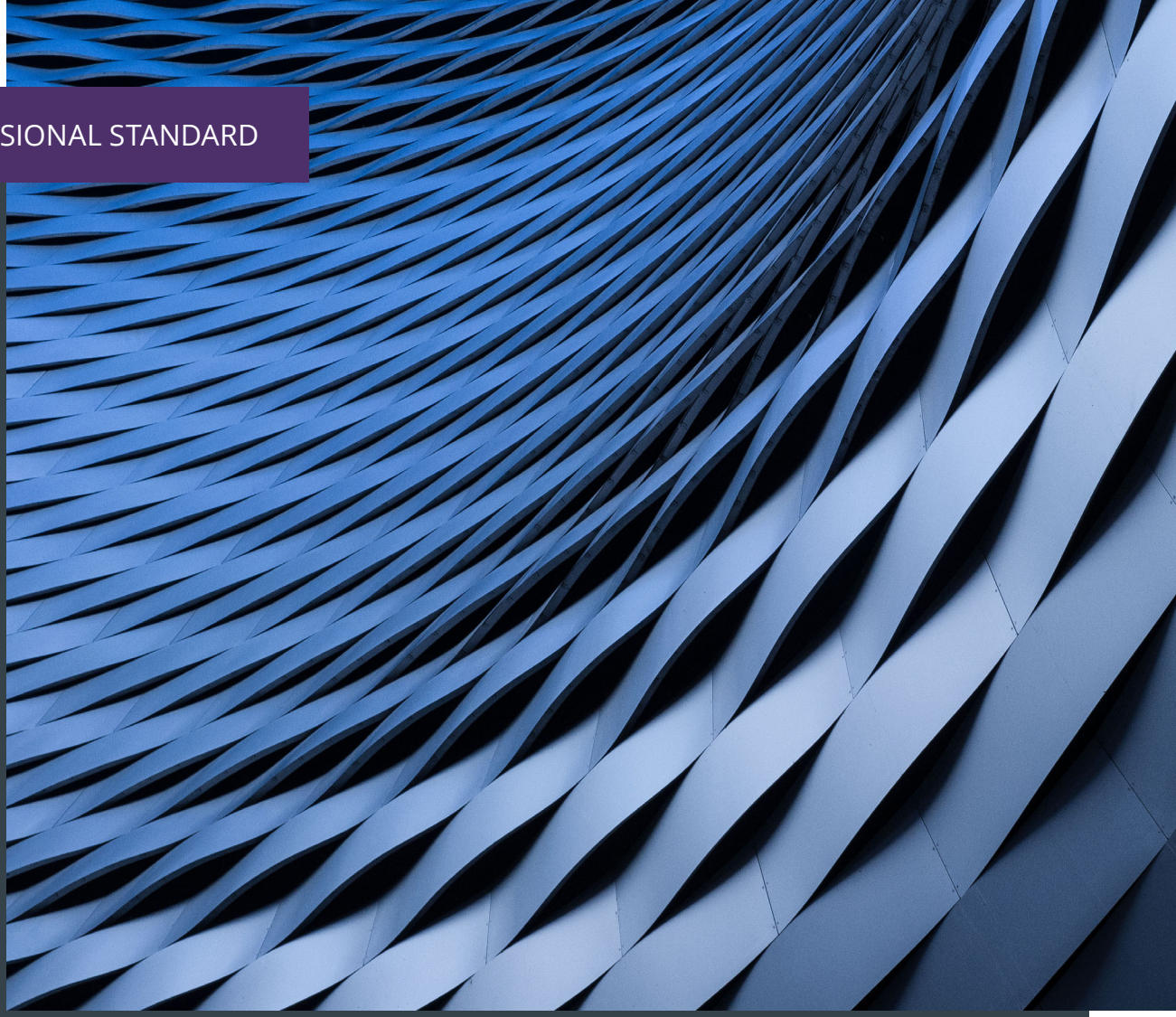
RICS PROFESSIONAL STANDARD



Measured surveys of land, buildings and utilities

Global

3rd edition, November 2014

Effective from 8 December 2014

RICS®

Measured surveys of land, buildings and utilities

RICS professional standard, global

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Contents

RICS standards framework

RICS' standards setting is governed and overseen by the Standards and Regulation Board (SRB). The SRB's aims are to operate in the public interest, and to develop the technical and ethical competence of the profession and its ability to deliver ethical practice to high standards globally.

The RICS Rules of Conduct set high-level professional requirements for the global chartered surveying profession. These are supported by more detailed standards and information relating to professional conduct and technical competency.

The SRB focuses on the conduct and competence of RICS members, to set standards that are proportionate, in the public interest and based on risk. Its approach is to foster a supportive atmosphere that encourages a strong, diverse, inclusive, effective and sustainable surveying profession.

As well as developing its own standards, RICS works collaboratively with other bodies at a national and international level to develop documents relevant to professional practice, such as cross-sector guidance, codes and standards. The application of these collaborative documents by RICS members will be defined either within the document itself or in associated RICS-published documents.

Document type	Definition
RICS professional standards	**Set requirements or expectations for RICS members and regulated firms about how they provide services or the outcomes of their actions.** RICS professional standards are principles-based and focused on outcomes and good practice. Any requirements included set a baseline expectation for competent delivery or ethical behaviour. They include practices and behaviours intended to protect clients and other stakeholders, as well as ensuring their reasonable expectations of ethics, integrity, technical competence and diligence are met. Members must comply with an RICS professional standard. They may include: • mandatory requirements, which use the word 'must' and must be complied with, and/or • recommended best practice, which uses the word 'should'. It is recognised that there may be acceptable alternatives to best practice that achieve the same or a better outcome. In regulatory or disciplinary proceedings, RICS will take into account relevant professional standards when deciding whether an RICS member or regulated firm acted appropriately and with reasonable competence. It is also likely that during any legal proceedings a judge, adjudicator or equivalent will take RICS professional standards into account.
RICS practice information	**Information to support the practice, knowledge and performance of RICS members and regulated firms, and the demand for professional services.** Practice information includes definitions, processes, toolkits, checklists, insights, research and technical information or advice. It also includes documents that aim to provide common benchmarks or approaches across a sector to help build efficient and consistent practice. This information is not mandatory and does not set requirements for RICS members or make explicit recommendations.

Preface

This third edition of *Measured surveys of land, buildings and utilities* (previously titled *Surveys of land, buildings and utility services at scales of 1:500 and larger*) is published by RICS and prepared by the Mapping and Positioning Practice Panel (MAPPP), the RICS Geomatics Professional Group and a specialist Measured Surveys Working Group. This publication forms part of a series of specifications and guidelines intended to assist those connected with the requesting, purchasing and production of surveys and mapping material at large scales and accuracies, by promoting good practice and avoiding the duplication of effort. The MAPPP is one of the foremost technical practice panels within RICS and is comprised of private and public sector surveying and mapping industry experts, academics and survey instrument manufacturers. This broad expertise enables MAPPP professional/technical guidance and output to adhere to industry good practice.

RICS and MAPPP would like to thank the following main authors and reviewers of this third edition:

- Richard Groom MRICS, Environment Agency
- Barry Gleeson MRICS, Network Rail
- Ian Coddington MRICS, Jacobs UK Ltd
- Adam Bradley MRICS, Jacobs UK Ltd
- James Kavanagh MRICS, RICS, Director Land Group
- All participants in the extensive consultation process.

This professional standard represents a complete review of the 1997 edition and supersedes *Surveys of land, buildings and utility services at scales of 1:500 and larger*, 2nd edition. One of the primary changes from the second edition is the use of survey accuracy band, which takes into consideration client requirements for scale independent metadata and digital data handling environments.

In such a fast moving and evolving technology driven environment this third edition is aimed at emphasising the importance of classical surveying and measurement good practice which will hopefully stand the test of time. It need not be connected directly to any specific survey technology or method and can be applied generally to underpin survey products and services. This is considered particularly important in light of the growth of building information modelling (BIM) and its wider application to the built environment.

The primary intention of this professional standard is to place the relationship and understanding between chartered surveyor and client at the core of any survey project. It is also hoped that it provides a reference document that supports downstream survey data users as well as enhanced collaboration processes such as BIM.

Another change in this edition is the integration of the feature detail annexes into the main specification document according to survey application. This underlines the fact that decisions on what to include in the measured survey are critical to the success of any project relying on survey information. It is hoped this will further complement the concept of level of detail (LOD) and standardisation of metadata to support BIM among other design, build, maintain and operate (life cycle) processes.

However, it is accepted in the current rapidly changing technological environment that an update to this edition may be required in the not-too-distant future.

This edition incorporates 'recommended good practice' and 'background information' elements within highlighted boxes.

Unlike many survey specifications, this document is intended to provide guidance only and is not intended to be incorporated verbatim into the text of individual contracts. In particular, it requires choices to be selected throughout thus making alternative choices inapplicable. Specification users are free to select the parts of the specification that are relevant to them to incorporate into their own specifications. However, the value of this specification is its structure which will become familiar to clients and surveyors. Users should therefore ensure that they retain the order of clauses within their documents and acknowledge the RICS as source where used.

There are a number of other RICS publications related to the full range of land surveying/ geomatics services, including:

- *Code of measuring practice*
- *Earth observation and aerial surveys*
- *Use of GNSS in land surveying and mapping.*

MAPPP also produces a full range of geomatics client guides on important subjects such as scale, laser scanning, calibration and imagery. A full list of relevant geomatics surveying RICS professional information and other publications can be found within appendix E. In addition, all MAPPP output and further information on the panel can be accessed at www.rics.org/geomatics.

RICS is a member of an international coalition initially comprised of 20 founder member organisations to establish the International Property Measurement Standards (IPMS). The first edition of these standards is due to be published in 2014 and the resultant IPMS will relate to and interconnect with all RICS published material (including professional standards and practice information). The use of IPMS will allow 'comparability' in space calculation by using agreed 'area classification' methodologies and an agreed baseline accuracy band as connected to valuation deviation requirements. This is particularly relevant in measured building surveys and this document contains references to the various IPMS Office standard area classifications (IPMS 1, 2, 3). More information on IPMS can be found at www.ipmsc.org.

Any comment or feedback on this document should be sent to pgsupport@rics.org and marked for the attention of MAPPP.

Measured survey specification – introduction

This measured survey specification is designed for use by land, engineering and measured building surveyors who are acting in an advisory capacity and by survey knowledgeable clients who specify their own surveys. This document should help clients communicate what they require and expect to receive in terms of survey detail, accuracy, grid, types of survey, formats and final deliverables. It will help both parties clarify related project information issues such as contacts, timescales, data management systems, site access, omissions and supply of existing information. It will assist in having a well-defined set of goals and expectations from a survey for all concerned.

It is recommended that the client and surveyor's initial meeting(s) or discussions in relation to completion of this specification are recognised as being of critical importance to the success of a survey project and if uncertainty exists on either side it is highlighted and resolved before finalisation.

The first question should always be: **What is the purpose of this survey?**

A complete measured survey project specification is contained within this professional standard and particular attention should be paid to the survey detail accuracy band table. The client can choose which features to include in the proposed survey in the relevant section.

Clients and surveyors should also pay attention to the notes and recommended good practice highlighted in boxes throughout this specification that should be followed, unless both parties have agreed it is not appropriate to do so.

Not all measured surveys may require a full specification and where the client-surveyor relationships and expectations are mature, the shorter 'quick specification' within appendix B may be sufficient. However, when specifying surveys all parties are expected to have sufficient competence in the land survey (geomatics) field.

Recommended good practice

It is recommended that this specification is completed by a client or adviser with sufficient competence in land and engineering surveying. If this is not the case he/she should seek advice and support from a chartered land surveyor.

1 Project information

The information given in the following clauses provides essential information needed for the project.

1.1 Project designation

The following are the main client reference titles for this project

Project name: .....

Project reference no: .....

1.2 Purpose of project

The project objective is to provide survey information to enable the following work to be carried out by the client: .....

1.3 Client/agent responsible for payment of works

The client/agent responsible for payment is: .....

1.4 Form of contract

The terms and conditions of contract are:

a	RICS' *Terms and conditions of contract for land surveying services* (now archived)	
b	Other (specify)	

1.5 Survey location/extent of survey

The location and extent of the survey is shown:

a	on a map attached to this specification (filename)	
b	as described below:	
c	The site is located at (address/description/ coordinates):	

The site contact is (name): .....

Plot number (if appropriate): .....

Recommended good practice

It is recommended that the client provides a digital map or plan of the survey extents in PDF and source computer-aided design (CAD) format which allows the surveyor to measure areas, distances etc.

1.6 Project requirements summary

The following sections describe in outline the main scope of work to be carried out by the surveyor and the relevant parts of this specification completed by the client (tick as applicable):

Sections specifying outputs	Required (Please tick)
Section 2: Survey accuracy, control, coordinate grid and datum (mandatory)	
Section 3: Topographic survey	
Section 4: Measured building survey	
Section 5: Underground utility surveys	
Section 6: Setting out	
Section 7: Monitoring and deformation	
Section 8: Deliverables (mandatory)	
Section: Other (specify)	

1.7 Survey schedule dates

The following are the proposed/key survey schedule dates as known at the time of specification issue (if not known insert 'to be confirmed'):

Tender submission: .....

Commission/award project: .....

Site works start: .....

Site works end: .....

Initial deliverables submission: .....

Final deliverables submission: .....

1.8 Project contacts

The principal contact names and addresses relating to this project are given in the clauses which follow – the site contact name is provided in subsection 1.5.

Client

Name: .....

Address: .....

Email: .....

Telephone (office/mobile): .....

Client representative for matters concerning the project

Position .....

Name: .....

Address: .....

Email: .....

Telephone (office/mobile): .....

Client contact or representative for day-to-day contact

Position .....

Name: .....

Address: .....

Email: .....

Telephone (office/mobile): .....

Others (known local and statutory authorities, etc.)

Position .....

Name: .....

Address: .....

Email: .....

Telephone (office/mobile): .....

1.9 Site access principles

The following site access principles apply to these works (tick one box):

a	There is no specific limitation on site access and the surveyor need make no special arrangements.	
b	The surveyor shall inform the client in advance of the proposed access dates required, so that the client may make arrangements with the owners/ occupiers.	
c	The surveyor is required to investigate land ownership and request permission to carry out the survey from land owners/occupiers giving at least a week's notice	
d	Other (specify)	

Recommended good practice

In all cases the client should provide a letter of introduction on request from the surveyor to facilitate site access and enquiries from land owners, including authorities. Should the surveyor encounter land owners/ occupiers who deny access, he/she should retire politely and inform the client immediately. The client should ensure confidential matters are clarified and to whom letters of introduction cannot be shown to.

1.10 Site access requirements

Responsibility for the following site access requirements are (leave blank if not applicable):

Requirement	By client	By surveyor	Comments
Keys to buildings/gates			
Site specific permits			
Industry safety cards (i.e. UK specific examples CSCS/PTS/ LUCAS/ CCNSG)			
Personal photo ID cards			
Letters of appointment			
Police clearance certificates*			
Security clearance certificates			
Other (specify)			

1.11 Survey facilities

Facilities to be provided (leave blank if not applicable):

Facility	By client	By surveyor	Comments
Office space/co-location			
Inductions (site procedures and health and safety)			
On site welfare (on site toilets, etc.)			
Security personnel			
Safety personnel			
Traffic management			
Temporary access equipment			
Temporary lighting/power			
Training courses (specify)			
Systems access (data)			
Survey equipment			
Software			
Other (specify)			

1.12 Information to support project execution

Information to be provided (leave blank if not applicable):

Information	By client	By surveyor	Comments
National mapping (digital – specify format)			
National mapping (hard copy extract)			
Imagery – satellite and/or orthophotography			
Existing survey information (specify)			
Example survey deliverables			
Site specific hazards*			
Statutory utility records			
Supply of templates for deliverables			
Supply of templates for safety critical document submissions			
Other (specify)			

*If not known, state ‘unavailable’.

1.13 Competence of survey staff

The surveyor is responsible for ensuring that his/her staff are qualified, competent, appropriately insured and trained to do the tasks for which they are engaged. Relevant qualifications can include professional and technical membership of RICS, relevant national or regional licences and membership of other equivalent professional bodies.

1.14 Calibration and checking of equipment

The surveyor is responsible for ensuring all equipment is calibrated/verified and checked prior to use and maintained as such throughout the period of survey works, as well as ensuring it is fit for the survey purpose required.

1.15 Protection of property

The surveyor is responsible for the prevention of damage to property and/or the environment caused by his/her works or the actions of employees or people under his/her direct control. This includes responsibility to ensure security of property where the surveyor has been supplied keys for access to normally locked areas and where no additional client security measures are in place.

The client should notify the surveyor of any restrictions in relation to the marking of survey control, vegetation clearance and security requirements. Surveyors should be aware of the potential damage that survey marking can cause to structures, underground utilities and to the environment and take appropriate steps to mitigate this.

1.16 Risk assessment and safety briefing

Unless expressly removed by written instruction the surveyor is responsible for the preparation of method statements, risk assessments, safety and task briefing prior to works commencement and the safety of staff. The surveyor shall provide health and safety documentation to the client as indicated in the following table (tick as appropriate):

Document	Supply for information	Submit for client approval	Comments
Method statement			
Health and safety risk assessments			
Staff briefing document			

The client is to provide the surveyor with any templates to be used for the above documents.

Where client approval is specified, this shall be provided within … days after submission by the surveyor. If no response is received within that time, the document will, by default, be deemed approved by the client.

Recommended good practice

Notwithstanding legal requirements the client should notify the surveyor of any hazards known to him/her prior to the preparation of the risk assessment (e.g. asbestos, confined spaces, site works).

1.17 Client identified project constraints

The following specific client constraints (e.g. working hours) will apply to the work carried out under this project: .....

Where constraints are identified by the client after commissioning of works these shall be communicated as soon as practicable to the surveyor and agreement sought on resolution/ impact.

1.18 Surveyor identified project constraints

Any constraints identified by the surveyor must be raised in writing to the client during the tender period.

Where constraints are identified after commissioning of works these shall be communicated as soon as practicable to the client and agreement sought on resolution/impact.

1.19 Obscured features

1.19.1 The surveyor will not be responsible for omission of details obscured during site survey dates unless action for clearance in advance has been agreed and completed for:

a features obscured by vegetation, debris, snow, sand, earth, when working outside and plaster, cladding, carpet etc. when working inside buildings

b features obscured by vehicles, trailers, temporary covers, stacked materials

c features inside buildings obscured by coverings, furniture, fixtures and fittings

d features inside inspection covers/manholes/ chambers obscured by debris, blockages (where internal chamber survey details are requested in the scope)

e features obscured by flooding when undertaking non hydrographic surveys

f features omitted due to lack of adequate lighting or physical access (i.e. at height)

g setting out of points where the placement of appropriate markers is restricted due to obscuration, lack of permission, impermeable or un-markable surfaces

h other (specify).

1.20 Action to reduce/remove obscured features

Actions to remove obstructions can be very costly particularly when sought from a surveyor who may not have the opportunity or resources to facilitate such work. Actions for reducing or removing obscured items are (tick more than one if appropriate):

a	to be undertaken by the client prior to the survey date and subject to confirmation as satisfactory by the surveyor for items (specify in relation to letters in 1.19.1)	
b	to be undertaken by the surveyor prior to or during the survey work for items (specify in relation to letters in 1.19.1)	
c	not expected and may be dealt with by the surveyor if practicable and at his discretion only.	

1.21 Access issues

The surveyor shall advise the client of any access restrictions or related issues which could have an impact on the survey requirements or deliverables. He/ she should notify the client as soon as practical of such issues and ensure all reasonable steps are taken to reduce adverse impacts.

The client and surveyor shall agree any actions to resolve identified access issues or provide explicit agreement on omission from the survey scope of areas proven to be inaccessible.

1.22 Survey records retention

The surveyor shall retain survey records for either (tick one box only):

a	a period of no less than 7 years	
b	for a period of no less than … years	

Recommended good practice

It is recommended that surveyors should keep copies of all survey records, including those obtained from other parties, for a period of no less than 7 years. Surveyors and clients should take note of any legal or quality management system requirements to retain records when deciding on this option.

1.23 Survey records access

The surveyor shall make available to the client for inspection, on request, all his/her survey data records including those obtained from other sources.

Recommended good practice

Surveyors shall also observe any legal requirements for records preservation, client confidentially and protection and ensure adequate storage and security systems are in place to avoid loss or unauthorised access to records.

1.24 Cost for supply of records

1.24.1 Where the surveyor is requested by the client to make accessible all or part of his/her survey records, which are not included as deliverables, the surveyor shall:

a	make them available to the client at the surveyors offices without charge	
b	make them available by supply to the client without charge	
c	make them available to the client at the surveyors offices subject to the following charge (specify costs or basis of charge)	
d	make them available to the client by supply subject to the following charge (specify costs or basis of charge)	

1.24.2 Where the surveyor is requested by the client to make accessible all or part of his/her survey records which are not included as deliverables the surveyor shall make them available within the following timescales:

a within one week's notice

b within (please specify) ... notice

c confirm the access lead time by agreement with the client no less than two days after formal request.

Recommended good practice

Where requested to provide access to records by a client it is recommended the surveyor should confirm availability within 7 days and provide access within no more than 1 month of request date at worst.

2 Survey accuracy, control, coordinate grid and datum

2.1 Survey accuracy

Background information

In a survey context accuracy is considered as the closeness a measurement recorded in a survey has to its true measurement. Differences between the two measurements (recorded and true) are the result of errors with the differences themselves termed residuals. Errors are classified as systematic (biases), gross (mistakes) and random (neither systematic nor gross).

The surveyor is required to eliminate all systematic errors (biases) and gross errors (mistakes) from his/her work and survey outputs.

Where possible the surveyor should ensure there is sufficient redundancy in his/her survey observations (control and/or survey detail) to enable survey accuracy to be proven by measurement and analysis of the distribution and size of random errors.

Background information

Random errors have certain statistical properties and in particular can be expected to be normally distributed. Random errors have an equal likelihood to be larger or smaller than the true measurement and are taken as+/− values. The measure of random errors in a normal distribution is expressed by a term called standard error or sigma. Standard deviation is similar to standard error but is based on a sample of measurements rather than an infinite set (both are represented by sigma). Standard deviation is taken to be more appropriate for quantifying survey accuracy based on sample measurements. Standard error is typically used as a measure of survey equipment accuracy based the extensive testing carried out by manufacturers.

For survey accuracy to be quantified there must be sufficient measurements to create redundancy in the observations (i.e. repeat or spare observations which allow an average to be generated and residuals to be calculated). Where there are no redundant or repeated observations survey accuracy cannot be verified.

Recommended good practice

Surveyors should eliminate detectable systematic and gross errors by calibrating and checking equipment prior to and during use, by using surveying methodologies and procedures that are self-checking and include independent verifications (e.g. such as comparison of trigonometric, GNSS and levelling data for heighting).

2.2 Survey accuracy banding

Background information

In previous editions of this document, survey detail accuracy has been determined relative to the plot scale at which survey plans or products will be output. Technological changes brought about by digital data capture, storage and processing have made this approach less useful to users of spatial data. It is also likely to be less useful for inclusion in collaborative processes such as building information modelling (BIM). In this edition, RICS has introduced the concept of survey detail accuracy banding. This concept is introduced for all the features recorded and output in surveys, maps/ drawings etc. It is expected to support new processes for developing the built environment such as BIM.

The survey detail accuracy band table at 2.3 shall be used to define what accuracies are to be achieved for different surveyed features independent of plot scale.

Where a client requires a bespoke or customised accuracy band(s) he/she shall complete row(s) for custom accuracy in band X Y for plan and band Z for height on the table and insert a prefix for the band within which it falls.

All accuracies quoted within the accuracy band table are taken as the accuracy of individual survey points relative to the survey control points. Verification of the survey detail accuracy by site checks must include measurement to or from survey control.

Relative accuracy between survey detail points shall be subject to the accuracy of each detail point's banding combined, plus the control parts per million (PPM) multiplied by the distance in excess of 100m between the points. This can be calculated by squaring the standard deviation of each survey detail point's relevant band accuracy, adding them together and then taking the square root of the total to establish the relative accuracy, i.e. $\sqrt{(\sigma 12+\sigma 22)}$ plus the distance minus 100m multiplied by the specified control PPM.

For example, the relative plan positional accuracy between a band B point and a band D point, located 200m apart and surveyed from survey control specified with 20 PPM will be:

[√(42+102)]+[((200m-100m)*1/50000)]=[11]+[2]=13mm.

2.3 Survey accuracy band table

The accuracy band table does not determine the level of detail shown for each feature, although it does indicate the minimum size of a feature that will be shown true to scale (true shape/geometry) and not symbolised. Clients may customise this if appropriate to their needs. In general, features will be surveyed by the minimum number of points required to show their geometric position or extents. For example, a tree can be described by a centre point with trunk diameter, spread diameter and a ground and crown level or height. Clients should seek advice from their survey consultant to ensure the correct levels of detail on a feature are surveyed, and to ensure this is consistent with the type of survey outputs requested (i.e. computer-aided design (CAD) model, imagery, scanned point cloud, bespoke measurement etc.).

2.3.1 The accuracy values stated in the table show both 1 sigma (standard deviation/error) and 2 sigma values. 1 sigma accuracy means that 68% of normally distributed observation residuals will fall within the band value shown for 1 sigma with 95% falling within the 2 sigma value. Using sigma accuracy it can be noted that 99.7% of observations will fall within 3 times the 1 sigma value.

2.3.2 Clients should select an accuracy band that suits their accuracy and confidence requirements. For example a client requiring 10mm plan accuracy at 95% confidence interval should select a band C survey (i.e.+/− 10mm at 2 sigma or 95% confidence).

Recommended good practice

Clients should seek advice on the implications of the chosen accuracy band in relation to cost and quality from a chartered land surveyor to ensure that the accuracy bands chosen are suitable for the survey outputs and intended survey data uses.

Plan accuracy (X,Y)			Height accuracy (Z)[1]					
	1 sigma	2 sigma	Band	Accuracy hard detail	Accuracy soft detail	Example survey types/uses[2]		Min size of feature shown true to scale (not
A	+/− 2mm	+/− 4mm	A	+/− 2mm	N/A	Monitoring, high accuracy engineering setting out and fabrication surveys	1:5	4mm
B	+/− 4mm	+/− 8mm	B	+/− 4mm	+/− 8mm	Monitoring, high accuracy engineering and measured building surveys and setting out	1:10	5mm
C	+/− 5mm	+/− 10mm	C	+/− 5mm	N/A	Engineering surveying and setting out, high accuracy measured building surveying, heritage recording	1:20	10mm
D	+/− 10mm	+/− 20mm	D	+/− 10mm	+/− 25mm	Engineering surveying and setting out, measured building surveys, high accuracy topographic surveys, determined boundaries, area registration	1:50	20mm
E	+/− 25mm	+/− 50mm	E	+/− 10mm	+/− 50mm	Measured building surveys, topographic surveys, low accuracy setting out, net area surveys, valuation surveys, area registration, utility verification (QL-A) PAS 128 (UK)	1:100	50mm
F	+/− 50mm	+/− 100mm	F	+/− 50 mm	+/− 100mm	Low accuracy measured building surveys, topographic surveys, high accuracy utility tracing, gross area surveys	1:200	100mm

Plan accuracy (X,Y)			Height accuracy (Z)[1]					
G	+/− 100mm	+/− 200mm	G	+/− 50mm	+/− 100mm	Topographic surveys, low accuracy measured building surveys, utility tracing surveys, boundary mapping, high accuracy geotechnical, detection (QL-B1 PAS 128 (UK)	1:500	200mm
H	+/− 250mm	+/− 500mm	H	+/− 125mm	+/− 250mm	Low accuracy topographic surveys, national urban area mapping, geotechnical mapping, tree surveys	1:1000	500mm
I	+/− 500mm	+/−	I	+/− 500mm	+/− 1000mm	Low accuracy topographic mapping, national non-urban mapping, general boundary mapping, asset mapping, utility survey – detection QL-B4 PAS 128 (UK)	1:2500	1000mm
J	+/−	+/−	J	+/− 1000mm	=+/− 2000mm	Low accuracy route/corridor planning surveys, large area GIS asset mapping	1:5000	2000mm
X Y	Cust-om[4]		Z	Custom	Custom	Note: To create a customised band please select the band letter required and add as a prefix to XY or Z (i.e.+/−125mm plan = G-XY)		Custom

[1] See section 2.3.1 and multiply by 2 for 2 sigma values.

[2] Example survey types/uses – The table includes examples for users of the types of survey and plot scale output that may be suitable for different accuracies. However, this is not an exhaustive list of examples nor fixed to each band.

[3] Legacy plot scale output – This has been included for the benefit of previous users of this document to understand the historical requirements for plot scale related accuracy to achieve this band.

[4] Add more customised rows if required.

2.4 Survey coordinate reference system

2.4.1 The survey shall use the following coordinate reference system in plan (tick one box only):

a	A local grid with a unitary scale factor which is either:	
	– An existing local grid for which there are existing survey control points	
	– A site grid based on existing site features (e.g. a building grid). Give details:	
	– An arbitrary grid proposed by the surveyor and agreed with the client	
b	The country's national grid. Give details:	

c	Other (specify)	

Recommended good practice

The selection of grids, height datum and transformation of coordinates is often a complex matter which may have serious technical and financial implications for a project. The client should seek advice from a chartered land surveyor if necessary.

2.4.2 Where a survey control network is tied into or based upon pre-existing survey control points, the source of the coordinate values, expected accuracy, hierarchy and reference grid and height datum shall by confirmed by the client and verified by the surveyor. The surveyor shall notify the client of any discrepancies in supplied control or transformation values which exceeds required accuracies and provide advice on potential implications or solutions to resolve them.

2.4.3 The survey shall use the following height (vertical) datum (select one of the following):

a	Surveyed heights (levels) shall be orthometric and quoted in metres above the national height datum published by the national mapping agency	
b	*Surveyed heights (levels) shall be orthometric and quoted in metres above a datum defined by the client using	
c	Surveyed heights (levels) shall be orthometric and quoted in metres above a datum defined by the surveyor and agreed with the client (this option could apply, for example, to a building where the datum might be a floor level).	

*Some countries do not have a clearly defined national height datum and height referencing system, in which case either a published global or regional geoid model will have to be used to convert GNSS heights to orthometric heights or a bespoke geoid model will have to be created for the project.

Recommended good practice

It is recommended that all surveys should be related to the national height datum.

2.5 Connection of chosen survey grid to other coordinate reference systems (where applicable)

Background information

There are instances where 3D coordinate transformations are appropriate, but it is more common to use a 2D transformation for situations where the height component is the same on each coordinate system. The quality of the transformation depends on the number of parameters solved for and this in turn depends on the number, coverage and quality of common points for which the coordinates are known on both coordinate reference systems. The surveyor should report the residuals of the transformed coordinates at each common point and ensure that the client understands any ramifications.

The client requires that (select one of the following):

a	The surveyor shall use transformation formulae provided by the client when converting between the survey grid specified in subsection 2.4 and the following coordinate reference systems: (please specify)	
b	The surveyor shall observe and compute transformations between the survey grid specified in subsection 2.4 and the following coordinate reference systems: (please specify)	

Recommended good practice

Due to the increasing need to relate surveys to national and global coordinate grids and height datums it is recommended that all surveys are linked by direct observation to the relevant national coordinate reference system and regional/international geodetic reference frame. When establishing the relationship between a local grid and national grid via Global Navigation Satellite Systems observations it is recommended that clients and surveyors refer to RICS' *Use of GNSS in land surveying and mapping.*

Where the client provides a defined set of transformation parameters for confirmation, or the surveyor relies on a defined set of parameters supplied by a third party (e.g. national mapping agency) the source values of the parameters shall be validated by the surveyor. When verifying pre-existing survey control coordinate values or transformation parameters to existing reference grids and height datums the surveyor and client should agree the extent of the verification (e.g. selected points/all points) and the type of outputs required (e.g. comparison table of coordinates, best fit transformation parameters and residual).

2.6 Survey control network

The surveyor shall establish survey control points that shall be linked together by a network of observations to realise the survey grid on the ground. This network shall include all types of observations required to establish plan and height control and provide sufficient redundancy in observations to allow proof of accuracy.

Background information

A network can include conventional traversing but should also include cross-bracing and self-checking geometry to ensure geometric weaknesses are mitigated and required accuracy is maintained throughout the network. These observations can include links to national or global survey control networks allowing a coordinated survey control point to be geospatially linked or transformed to national or global coordinate systems.

All survey control point network observations, regardless of observation method, shall be computed and adjusted rigorously using the most appropriate technique to ensure that the survey control accuracy is achieved, and supports the detail accuracy as defined in the accuracy band table and survey detail specification.

Recommended good practice

Where national grid control is relied on for dynamic survey capture (i.e. mobile surveying systems), specific survey control points local to the survey extents shall be established to verify the accuracy of the surveyed detail and/or control the trajectory of the survey sensor.

2.7 Survey control network plan accuracy

The surveyor should use appropriate equipment and techniques to achieve the accuracies required. Should the surveyor decide to use equipment with a higher specification than required, the results should be tested against the accuracy of the equipment used, not the specification, because unexpectedly large residuals achieved with precise equipment could indicate that there are gross or systematic errors in the observations.

2.7.1 Survey control plan accuracy is specified as a minimum between adjacent points (+/- mm) less than 100 metres apart and a ratio or PPM for points over 100 metres apart up to a maximum distance.

2.7.2 Where a survey control network is established it shall be observed and adjusted to achieve the following plan accuracy in the following hierarchy (tick one box):

	The client	The surveyor
Plan control hierarchy shall be defined by:		

Primary/first order plan control accuracy of ...+/- mm up to 100 metres and 1:... or ...PPM in excess 100 metres up to a maximum of ...km

Secondary/second order plan control accuracy of ...+/- mm up to 100 metres and 1:... or ... PPM in excess 100 metres up to a maximum of ...km

Tertiary/third order plan control accuracy of ...+/- mm up to 100 metres and 1:... or ...PPM in excess 100 metres up to a maximum of ...km

(add additional orders/hierarchy if required or add 'n/a' if not applicable above).

Recommended good practice

It is recommended to establish survey control in a hierarchy from primary to secondary to tertiary (first, second or third order) etc. working from the whole to the part (i.e. establish primary or first order control over the full extents of the survey followed by the addition of secondary/second order points etc. to increase density of survey control points for survey detail observation purposes).

The surveyor shall ensure that the required accuracy and suitability of survey control points and traverse/network observations have been met prior to processing of survey detail observations.

The client and surveyor should consider survey control accuracy requirements for the life cycle of a project including future phases which may require a higher accuracy (i.e.

setting out, monitoring). Maintenance of survey control is also important and is covered in subsection 2.13.

2.8 Survey control height accuracy

Survey control height accuracy is specified as a minimum between adjacent points (+/- mm) less than 100 metres apart and a ratio or PPM for points over 100 metres up to maximum distance.

Where a survey control network is established it shall be observed and adjusted to achieve the height accuracy in the following hierarchy:

	The client	The surveyor
Plan control hierarchy shall be defined by:		

Primary/first order plan control accuracy of ...+/- mm up to 100 metres and 1:... or ...PPM in excess 100 metres up to a maximum of ...km

Secondary/second order plan control accuracy of ...+/- mm up to 100 metres and 1:... or ... PPM in excess 100 metres up to a maximum of ...km

Tertiary/third order plan control accuracy of ...+/- mm up to 100 metres and 1:... or ...PPM in excess 100 metres up to a maximum of ...km

(add additional orders/hierarchy if required or add 'n/a' if not applicable above).

Recommended good practice

When tying into national grid or global survey control it is recommended that the tie-in should include observations to sufficient numbers of national or global survey control reference points within and surrounding the survey area.

Where use of mobile survey capture systems is envisaged (i.e. vehicle mounted systems) the trajectory path and adjustment files of sensors must be recorded and evidenced to prove the achievement of survey detail accuracy. In such cases sufficient secondary and tertiary survey control points shall be established within the survey for ease of verification.

Where Global Navigation Satellite System (GNSS) observations are used to observe survey control, refer to RICS's Use of GNSS in land surveying and mapping.

For high precision height datum establishment, it is common for specialist markers to be used which may require specific adapters. Any use of such markers should be agreed in detail with the client.

2.9 Survey control outputs

Recommended good practice

Survey control may be observed simultaneously with observations to detail, but should always be computed before computing detail observations. The surveyor should ensure that

the control is systematic and gross error-free and conforms to the accuracy specification before computing detail observations. If the surveyor fails to do this, he/she runs the risk of having to recompute the detail survey should a subsequent error be found in the control survey.

The following table confirms the survey control outputs required. The deliverable type column should be used to define the generic output format such as CAD, point cloud, report, hard copy, image file, video file, spreadsheet, textual data, database, GIS database etc.

Description of output	Required	Digital deliverable format (if applicable)	Comments
Survey control report			
Survey control witness diagrams			
Survey control observation adjustment – to be submitted for review before survey detail is processed			
Survey control observation adjustment	Mandatory		
Survey control levelling observations and reductions – to be submitted for review before survey detail is processed			
Survey control levelling observations and reductions	Mandatory		
Survey control network diagram	Mandatory		
Survey control levelling network diagram	Mandatory		
Survey control grid and datum definition/s and transformations between other systems where requested	Mandatory		
Survey control tie-in report showing connections to existing survey control and misclosures or changes to legacy values			
Survey control coordinate list	Mandatory		
Survey control photographs			

Recommended good practice

It is good practice to combine a summary of the survey control outputs in a survey control report with supporting files. A template for such a report can be provided by the client or defined in the deliverables section.

2.10 Survey control markers

The surveyor shall provide permanent survey control markers on site based on (tick one box):

a	the minimum number to define the grid and height datum over the geographic extents of the survey area and enable verification of detail accuracy	
b	at every setup or survey control point where practicable	
c	in accordance with the following client requirements (please specify)	

2.11 Survey control marker locations

Permanent markers for survey control shall not be placed so that they present a health and safety hazard to people or animals or cause damage to property or equipment. Clients shall be consulted if any doubt or difficultly arises.

The surveyor shall locate permanent markers for survey control (tick one box):

a	As required for the survey at the surveyor's discretion	
b	As required for the survey and agreed in advance with the client	
c	As required by the client and confirmed in advance to the surveyor Method of confirmation will be: (please specify)	

In certain environments (railways, heritage, industrial/ commercial buildings) installation of permanent markers may be strictly controlled. Clients and surveyors should ensure any such constraints are reconciled with the survey control permanent marker requirements and locations and clearly understood.

Recommended good practice

It is good practice to ensure that the survey control points are located in stable locations with good intervisibility to other points on the network (for measuring angles) and are likely to be free from disturbance (particularly construction works).

When setting up survey control points for monitoring surveys it is essential that sufficient primary points are located outside any zone of influence of expected movement. The same may be appropriate for all survey works where subsequent site changes are likely to cause substantial loss or disturbance to the survey control network points.

It is useful to plan in advance, with the aid of existing site location information, the intended survey control network and method of installation. When planning monitoring networks

it can also be appropriate to confirm the expected accuracy of the survey control network based on pre-analysis of locations and observation geometry.

2.12 Survey control marker types

The following requirements for survey control marker type selection shall be followed (tick one box):

a	The surveyor shall use his/her discretion to select the most appropriate marker type for all survey control points noting the examples shown in appendix A	
b	The following types of markers (see examples in appendix A) shall be used: – Type 1 ..... for the following hierarchies of control ..... – Type 2 ..... for the following hierarchies of control ..... – Type 3 ..... for the following hierarchies of control ..... (Client to add additional types as required)	

Recommended good practice

If using specialist marker types that require specific adapters etc. these should be detailed in the specification and/or confirmed by the surveyor in the survey report to ensure future compatibility/usefulness. If survey control is taken from existing site features it should be of sufficient stability and definition (plan and height) to allow verification of the survey control accuracy requirement.

2.13 Survey control maintenance

The following are the survey control maintenance requirements (tick one box):

a	The client shall take full responsibility for the protection and maintenance of survey control points post installation	
b	The surveyor shall undertake an inspection and report on the status of survey control points (existence, risk of disturbance, visibility to original network) and likely maintenance/update requirements after ... months/years from survey completion and this shall be repeated ... times until ...	
c	Other (specify)	

Recommended good practice

Clients should consider in a Survey Strategy, or otherwise, the ongoing need to maintain and replace survey control points, particularly where changes are inevitable as part of planned works.

Clients should allow for verification and update of survey control at various stages in a project life cycle including prior to setting out, construction works, final as-built surveys and project hand back.

Clients should also consider any need for densification or improvement of survey control if tasks require higher accuracies than those initially anticipated at commissioning (such as for monitoring works).

2.14 Survey control point records

Regardless of the survey control output requirements the surveyor shall record the following in relation to survey control permanent markers or reference points:

a control point hierarchy, accuracy and name

b plan co-ordinates and grid

c height value and datum

d type of marker

e photograph of marker and location

f sketch or plan with dimensions (to 1cm resolution) to adjacent visible features.

Supply of survey control records can be confirmed in the survey outputs table and the format in the deliverables section (section 8).

Recommended good practice

Where use or tie-in to existing survey control points has been specified, a similar list of information defining the existing survey control points should be supplied by the client where available.

Where survey control points are taken from existing features (e.g. well-defined building corners or corner of manhole frames) these shall be recorded in the same manner as survey control markers to ensure that the exact reference point can be located and measured from.

3 Topographic surveys

This section will be used by the client to specify which topographic survey features will be surveyed and to what accuracy band, as stated in the survey detail accuracy band table (section 2.3).

The table indicates the size of detail that can be surveyed true to scale for each accuracy band. Detail that is smaller than this size will be generalised or symbolised.

3.1 Default accuracy band

The default topographic survey detail accuracy band for this project will be: .....

The client will confirm features to be surveyed at a different accuracy band, or that are not to be surveyed, in the following tables.

Recommended good practice

Survey features captured at bands A, B and C are generally considered to involve additional work and may incur additional cost. The methods of survey required are dependent on the survey band selected. It should be remembered that all surveys shall be connected to a local and/or national grid system as outlined in section 2.

3.2 Topographic survey outputs

The following table confirms the topographic survey outputs required. The deliverable type column should be used to define the generic output format such as CAD, point cloud, report, hard copy, image file, video file, spreadsheet, textual data, database, GIS database etc. Section 8 Deliverables shall be used to confirm the specific client requirements for each deliverable type.

Output	Required	Deliverable type	Comments
2D topographic survey			
3D topographic survey			
3D/digital terrain model (grid)			
3D/digital terrain model (triangular irregular network – TIN)			
3D contours			Minor interval ..... Major interval .....
(1) Registered point cloud (intensity)			

Output	Required	Deliverable type	Comments
(2) Registered point cloud (colour – RGB values)			
(3) Registered point cloud (viewer format, intensity			
(4) Registered point cloud (viewer format, colour)			
GIS			
Cross sections			
Long sections/ alignments			
ASCII data			
Survey report			
Other (specify)			

Recommended good practice

If aerial imagery is specified, clients and surveyors should refer to RICS' *Earth observation and aerial surveys*.

3.3 Topographic features

Recommended good practice

The following tables provide a listing of features to be surveyed. This is not intended to be an exhaustive list and the client should add additional features and comments if required.

Some features have been pre-selected as 'default features'. These are considered by RICS to be features which, if present on site, should be surveyed and presented on a standard topographic survey, irrespective of the accuracy band selected by the client. However, features not required for a specific survey can be identified by the client by removing the tick from the relevant box.

The following topographic survey features are to be surveyed:

3.3.1 Permanent buildings/structures

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Archways, underpasses, culverts	√		
Bridge over, bridge under	√		

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Buildings/ structures detailed at plinth line	√		
Building/ structure corners (spot heights)	√		
Foundations (where exposed)	√		
Overhead features, canopies, porches, etc.	√		
Ramps, loading bays	√		
Ruins	√		
Steps (generalised)	√		
Gullies	√		
Rainwater down pipes	√		
Rodding eyes	√		
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			
Floor/threshold levels			
Steps: individual			
Steps and ramps, top and bottom (spot levels)			
Threshold/damp proof course levels			
Boot scraper			
Waste pipes			
Additional feature detail not requested above (specify detail required)			
Heights of features (specify detail required)*			
Other (specify)			

*Height detail could include spot heights, annotations, 3D graphics or other.

3.3.2 Temporary/mobile buildings

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Garden sheds, greenhouses	√		
Mobile buildings	√		
Temporary buildings or structures	√		
Overhead features, canopies, porches, etc.	√		
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			
Additional feature detail not requested above (specify detail)			
Heights of features (specify detail required)*			
Other (specify)			

*Height detail could include spot heights, annotations, 3D graphics or other.

3.3.3 Road, path, track features

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Channel line – road	√		
Centre line – road	√		
Camber line on roundabouts	√		
Carriageway edge	√		
Drop kerbs	√		
Top of kerb	√		
Road centreline, channel, kerb, pavement levels shown as text on drawings	√		Surveyed at [...]m intervals
Crash barriers	√		

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Gullies, kerb outlets	√		
Pedestrian barriers	√		
Pedestrian crossings	√		
Speed humps/ tables/traffic calming features	√		
Traffic islands, details	√		
Back edge of footway	√		
Changes of surface material (hard detail)	√		
Changes of surface material (soft detail)	√		
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			
Road markings, painted			
Other road features, e.g. vehicle sensors			
Unmade tracks and paths (specify centre only, or sides required)			
Paving pattern details			
Additional feature detail not requested above (specify detail)			
Heights of features (specify detail)*			
Other (specify)			

*Height detail could include spot heights, annotations, 3D graphics or other.

3.3.4 Visible boundary features – walls, fences, hedges

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 4)	Comments
Fences: with type, with height (if required)	√		
Gates	√		
Hedges and ditches	√		
Walls: with type, with height (if required)	√		
Wall buttresses	√		
Cadastral features (boundary markers, stones, beacons, posts, stakes etc.)	√		
Trees	√		
Other			
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			
Gate: direction of opening shown			
Additional feature detail not requested above (specify detail required)			
Heights of features (specify detail required)*			
Other (specify)			

*Height detail could include spot heights, annotations, 3D graphics or other.

3.3.5 Street furniture

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Belisha Beacons/ special road crossings	√		
Barriers	√		
Bollards	√		
Bus stops, bus shelters	√		

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Junction/control boxes	√		
Hoardings	√		
Lamp posts	√		
Telegraph/ electricity poles	√		
Road signs	√		
Traffic signals	√		
Post boxes	√		
Mile posts	√		
Notice boards	√		
Posts	√		
Ticket machines	√		
Troughs	√		
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			
Flagstaffs			
Street name plates, wall mounted			
Vent pipes			
Drainage channels			
Cellar hatches and pavement lights			
Coal holes			
Cycle racks			
Litter bins			
Reflector posts			
Salt/grit bins			
Seats/benches			
Additional feature detail not requested above (specify detail required)			
Heights of features (specify detail required)*			
Other (specify)			

*Height detail could include spot heights, annotations, 3D graphics or other.

3.3.6 Statutory authorities' plant and utility covers where visible

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Air valves	√		
Cable TV inspection covers	√		
Cabinets (identified)	√		
Electricity covers	√		
Electricity poles	√		
Fire hydrants	√		
Inspection covers/ manholes with level	√		
Gas/water stop valves and stop cocks (cover)	√		
Water meter or gas meter covers (distinguished from valve)	√		
Marker posts	√		
Surveillance cameras	√		
Telecoms inspection covers	√		
Telegraph poles	√		
Telephone call boxes	√		
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			
Cable TV house points			
Pole stay wires			
Lamp posts			
Additional feature detail not requested above (specify detail required)			
Heights of features (specify detail required)*			
Overhead wires, (specify if building connections to be shown)			
Other (specify)			

*Height detail could include spot heights, annotations, 3D graphics or other.

Recommended good practice

Survey of underground utilities is specified in section 6. Also note that identification of service covers should be made where possible from the service cover annotation/ appearance.

3.3.7 Trees, wooded areas, limits of vegetation

Trees to be surveyed to BS 5837:2012 or equivalent national standard Yes ..... No .....

Recommended good practice

In the UK, surveys of trees in preparation for a Tree Survey to British Standard BS 5837:2012 requires additional survey work including survey of all individual trees with trunk girth greater than 74mm, when measured at 1m above ground level. This may incur additional cost. Clients and surveyors should refer to their national and/or international standards for tree surveys. If BS 5837:2012 is required for this survey the requirements of the standard will override any conflicting requirements in the following table.

Individual trees/bushes details to be annotated on drawing	
Individual trees/bushes to be numbered with details provided in a schedule	

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Woodlands perimeter trees/ tree canopy	√		
Bushes/shrubs	√		Minimum girth to be surveyed [...]m
Individual trees	√		
Isolated trees	√		Minimum trunk girth (at 1m above ground level) to be surveyed [...]m
Ornamental/roadside trees, including planting boxes	√		
Edge of vegetation	√		
Areas of saplings/young trees	√		
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Staked saplings (individual)			
Tree numbers (specify detail required)			
Tree heights (estimated)			
Tree heights (measured)			
Tree spread (canopy diameter)			
Tree trunk girth at 1m above ground			
Tree species (may require specialist knowledge and input)			
Additional feature detail not requested above (specify detail required)			
Other (specify)			

3.3.8 Pitches/recreation

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Pitch/playground limits only	√		
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			
Pitch markings, goal posts			
Playground apparatus			
Additional feature detail not requested above (specify detail required)			
Heights of features (specify detail required)*			
Other (specify)			

*Height detail could include spot heights, annotations, 3D graphics or other.

3.3.9 Water features

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Watercourses (drains, ditches, streams, rivers) levels to be shown on drawn plans at [...]m intervals	√		
Waterline	√		
Water level	√		
Shore line (detail exposed at low tide)	√		
Bodies of water (ponds, lakes, reservoirs)	√		
Top of banks	√		
Bottom of banks	√		
Weirs	√		
Locks	√		
Flood defence structures	√		
Flood/lock gates	√		
Flood/harbour/ sea/ retaining walls	√		
Sheet piling	√		
Groynes/sea defences	√		
Pipes/outfalls/ culverts	√		Minimum diameter pipe to be surveyed [...]m
Piers, jetties, walkways, gantries, landing stages, bridges	√		
Fountains	√		
Waterfalls	√		
Gabions	√		
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			
Direction of water flow			
Time of survey for waterline/ level			

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
High water mark (inc. date)			
Low water mark (inc. date)			
Wrack marks			
Bottom bank below water level, surveyed from bank where possible			
Bottom bank below water level, surveyed from within watercourse			
Hard bed levels (surveyed at [...]m intervals)			
Soft bed/silt levels (surveyed at [...]m intervals)			
Bed type/ material			
Scours			
Floating structures/ booms			
Crest/spill levels			
Pipe/outfall/ culvert dimensions (diameter/ invert/ soffit levels)			Minimum diameter pipe to be surveyed [...]m
Machinery, pumps			
Telemetry equipment			
Navigation beacons			
Aprons, footings, sills, bases			
Steps, access ladders			
Mooring posts, bollards, rings, piles			
Life rings/life buoys			
Rubbing strips			
Ornamental water features			
Gauge boards			Relate readings on gauge board to survey height datum
Fishing platforms			

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Pontoons			
Booms			
Additional feature detail not requested above (specify detail required)			
Heights of features (specify detail required)*			
Other (specify)			

*Height detail could include spot heights, annotations, 3D graphics or other.

3.3.10 Earth works

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Bank bottom	√		
Bank top	√		
Hilltops, depressions and saddles (spot heights)	√		
Mounds, spoil heaps	√		
Quarries, pits and mineral workings (limit only)	√		
Quarries, pits and mineral workings, detailed survey	√		
Retaining wall, base	√		
Retaining wall, top	√		
Sloping masonry, bottom	√		
Sloping masonry, top	√		
Terraces	√		
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			
Additional feature detail not requested above (specify detail required)			

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Heights of features (specify detail required)*			
Other (specify)			

*Height detail could include spot heights, annotations, 3D graphics or other.

3.3.11 Industrial sites (e.g. treatment works, oil refineries, etc.)

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Aerials	√		
Cable tracks/ ducts (outline only)	√		
Chimneys	√		
Electric sub stations or transformers (perimeter fence only)	√		
Filter beds (limits only)	√		
Inspection pits	√		
Inspection covers, gullies, ducts and conduits (spot levels)	√		
Pipe work or ducts (outline only)	√		
Overhead pipes/ cables	√		
Overhead line tower/ freestanding mast or pylon, including visible bases	√		
Tanks/storage chambers (outline only)	√		
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			
Flood lights			
Water taps/stand pipes/ troughs			
Earth rods			

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Additional feature detail not requested above (specify detail required)			
Heights of features (specify detail required)*			
Other (specify)			

*Height detail could include spot heights, annotations, 3D graphics or other.

3.3.12 Railway features

Recommended good practice

In addition to the features below, surveyors and clients should also refer to their national and/or regional rail survey specifications (for example, Network Rail specification in the UK).

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Railways, centre of tracks surveyed at sleeper level	√		Surveyed at [...]m intervals
Stations/ platforms (specify detail required)	√		
Ballast shoulder	√		
Buffers/stop blocks	√		
Cabinets, switch boxes	√		
Cable ducts	√		
Catchpits	√		
Cess limits	√		
Electrified rails (indicative only)	√		
Gantries (outline only)	√		
Signal boxes	√		
Huts	√		
Mile posts	√		
Platform furniture (specify)	√		

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 3.1)	Comments
Points and crossovers (specify)	√		
Power masts	√		
Signals	√		
Refuges	√		
Signs	√		
Telephones	√		
TV monitors/ cameras	√		
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			
Railway lines, both rails/low rail/high rail			
Height gauges			
Rails (gauge faces)			
Gradient posts			
Grease points			
Grit bin			
Point rods (symbolised)			
Track (distance) markers			
Check rail (on curves or bridges)			
Non ducted cables			
Points box/lever			
Additional feature detail not requested above (specify detail)			
Heights of features (specify detail)*			
Other (specify)			

*Height detail could include spot heights, annotations, 3D graphics or other.

3.3.13 Other – specialist requirements or environments not yet covered

The features below are not classified above and are to be identified and selected by the client. The table has been intentionally left blank for completion by the client			
Feature	**Required (tick or untick)**	**Accuracy band (if different to band stated in 3.1)**	**Comments**

3.4 Digital terrain model/3D model definition

Should a digital terrain model (DTM) be required by the client (as identified in 3.2) this shall be defined as follows:

The spacing/resolution of surveyed detail points on DTM features shall be such that any point interpolated on the DTM is correct to within twice the specified accuracy band of the surveyed features.

Optional: The maximum distance between surveyed points used to construct a DTM shall be …m.

4 Measured building surveys

This section of the specification refers to the internal and external survey of standing buildings or structures. Section 3 (Topographic survey) is intended to deal with the survey of the surrounding area and the provision of external control. Both types of survey can be combined if necessary.

This section shall be used by the client to select specific features for survey and the desired accuracy – **please review the survey detail accuracy band table in section 2.**

At each increase in accuracy more details can be shown. This is not meant to be an exhaustive list.

4.1 Default accuracy band

The default measured building survey detail accuracy band for this project will be accuracy band ….

The client will confirm features to be surveyed at a different accuracy band, or not to be surveyed, in the following tables.

Recommended good practice

Survey features noted captured at bands B and C are generally considered to involve additional work and may incur additional cost. The methods of survey required are dependent on the survey band selected. Remember that all surveys shall be connected to a local and/or national grid system as outlined in section 2.

4.2 Measured building survey outputs

The following table confirms the measured building survey outputs required. The deliverable type column should be used to define the generic output format such as computer-aided design (CAD), point cloud, report, hard copy, image file, video file, spreadsheet, textual data, database, GIS database, building information modelling, wireframe model, etc. Section 8 Deliverables shall be used to confirm the specific client requirements for each deliverable type.

Output	Required	Deliverable type	Comments
Floor plan drawing			
Roof plan drawing			
Reflected ceiling plan drawing			
Cross sections			

Output	Required	Deliverable type	Comments
Elevations			
3D model (wireframe)			
3D model (surface)			
3D model (solid)			
BIM (see section 8)			
(1) Registered point cloud (intensity)			
(2) Registered point cloud (colour – RGB values)			
(3) Registered point cloud (viewer format, intensity)			
(4) Registered point cloud (viewer format, colour)			
IPMS 1			
IPMS 2 (components A–H)			
IPMS 3			
ASCII data			
Survey report			
Other (specify)			

Recommended good practice

The tables that follow provide a list of features to be surveyed. This is not intended to be an exhaustive list and the client should add additional features and comments if required.

Some features have been pre-selected. These are considered by RICS to be features which, if present on site, should be surveyed and presented on a standard topographic survey, irrespective of the accuracy band selected by the client. However, features not required for a specific survey can be identified by the client by removing the tick from the relevant box.

4.3 Measured building survey features

The following measured building survey features are to be surveyed:

4.3.1 Structure

Detail	Required (Note: remove if **not** required)	Accuracy band if different to band stated in 4.1	Comments
Beams	√		
Ceilings	√		
Columns	√		
Doors	√		
Floors	√		
Steps/stairs/ ramps/lifts	√		
Walls	√		
Windows	√		
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			
Internal roof and ceiling structure			
Under floor details			
Additional feature detail not requested above (specify detail required)			
Other (specify)			

4.3.2 Fitting out

Detail	Required (tick or untick)	Accuracy band if different to band stated in 4.1	Comments
Partitions	√		
Raised floor/ changes in floor level	√		
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			
Cupboards			
False ceiling			
Fixed furniture			

Detail	Required (tick or untick)	Accuracy band if different to band stated in 4.1	Comments
Floor, wall and ceiling description			
Planters			
Window details (specify requirements)			
Additional feature detail not requested above (specify detail required)			
Other (specify)			

4.3.3 Heights/levels annotation

Given from floor level	
Related to datum specified in section 2	

Detail	Required (tick or untick)	Accuracy band if different to band stated in 4.1	Comments
Arch heights	√		
Beam soffits	√		
Ceiling heights	√		
Floor levels at centre of each room	√		
Floor levels at stairs, (top and bottom)	√		
General floor levels	√		
Window and door heights	√		
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			
Floor levels at doorways			
Floor levels in corners of each room			
Heights of other features (specify features and detail required)			
Other (specify)			

Recommended good practice

In this context, 'height' refers to dimensional information (the physical distance from a floor level to the top of an arch for example) while 'level' refers to a value derived from an agreed datum.

4.3.4 Services

Detail	Required (tick or untick)	Accuracy band if different to band stated in 4.1	Comments
WCs, sinks and basins	√		
Inspection chambers (cover location and level only)	√		
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands			
Fire equipment			
Lights			
Pipework			
Plant			
Radiators			
Risers			
Service intakes			
Sprinklers			
Switches/sockets			
Additional feature detail not requested above (specify detail)			
Other (specify)			

4.3.5 Roofs (if requested in 4.2)

Detail	Required (tick or untick)	Accuracy band if different to band stated in 4.1	Comments
Chimneys (outline only)			
Drainage features			
Fire escapes, catwalks (outline only)			
Parapets			

Detail	Required (tick or untick)	Accuracy band if different to band stated in 4.1	Comments
Plant and services (outline only)			
Ridge lines			
Surface materials			
Vents			
Windows and skylights (outline only)			
Additional feature detail not requested above (specify detail)			
Other (specify)			

4.3.6 Internal roof spaces and ceiling voids

Detail	Required (tick or untick)	Accuracy band if different to band stated in 4.1	Comments
Ceiling joists - size, spacing and alignment			
Hatches			
Services (specify detail required)			
Tanks (outline only)			
Trusses - size, spacing and alignment			
Additional feature detail not requested above (specify detail required)			
Other (specify)			

4.3.7 External features

Detail	Required (tick or untick)	Accuracy band if different to band stated in 4.1	Comments
Balconies			

Detail	Required (tick or untick)	Accuracy band if different to band stated in 4.1	Comments
Car parking			
Curtilage			
Pathways			
Gardens			
Roof terraces			
Swimming pools			
Ponds			
Play areas			
Additional feature detail not requested above (specify detail required)			
Other (specify)			

Recommended good practice

Should more detail/additional features be required for external areas it is recommended that this be specified using section 3 (Topographic survey).

4.4 Areas and dimensions

The following detail features/information is to be shown on floor plan drawings (if requested in 4.2).

Detail	Required (tick or untick)	Accuracy band if different to band stated in 4.1	Comments
Dimensions (specify detail)			
Main room dimensions (annotated)			
Room areas			
Room volumes			
Gross External Area (GEA)			
Gross Internal Area (GIA)			
Net Internal Area (NIA)			
IPMS 1			
IPMS 2			
IPMS 3			

Detail	Required (tick or untick)	Accuracy band if different to band stated in 4.1	Comments
Additional feature detail not requested above (specify detail)			
Other (specify)			

4.5 Cross-section features

The following detail features/information is to be shown on cross-section drawings (if requested in 4.2).

Detail	Required (tick or untick)	Accuracy band if different to band stated in 4.1	Comments
External building face shown in outline			
External building face shown in full detail			
Sections to show simple outline elevation of facing wall			
Principal heights			
Structural members			
Additional feature detail not requested above (specify detail)			
Other (specify)			

4.6 Elevations features

The following detail features/information is to be shown on cross-sections drawings (if requested in 4.2).

Detail	Required (tick or untick)	Accuracy band if different to band stated in 4.1	Comments
Elevations shown in outline only			

Detail	Required (tick or untick)	Accuracy band if different to band stated in 4.1	Comments
Elevations shown with detail features (as selected below)			
Balconies			
Chimneys			
Door and window reveals			
Door and window sills and heads			
Door and window detail			
Parapets			
Pipes			
Principal heights			
Roof details			
Stonework/ brickwork details			
String courses			
Indicate floor levels with broken lines			
Additional feature detail not requested above (specify detail)			
Other (specify)			

4.7 Additional information/references

For the purposes of investment valuation, valuation, estate agency or other forms of property agency, clients and surveyors should refer to RICS' *Code of measuring practice*. This document is under review (2014/15) due to the production of the International Property Measurement Standards (IPMS). Within the new *Code of measuring practice* and IPMS document, important concepts of space are defined. See the IPMS website (www.ipmsc.org) for the latest updates.

For surveys of historic and heritage buildings and structures, clients and surveyors can find guidance and further information in Metric survey specifications for cultural heritage (2009, English Heritage).

5 Underground utility surveys

This section of the specification refers to the survey of underground utilities. The term refers to the detection, location, positioning and identification of buried pipes and cables beneath the ground. In order to present the results of the survey in context it will be necessary to provide an associated topographic survey of the surrounding area at surface level in accordance with section 3. This survey should include any surface indications of buried utilities such as reinstatement scars and covers to valves, manholes and inspection pits. If no suitable topographic survey is available, then both surveys can be combined into one commission.

In June 2014 the British Standards Institute published in conjunction with the Institution of Civil Engineers a specification on underground utility surveys. PAS 128:2014 *Specification for underground utility detection, verification and location* provides clear and explicit requirements that a survey practitioner is to follow in executing utility surveys. This section advises the client in selecting what specific requirements and methodologies the practitioner should follow.

Note: Other terms used for this type of survey include service tracing, utility detection survey, and utility mapping survey. The terms radar or GPR survey or CAT scan or CAT and genny survey are not appropriate as they refer to just one technique and should therefore be avoided.

Recommended good practice

A successful utility survey will rely on more than just a methodical collection of data with the techniques described below. A holistic approach is needed to understand the whole network of utilities that are present within the survey area. An awareness of how these networks are installed and function is essential requiring experienced, well trained site staff.

5.1 How PAS 128 is structured

PAS 128 follows a hierarchical methodology to underground utility surveying with four levels that the client can instruct:

1 **Quality Level D**: The lowest level of survey being essentially a utility record search.

2 **Quality Level C**: A reconnaissance survey correlating, where possible, the results of the record drawings with surface features related to the buried utilities thus improving the quality of the record data.

3 **Quality Level B**: A detection survey of utilities carried out using, as a minimum, the two techniques of electromagnetic location and ground probing radar (GPR). There are

four accuracy bands within Quality Level (QL) B which the surveyor allots to each utility detected. These reflect the accuracy and confidence of the detection results.

4 **Quality Level A**: The highest level being a verification survey where critical utilities are exposed so that their precise position and depth can be verified.

5.2 Selection of survey type to be instructed

Underground utility surveys shall be carried out according to Table 1 in PAS 128 or the equivalent in any national or international specification that supersedes PAS 128. It should be recognised that the higher QLs are likely to entail higher costs so the client must balance expenditure against the need to have comprehensive and accurate survey results. The table below demonstrates the relationships between accuracy, confidence and cost for each survey QL.

Quality Level	Scope upon which results are based	Relative accuracy obtained	Relative confidence level in results	Relative cost
D	**Desktop utility records search**	Lowest	Lowest	Lowest
C	**Site reconnaissance**	Medium low	Medium low	Medium low
B	**Detection** with EML and GPR	Medium high	Medium high	Medium high
A	**Verification** using intrusive inspection	Highest	Highest	Highest

© Table courtesy of Peter Barker at SUMO Services (member of the PAS 128 drafting panel).

It should be understood that generally each type of survey follows on from each other, but in reverse order so a type A survey would usually be a combination of type A + B + C + D. As a minimum a QL D survey is required before either QL C, QL B or QL A surveys are carried out.

Note: Accuracies of surveyed points marked on the ground will not necessarily correspond to the positional accuracy of individual utilities as this will also be affected by the detection method used and the size and depth of the utility itself. Factors such as different accuracies for plan and depth, diameter, wall thickness and concrete surround should be addressed in 3D models.

Recommended good practice

It is important that, if required, an agreed 'colour code' for onsite marking and drawing should be agreed beforehand. This could be based on appendix 4 of The Essential Guide to Utility Surveys from The Survey Association (TSA).

The position of detected utilities shall be surveyed according to section 4 of this document. All work should be carried out with due regard to the health and safety guidelines for working within confined spaces.

5.3 Instructing detection survey methodologies

Table 2 in PAS 128 sets out the different options available to the client in specifying the intensity of survey required. In general, complex utility networks will require closely centred survey transects (M3 and M4 in Table 2 of PAS 128). In less complex networks the survey intensity can be relaxed (M1 and M2 in Table 2 of PAS 128). Each of these methodologies can be enhanced by requiring post processing and analysis of the GPR data.

5.4 Extent of survey required

The extent of the utility survey should be shown clearly on a drawing of the site. Note that different quality levels and intensity of detection survey can be instructed within different parts of a survey area, for example a desktop utility assessment (Quality Level D) could be conducted across the whole of the area, with a detection survey (Quality Level B) targeted at areas where excavations may take place.

5.5 Utility survey outputs

(See section 8 Deliverables)

Survey outputs for underground utility surveys shall include as a minimum:

- computer-aided design (CAD) and
- report.

The survey report should be issued in accordance of the requirements of section 8.7 and survey records shall be retained to align with the timeline in section 1.22 Survey records retention.

5.6 Presentation of survey information

Utility survey results shall be shown on a topographic survey base map. Where the client does not prescribe a specific layer/model naming convention, line style and line weight, the CAD/BIM drawing layers, model names and colour coding shall be in accordance with TSA's *The essential guide to utility surveys*.

5.7 Additional information

A more detailed explanation of a utility survey and its various techniques and technologies can be found from:

- *The essential guide to utility surveys* (issue 4 October 2011), TSA (see www.tsa-uk.org.uk/)

- PAS 128:2014 *Specification for underground utility detection, verification and location*, BSI (see http:// shop.bsigroup.com/).

6 Setting out surveys

This section of the specification refers to the setting out requirements for the project. This section shall be used by the client to specify which of the features below are to be set out, how the setting out shall be marked and the desired accuracy – **review the survey detail accuracy band table in subsection 2.3.**

6.1 Default accuracy band

The default setting out survey accuracy band for this project will be accuracy band ….
The client will confirm features to be surveyed at a different accuracy band, or not to be surveyed, in the following tables.

Guidance: Setting out of features at bands A and B are generally considered to involve additional work and may incur additional cost. The methods of survey required for setting out are dependent on the accuracy band selected. All surveys shall be connected to a local and/or national grid system as outlined in section 2.

6.2 Setting out outputs

The following table confirms the setting out survey outputs required. The deliverable type column should be used to define the generic output format such as CAD, point cloud, report, hard copy, image file, video file, spreadsheet, textual data, database, GIS database etc. Section 8 Deliverables shall be used to confirm the specific client requirements for each deliverable type.

The following outputs are required:

Output	Required	Deliverable type	Comments
Site mark out (set out points physically marked on the ground)			
Setting out report (include surveyed coordinates of set out points compared with design/supplied data)			
Plan drawing of set out points			
Photography of set out points			
Other (specify)			

6.3 Setting out features

The following features are to be set out:

Feature	Required (tick or untick)	Accuracy band (if different to band stated in 6.1)	Comments
Temporary site benchmarks			
Geotechnical survey locations			
Earthworks			
Drainage			
Ground works			
Concrete (including openings, steel rebar)			
Substructure			
Slipform			
Holding down bolts			
Structural steel			
Cladding			
Floor levels			
Piles			
Sheet piling			
Brickwork			
Roads			
Railways			
Structures			
Other (specify)			

6.4 Setting out interval

Points set out should be:

a	Marked at the coordinates of points supplied by the client	
b	Marked at intervals of ...m	
c	Other requirements:	

6.5 Setting out marking

Marking of points – Set out points set out should be marked in the following way:

6.5.1 For points in hard surfaces (concrete, tarmac, etc.)

Marker	Required (tick or untick)	Accuracy band (if different to band stated in 6.1)	Comments
Spray paint mark			
Survey nail (specify type/ size if appropriate)			
Other (specify)			

6.5.2 For points in soft surfaces (grass, earth, etc.)

Marker	Required (tick or untick)	Accuracy band (if different to band stated in 6.1)	Comments
Spray paint mark			
Peg (specify type/size if appropriate)			
Peg with nail (specify type/ size if appropriate)			
Ground anchor (specify type/size if appropriate)			
Other (specify)			

Recommended best practice

The client and surveyor should discuss the type of survey marker chosen, the duration over which it is expected to remain in place and the nature of work that it will support.

The surveyor should assess the health and safety (i.e. permit to dig/impact of errors) and liabilities associated with the work. As such, the client and surveyor should double check for the presence of underground utilities including transport tunnels, culverts etc., before setting out the site.

7 Monitoring and deformation

This section of the specification refers to the deformation monitoring requirements for the project.

This section shall be used by the client to specify the type of monitoring required; the features to be monitored, the frequency of monitoring required; the monitoring point monumentation to be used and the desired accuracy. **The survey detail accuracy band table in subsection 2.3 should be reviewed.**

7.1 Default accuracy band

The default deformation monitoring survey accuracy band for this project will be accuracy band ....

The client will confirm features to be surveyed at a different accuracy band, or not to be surveyed, in the following tables.

Recommended good practice

Monitoring of features at bands A and B are generally considered to involve additional work and may incur additional cost. The methods of survey required for monitoring are dependent on the accuracy band selected. It should be remembered that all surveys shall be connected to a local and/or national grid system as outlined in section 2.

7.2 Deformation monitoring outputs

The following table confirms the deformation monitoring survey outputs required. The deliverable type column should be used to define the generic output format such as CAD , point cloud, report, hard copy, image file, video file, spreadsheet, textual data, database, GIS database etc. Section 8 Deliverables shall be used to confirm the specific client requirements for each deliverable type and its presentation, topology.

The following outputs are required:

Output	Required	Digital Deliverable format (if applicable)	Comment
Supply of monitoring points/system			
Installation of monitoring points/system			
Plan of monitoring points			

Output	Required	Digital Deliverable format (if applicable)	Comment
Survey report detailing methodology			
Survey report detailing monitoring point movement			
Tabular/graphical survey results			
Website based results			
Critical tolerance alerts via email/ SMS text message			
Other (specify)			

7.3 Survey type

A survey is required to monitor the following types of movement:

Movement type	Required	Comments
Horizontal movement		
Vertical movement		
Verticality		
Tilt movement		
Vibrational movement		
Crack/joint expansion		
Other (specify)		

7.4 Features to be monitored

The following features are to be monitored for deformation/movement (client to provide a map showing features):

Features	Required	Accuracy band (if different to band stated in 7.1)	Comment
Buildings			
Earthworks			
Walls (including retaining walls)			

Features	Required	Accuracy band (if different to band stated in 7.1)	Comment
Industrial/ mechanical structures			
Railways			
Roads			
Bridges			
Tunnels/subways			
Pipe work			
Other (specify)			

7.5 Monitoring frequency

The monitoring survey is to be repeated at the frequency stated below:

Frequency	Required	Comments
Constant monitoring		
Hourly		
Daily		
Weekly		
Monthly		
Quarterly/ seasonally		
Annually		
Other (specify)		

7.6 Monitoring point monumentation

The following monitoring point monumentation should be used to mark monitoring points.

Marker	Required	Comments
Spray paint mark		
Peg (specify type/ size if appropriate)		
Peg with nail (specify type/ size if appropriate)		
Ground anchor (specify type/size if appropriate)		

Marker	Required	Comments
Survey nail (specify type/ size if appropriate)		
Reflective/retro target (specify type/size if appropriate)		
Survey prism (specify type/ size if appropriate)		
GNSS receiver (specify type/size if appropriate)		
Tiltmeter		
Crack gauge		
Other (specify)		

Recommended good practice

The client and surveyor should discuss the type of marker/sensor chosen, the duration over which it is expected to remain in place and the nature of work that it will support.

The surveyor should assess the health and safety (i.e. permit to dig/impact of errors) and liabilities associated with the work.

Monitoring points must be measured with respect to a reference, which will typically (but not always) be defined by reference monuments of a type and set in locations which will not be affected by the movement to be monitored. They will remain in place for the duration of the monitoring survey.

8 Deliverables

The following defines the client requirements for specific deliverable formats and method of delivery. It is designed to allow a client to refer to his/her existing formats and templates where appropriate.

Due to a lack of convention in relation to digital formatting and standards this section does not incorporate a default specification for formats, and it is the client's responsibility to ensure sufficient information is supplied to the surveyor. Where the client does not provide sufficient detail, the surveyor shall confirm to the client the proposed format of deliverables.

The formats applicable to the deliverables shall be based on the requirements selected in each section: 3 Topographic surveys, 4 Measured building surveys, 5 Underground utility surveys, 6 Setting out surveys, and 7 Monitoring and deformation.

Recommended good practice

Clients should note that software versions and formats supported change rapidly over time. It is recommended that along with a client system compatible format a standard exchange format should be specified. For certain agencies that have long archiving periods this can be a pre-requisite for acceptance of survey data (heritage). The list given here is by way of suggestion and not exhaustive, nor does it guarantee that all information in one format can be consistently exchanged into another.

Deliverable type	Suggested exchange formats
CAD	*.dxf
Digital terrain model (TIN/string)	*.dxf
Digital terrain model (grid)	*.csv
Photography	*.jpeg ; *.TIF, *.ECW
Video imagery	*.mpeg, *.avi
Point cloud	*.LAS; E57
Survey reports	*.pdf, *.docx
GIS	*.dxf, *.GML
Textual data	*.csv, *.txt
BIM	Revit®, AutoCAD, MicroStation and Navisworks

8.1 CAD deliverables

8.1.1 Presentation of CAD deliverables

The following CAD presentation standards will be used:

a	Client supplied standards	
b	Surveyor defined standards	
c	Other (i.e. BS 1192 – BIM execution plan)	
d	As per the following table:	

Suggested item	Example	Requirement	Comment/ explanation
Feature descriptive level/ layer naming	Trees, walls, road markings, roads, buildings, walls, windows		
Pre-fix level layer naming	SU (i.e. survey discipline) NRT (i.e. originator) Network Rail Thameslink		
Suffix-fix level layer naming	G-E (i.e. graphics- existing, from BS 1192		
Detail segregation	Groups/classification (i.e. BIM, utility groups, entity types (3D surfaces, strings, points)		
Segregation			
Legend			
Key/ Location Plan			
North arrow			
Block/cell types library			
Line styles library			
Colour	Red = electric, green = communications, blue = water – by level/layer or by entity		

Format of CAD deliverables

The required software file format/s for CAD deliverables are:

Format 1: Software system:.....Version.....

And if required:

Format 2: Software system: .....Version.....

(Client to add more if appropriate.)

Recommended good practice

The client should ensure CAD deliverable formats and presentation standards are well specified and compatible with his/her own or intended user's systems. Consideration should also be given to the contents of drawing title blocks. These should include:

- survey reference number (so drawings can be
- related to the report if they are separated)
- survey date
- filename
- project/drawing title
- survey company
- client name
- legend (all used symbols, abbreviations, line styles, etc.)
- north point/arrow
- annotated map grid
- scale bar
- plot scale and applicable paper size
- key plan
- details of the survey control
- grid and datum
- location data referred to elsewhere (cross-sections).

Clients should also note that developing conventions in relation to BIM are designed to increase collaboration and sharing of data in a consistent manner and this can lead to significant efficiencies in data management and decision making. Clients should therefore keep abreast of BIM guidance and overlapping specifications (e.g. BIM execution plan) when completing this section.

Due to the move away from hard copy plans/drawings it is good practice that all digital drawings with title blocks be output as *.pdf as a proof copy. The *.pdf copy serves as a record of the digital deliverable.

8.2 Digital terrain model (TIN) deliverables

8.2.1 Presentation of TIN deliverables

The following TIN standards will be used:

a	Client supplied standards	
b	Surveyor defined standards	
c	Other (specify)	

8.2.2 Format of TIN deliverables

The required software file format/s for TIN deliverables are:

Format 1: Software system: .....Version .....

And if required:

Format 2: Software system: .....Version .....

(Client to add more if appropriate.)

Recommended good practice

When specifying a TIN format, clients should confirm specialist rules in relation to direction of face or closing of triangulation (i.e. right-hand rule).

8.3 Format of digital terrain model (TIN) (grid)

8.3.1 Presentation of TIN (grid) deliverables

a	Client supplied standards	
b	Surveyor defined standards	
c	Other (specify)	

8.3.2 Format of TIN (grid) deliverables

The required software file format/s for TIN (grid) deliverables are:

Format 1: Software system: ..... Version .....

And if required:

Format 2: Software system: ..... Version .....

(Client to add more if appropriate.)

Recommended good practice

When specifying a grid format, clients should be aware of the increase in data file sizes with increasing density of points, particularly over large areas. It may be suitable in such circumstances to specify multiple densities or test data sets in consultation with the surveyor.

It is important to specify the grid cell size and the position of the centre of cells.

8.4 Point cloud deliverables

8.4.1 Presentation of point cloud deliverables

The following point cloud standards will be used:

a	Client supplied standards	
b	Surveyor defined standards	
c	Other (specify)	

8.4.2 Format of Point cloud deliverables

The required software file format/s for point cloud deliverables are:

Format 1: Software system: ..... Version .....

And if required:

Format 2: Software system: ..... Version .....

(Client to add more if appropriate.)

Recommended good practice

Clients should specify cleaning of spurious data from moving objects captured during the creation of point clouds (i.e. people, moving vehicles, false reflections from car mirrors etc.).

The client should take care to ensure point cloud deliverable formats including generic formats which will serve as future archive of data as well as formats compatible with their own or their intended user's systems.

Clients should also note that developing conventions in relation to building information modelling (BIM) are designed to increase collaboration and sharing of data in a consistent manner and this can lead to significant efficiencies in data management and decision making. Clients should therefore keep abreast of BIM guidance and overlapping specifications (i.e. BIM execution plan).

8.5 Point cloud viewer deliverables

8.5.1 Presentation of point cloud viewer deliverables

a	Client supplied standards	
b	Surveyor defined standards	
c	Other (specify)	

8.5.2 Format of point cloud viewer deliverables

The required software file format/s for point cloud viewer deliverables are:

Format 1: Software system: ..... Version .....

And if required:

Format 2: Software system: ..... Version .....

(Client to add more if appropriate.)

Recommended good practice

Where clients have requested point cloud data, they should consider specifying a point cloud viewer output. Clients should note when specifying colour image overlaid point cloud viewing formats they should also seek delivery of light intensity only formats to ensure changes in capture between scanning and image does not result in misinterpreted survey data (i.e. moving vehicles).

Recommended good practice

The client should take care to ensure point cloud viewer formats specified are compatible with his/her own or intended user's systems. Where a client does not have a point cloud viewer he/she may be able to download one online as many manufacturers provide free downloadable viewers.

Clients should also note that point cloud viewers can work on lower performance PC's and generally rely upon smaller files which can be shared over online hosting systems.

8.6 GIS deliverables

8.6.1 Presentation of GIS deliverables

The following GIS standards will be used:

a	Client supplied standards	
b	Surveyor defined standards	
c	Other (specify)	

8.6.2 Format of GIS deliverables

The required software file format/s for GIS deliverables are:

Format 1: Software system: ..... Version .....

And if required:

Format 2: Software system: ..... Version .....

(Client to add more if appropriate.)

Recommended good practice

The client should take care to ensure GIS deliverable formats and presentation standards are well specified and compatible with their own or their intended users systems.

GIS data requires detailed format specification in terms of the data topology, rules for feature code snaps, nodes, creation of polygons, dark links etc. This is not a trivial consideration in large datasets and it will have a significant effect on the cost of the data capture and processing.

8.7 Report deliverables

8.7.1 Presentation of report deliverables

a	Client supplied standards	
b	Surveyor defined standards	
c	Other (specify)	

8.7.3 Format of report deliverables

The required software file format/s for Report deliverables are:

Format 1: Software system:.....Version.....

And if required:

Format 2: Software system:.....Version.....

(Client to add more if appropriate.)

Recommended good practice

It is considered good practice to produce a survey report for various types of surveys. It can provide proof of provenance, methodology and agreed specification and can act as an important historical reference document in case of dispute. It can also aid future use of survey deliverables (particularly survey control) and enhance the future value of the surveyed data.

The client should specify the following as a minimum for topographic and utility survey reports where requested, date of survey, details of the specification being followed, outline methodology, name of surveyors involved and roles, computing and presentation of the survey, equipment make, model, serial numbers and calibration certificate, site photography, details of quality control for site and processing work, survey issues or difficulties encountered on site (i.e. omissions, access etc.).

For survey control reports in addition to the above the client should also specify , survey control network diagram, list of supplied survey control, numerical results (loop closures, residuals etc.), network adjustment files, details of survey control points (including location information sufficient to find control stations as stated in subsection 3.10).

8.8 Imagery deliverables

8.8.1 Presentation of imagery deliverables

The following imagery standards will be **used**:

a	Client supplied standards	
b	Surveyor defined standards	
c	Other (specify)	

8.8.2 Format of imagery deliverables

The required software file format/s for Imagery deliverables are:

Format 1: Software system:.....Version.....

And if required:

Format 2: Software system:.....Version.....

(Client to add more if appropriate.)

Recommended good practice

The client should note that file sizes can vary dramatically with different file formats. Clients, where appropriate, should consider multiple formats which preserve the original data capture but also provide lighter file format for ease of handling and sharing. Clients should consider specifying geo-location attribute capture of imagery to ensure location and direction of view can be verified.

8.9 Video deliverables

8.9.1 Presentation of video deliverables

The following video standards will be used:

a	Client supplied standards	
b	Surveyor defined standards	
c	Other (specify)	

8.9.2 Format of video deliverables

The required software file format/s for video deliverables are:

Format 1: Software system: .....Version.....

And if required:

Format 2: Software system:.....Version.....

(Client to add more if appropriate.)

Recommended good **practice**

The client should note that file sizes can vary dramatically with different file formats. Where appropriate, clients should consider multiple formats which preserve the original data capture but also provide lighter file format for ease of handling and sharing.

Where clients require CCTV or fly-through video files they should consider specifying supply of a flight path, video trajectory with time, distance correlation. This is particularly important for condition surveys of sewers.

8.10 Spreadsheet deliverables

8.10.1 Presentation of spreadsheet deliverables

The following spreadsheet standards will be used:

a	Client supplied standards	
b	Surveyor defined standards	
c	Other (specify)	

8.10.2 Format of spreadsheet deliverables

The required software file format/s for spreadsheet deliverables are:

Format 1: Software system:.....Version.....

And if required:

Format 2: Software system:.....Version.....

(Client to add more if appropriate.)

Recommended good practice

The client should consider carefully spreadsheet output requirements for monitoring or macro driven spreadsheet outputs. This can include validation tools and coordinate conversions where reporting requires change of system from site capture to output analysis.

8.11 Textual data deliverables

8.11.1 Presentation of textual data deliverables

The following textual data standards will be used:

a	Client supplied standards	
b	Surveyor defined standards	
c	Other (specify)	

8.11.2 Format of textual data deliverables

The required software file format/s for textual data deliverables are:

Format 1: Software system: ..... Version .....

And if required:

Format 2: Software system: ..... Version .....

(Client to add more if appropriate.)

Recommended good practice

The client should consider carefully specific textual data formats if they are system dependent. In particular sample data and trial inputs should be included in the specification if submissions are likely to be used in critical operations that require high reliability in data sequencing.

8.12 Supply of surveyor records/ supporting data

With regards to surveyors' records, the surveyor is:

a	not required to supply survey records/ supporting data other than those specified in the survey outputs	
b	is required to supply survey records/ supporting data on request for QA or audit purposes	

c	Other (specify)	

Recommended good practice

The surveyor shall make available the following types of survey records/supporting data as a minimum in relation to this clause – contemporaneous field/office survey notes, photographs, raw data, processed data, observations and computations relating to the survey, quality control checks, equipment calibration certifications and checks.

8.13 Hard copy deliverables

8.13.1 Presentation of hard copy deliverables

The following hard copy standards will be used:

a	Client supplied standards	
b	Surveyor defined standards	
c	Other (specify)	

8.14 Method of delivery

The surveyor shall send the survey deliverables to the client via:

Method	Required
Via FTP site	
Upload to client's system	
Email attachment	
Delivered portable hard drive or USB	
Delivered CD/DVD	
Delivered hard copy	
Other (specify)	

It is assumed that any method of delivery (e.g. hand/ post/courier) to the client's specified address is acceptable. Proof of delivery must be supplied by the surveyor if required/ requested.

8.15 Notification/receipt of delivery

The surveyor/client shall use the following formal notification/acknowledgement as follows (assume not required if left blank):

Notification type	Notification	Receipt
Hard copy transmittal note/receipt		
Email transmittal note receipt	√	√
SMS/text transmittal/receipt		
Notification on client's system		
Other (specify)		

8.16 Validation of delivery

The client should satisfy himself that he/she has received all requested deliverables and notify the surveyor within a reasonable period of time (nominally seven days, but to be agreed by the client and surveyor), should any deliverables be considered to be incomplete or outstanding.

Recommended good practice

The client should take measures to satisfy him/herself that supplied deliverables meet the agreed specification. This may be by way of desktop study, field checks or a set of self-certification checks for the surveyor to complete prior to submission.

This does not absolve the surveyor from his/her responsibilities to deliver correct data.

8.17 Building information modelling (BIM)

Should surveys be required for building information modelling (BIM) it is recommended that a BIM deliverable shall be provided in accordance with the employer's information requirements (EIR) and the BIM execution plan (BEP) as specified in PAS 1192-2:2013 or other national or international equivalent standard as applicable. PAS 1192-3:2014 is due for release in 2014 and should also be referenced.

Recommended good practice

Some BIM software packages use an internal coordinate system which is then referenced to real world coordinates. It is important that surveyors engaging in surveys to BIM projects read section 2 Survey accuracy, control, coordinate grid and datum and correctly set project coordinate systems to enable integration with real world coordinate systems.

Example basic survey for BIM checklist

Stage	Complete
BIM execution plan consulted and/or completed	
Stage 1 – Computational check of control survey and point cloud registration	
Stage 2 – Geometric check of the final BIM model against measured survey data/point cloud/base data	

Stage	Complete
Stage 3 – Integrity check of BIM model construction, to ensure efficient and consistent construction of families and objects	
Stage 4 – Presentation check to ensure that extracted 2D plans, sections and elevations meet required standards of presentation	

Refer to specified survey accuracy band (subsection 4.1) and measured survey output details (subsection 4.2).

8.17.1 Basic survey for BIM specification

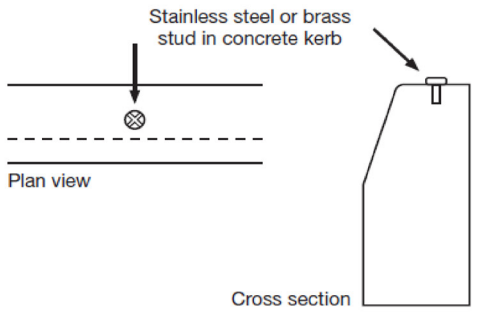
Recommended good practice

The below sample specification and the level of detail achievable is directly influenced by the required accuracy detail banding (see subsections 2.3 and 4.1).

BIM output	Required	Accuracy band	Comments
Construction detail			
Modelled to fit specification			
All deviations included (medium/high accuracy)			
Graphical level of detail			
Mass model			
Basic structural model			
Basic architectural model			
Detailed architectural model			
Meta data detail			
Basic			
Detailed			
Digital output and delivery (see also section 9)			
Extra information/ other requirements			

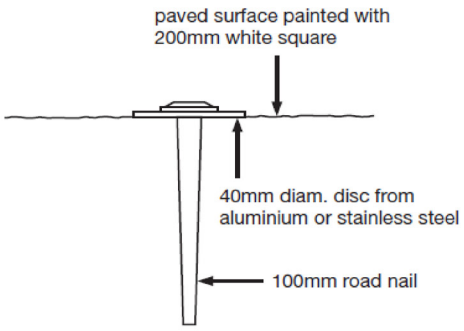
Appendix A: Permanent ground markers

Rivet Marker



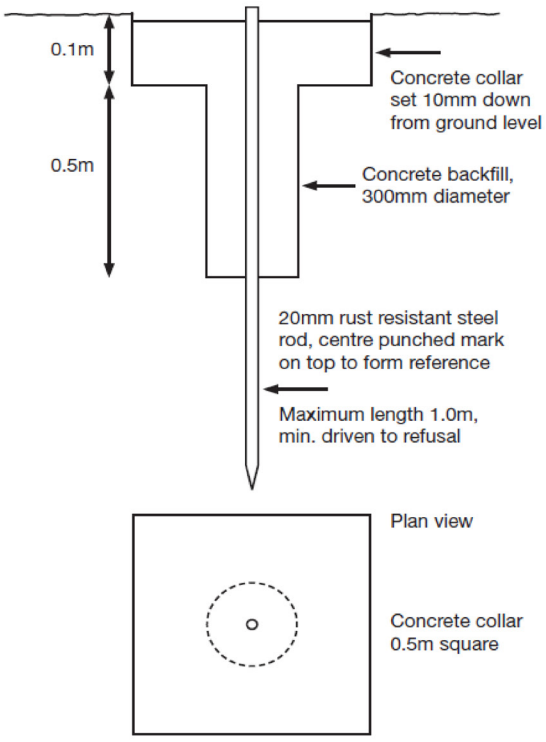
Used in concrete or stone formed surfaces

Type 1 Marker



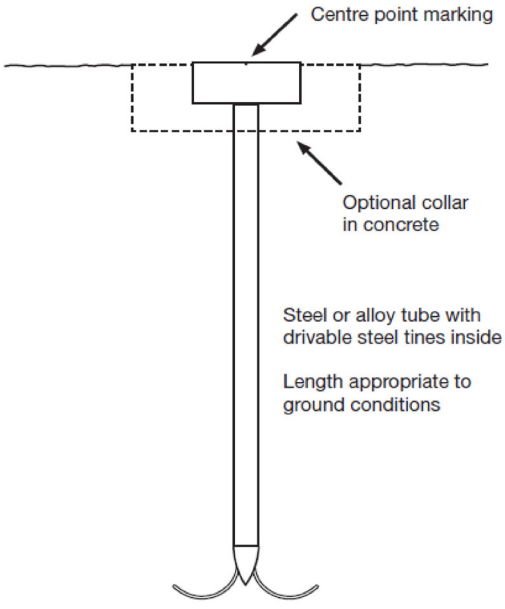
Used in dense, very stable paved surfaces

Type 2 Marker



Used for non-agricultural sites and unpaved surfaces

Type 4 Marker



This illustration is indicative only – various types of proprietary marker are available in one piece or extendable units.

Used for soft surfaces

Appendix B: Quick specifications

This quick reference specification sheet, summarising the full RICS guidance, is intended for use on small or straightforward schemes and assumes that the first option clause (where appropriate) is used throughout. Margin numbers indicate the relevant main guidance sections or clauses.

The client should tick the requirement(s) needed in each subject category. Where no item is selected for a particular category the surveyor will assume that there is no requirement. Additional information, where necessary, should be provided in a covering letter.

If this sheet does not provide adequate opportunity to specify the survey then the main guidance document should be used to prepare the survey specification.

Quick specifications for topographic and measured building surveys

Clause	Subject	Details									
1	Project information										
1.8	Client										
1.8	Contact and telephone										
1.5	Survey extent	Location plan attached		Textual description		Proposals plan		(Indicate items supplied by specifier)			
2.3	Band and/or scale	1:50/D		1:100/E		1:200/F		1:500/G		Other	

Clause	Subject	Details									
2.4.1	Plan control grid	Local grid		Site grid plan		Based on national grid*					
2.4.3	Level datum	GPS derived national datum		Benchmark derived national datum		Site datum		Local datum			
3.2	Detail survey	Boundaries		Outline		Full detail					
3.3.7	Trees	Foliage lines		Trunk over 0.3m dia.		All trees					
23.2	Height information	Spot heights		Contour interval		Road section spacing					
5	Underground services	Cover position		Cover level		Invert/pipe size					
4.2	Buildings external	Outline		Full		Footprint		Eaves/ridge		Elevations	
4.2	Buildings internal	Ground floor		All floors		Roof		Sections			
8	Plan reproduction	Final drawings		Proof plots		Survey report					
8	Digital data	State format				Point cloud		3D model			
8	Computer media	Internet download		Email attachment		Portable hard drive		CD/DVD		Other	
	Remarks										

*Scale factor may apply

Quick specifications for utility surveys

Clause	Subject	Details							
1	Project information								
1.8	Client								
1.8	Contact and telephone								
1.5	Survey extent	Location plan attached		Textual description		Proposals plan			
2.3	Band and/or scale	1:50/D		1:100/E		1:200/F			
2.4.1	Plan control grid and datum	All PAS 128 surveys should be referenced to National Grid							
		GNSS derived datum (recommended)		Benchmark derived datum					
5.2	QL D desktop utility records search (required for levels C-A)			QL C site reconnaissance					
5.2	QL B detection survey			QL A verification survey					
5.2	QL B detection methods	M1		M2		M3		M4	
		Post-processing of GPR data				Yes		No	
5.2	QL A verification methods	Inspection chamber survey		Machine/hand dug trial holes		Vacuum excavation			
		Number of inspection chambers		Soft dig (number)		Hard dig (number)			

Clause	Subject	Details							
5.5	Deliverables and delivery medium	CAD		PDF		BIM		GIS	
		Email		DVD		Paper		Other	

Appendix C: Definitions

Term	Definition
Absolute accuracy	Absolute accuracy is the measurement of RMSE of normally distributed error vectors relative to a defined grid and/or height datum. This is typically measured from the nearest survey control marker which was used as part of the primary grid establishment. (See the Ordnance Survey table overleaf.)
Accuracy	In general, when accuracies (or tolerances) have been specified, they refer to vector errors and are defined statistically as root mean square errors (RMSE) or standard deviation. The RMSE or standard deviation is equivalent to 68% of normal distribution of random errors and is often used to express tolerance or confidence in measurements. The standardised normal distribution table determines the ratio of RMSE to different confidence or measurement error tolerances. A 90% tolerance or confidence in a set of measurements is equal to 1.65 times the RMSE or standard deviation when a representative sample of points is tested. Thus a RMSE of ± 0.1m indicates that in a representative sample of 100 points, not less than 68 shall be correct to better than ± 0.1m, and not less than 90 points shall be correct to better than ± 0.165m. Any errors exceeding three times the RMSE (outside of 99.7% of confidence or tolerance in the normal distribution of errors) in this case ± 0.3m, may be regarded as gross errors or mistakes.

Term	Definition
Datum	The starting point or source of a grid (horizontal datum), height (vertical datum) or projected coordinate system (map datum). It is commonly referred to in relation to vertical heighting or levelling but can be applicable to a grid origin, global spheroid shape and origin, and origin of a true bearing or rotation and scale factor in a map projection.
Georeferencing	To georeference something means to define its existence in physical space. That is, establishing its location in terms of a map projection and/or coordinate system.
Grid	Generally, an orthogonal and planar (flat) coordinate system used to define locations on a map. A grid can have an arbitrary or local origin, or be geospatially related to an earth based datum. Grids can have a 1:1 true-scale factor or be projected from curved surfaces to have non uniform or non- unity scale factors.
Projection	Projections contain the parameters by which measurements on the ground or in space have been scaled, rotated or shifted to present them on a map coordinate system. They are typically used for large areas, country wide or global mapping systems to overcome representing earth curvature on a plan.
Relative accuracy	Relative accuracy is the measurement of RMSE of normally distributed vector errors between proximate features shown in survey or setting out on the ground. The calculation can be made independently of the absolute accuracy of features shown on a grid (i.e. the distance between a two buildings measured from the same survey). (See the Ordnance Survey table overleaf.)

Term	Definition
Survey control	The physical markers or point features that are used to realise coordinate grids on the ground, often referred to as permanent ground markers or PGMs where specifically installed for that purpose. Survey control is typically made up of a number of points observed along interconnected baselines. They are used for setting out or mapping all other features to the established grid. Survey control is generally classified as primary, secondary or tertiary depending on its importance in defining a grid and/or its accuracy for use in surveying or setting out.
Survey traverse or survey control network	The complete set of baselines measured between survey control points is called a survey traverse or control network where the baselines exceed more than 1 (i.e. more than 2 points). Where the set of baselines closes back on itself it is typically called a traverse loop. A closed traverse is one that starts and ends on a known baseline, even where the baseline is the original start of the traverse (i.e. as in a closed loop traverse). Where a traverse includes cross-bracing of multiple baselines (more than 2 baselines observed from one survey control point) it is typically referred to as a network. Where a baseline does not close back it can be called a flying traverse or in the case of a single baseline a traverse leg. As with survey control, survey traverses or survey control networks can also be classified as primary, secondary or tertiary depending on its importance in defining a grid and/or its accuracy for use in surveying or setting out. Traverses can include angle, distance, height and co-ordinate measurement.

The following table, based on more than 40 years of accuracy testing, represents the absolute and relative accuracy of UK Ordnance Survey large scale topographic mapping data:

Original survey scale	99% confidence level	95% confidence level	RMSE*
1:1250			
Absolute accuracy	0.9m	0.8m	0.5m
Relative accuracy	+/- 1.1m (up to 60m)	+/- 0.9m (up to 60m)	+/- 0.5m (up to 60m)
1:2500			
Absolute accuracy	2.4m	1.9m	1.1m
Relative accuracy	+/- 2.5m (up to 100m)	+/- 1.9m (up to 100m)	+/- 1.0m (up to 100m)
1:10 000			
Absolute accuracy	8.8m	7.1m	4.1m
Relative accuracy	+/- 10.1m (up to 500m)	+/- 7.7m (up to 500m)	+/- 4.0m (up to 500m)

Table 1: Ordnance Survey mapping accuracies of large-scale topographic mapping data

(Confidence level is how frequently a parameter falls within the quoted limits.)

*RMSE (root mean square error) is the square root of the mean of the squares of the errors between the observations. Source: www.ordnancesurvey.co.uk/oswebsite/support/products-services.html

Appendix D: References and online resources

Bannister, A., and Raymond, S., *Surveying* (7th edition), Pearson, 1998

Beach, M., and Schofield, M. *Engineering Surveying* (6th edition), A Butterworth-Heinemann, 2007 Bomford, G. Geodesy (4th edition), Clarendon Press, Oxford, 1980

Hofmann-Wellenhof, B., Lichtenegger, H., Wasle, H. *GNSS – Global Navigation Satellite Systems: GPS, GLONASS, Galileo and More*, Springer-Verlag, New York, 2007

Iliffe, J.C. and Lott, R. *Datums and Map Projections for Remote Sensing, GIS and Surveying* (2nd edition), Whittles Publishing, Dunbeath, 2008

Kaula, W. *Theory of Satellite Geodesy: Applications of Satellites to Geodesy*, Dover Publications Inc, Mineola, NY, 2003

Leick, A. GPS *Satellite Surveying* (3rd edition), John Wiley & Sons, Chichester, 2004

Metric Survey Specifications for Cultural Heritage 2009 English Heritage (available to download at www.english- heritage.org.uk/publications/metric-survey-specification/)

Seeber, G. *Satellite Geodesy, Foundations, Methods and Applications* (2nd edition), Walter de Gruyter, Berlin, 2003 Survey4BIM task group – www.bimtaskgroup.org/survey4bim/

Uren, J. *Surveying for Engineers* (5th edition), Palgrave Macmillan, 2010

Van Sickle, J. *GPS for Land Surveyors* (3rd edition), CRC Press, Lincoln, US, 2008

The International Standards Organisation (ISO)

ISO produces several suites of standards related to many of the surveying and measurement topics contained within this professional standard. This listing is by no means exhaustive and all ISO standards can be sourced at www.iso.org/iso/ home.htm

ISO 17123-1:2010 gives guidance to provide general rules for evaluating and expressing uncertainty in measurement for use in the specifications of the test procedures of ISO 17123-2, ISO 17123-3, ISO 17123-4, ISO 17123-5, ISO 17123-6, ISO 17123-7 and ISO 17123-8.

ISO 17123-2, ISO 17123-3, ISO 17123-4, ISO 17123-5, ISO 17123-6, ISO 17123-7 and ISO 17123-8 specify only field test procedures for geodetic instruments without ensuring traceability in accordance with ISO/IEC Guide 99. For the purpose of ensuring traceability, it is intended that the instrument be calibrated in the testing laboratory in advance.

ISO 17123-1:2010 is a simplified version based on ISO/IEC Guide 98-3 and deals with the problems related to the specific field of geodetic test measurements.

ISO 4463-3:1995 – Measurement methods for building – Setting-out and measurement

ISO/TS 12911:2012 – Establishes a framework for providing specifications for the commissioning of building information modelling (BIM).

ISO 9849:2000 – Optics and optical instruments – Geodetic and surveying instruments – Vocabulary ISO 19152:2012 – Geographic information – Land Administration Domain Model (LADM)

British Standards Institute (BSI)

BSI also produces suites of standards and Publicly Available Standards (PAS) which can be sourced at http:// shop.bsigroup.com/

British Standards Institute (BSI) PAS 128:2014 – Specification for underground utility detection, verification and location

British Standards Institute (BSI) PAS 1192-2:2013 – Specification for information management for the capital/delivery phase of construction projects using building information modelling, PAS 1192-3:2014 (when available)

The International Federation of Surveyors (FIG)

FIG produces a series of best practice documents of measurement subjects. A full suite of FIG publications can be sourced at www.fig.net/pub/figpub/index.htm

No. 49 Cost Effective GNSS Positioning Techniques. FIG Commission 5 Publication. FIG Report, 2010

The Survey Association (TSA)

TSA also produces a suite of geomatics and surveying related client guides and guidance notes many of which are cross endorsed by RICS. These can be sourced at www.tsa-uk.org.uk/

Network RTK GNSS Best Practice (2012)

The Essential Guide to Utility Surveys (2009)

Detailed guidance notes for specifying a utility survey (2009)

RICS standards and information

Boundaries: procedures for boundary identification, demarcation and dispute resolution

Code of measuring practice

Daylighting and sunlighting

Earth observation and aerial surveys

Party wall legislation and procedure

Rights of light

Use of GNSS in land surveying and mapping

RICS Geomatics client guides

Guides for the client and other professional advisers (available to download from www.rics.org/uk/knowledge/more-services/guides-advice/rics-geomatics-client-guide-series/)

Map projection Scale-Factor: Avoid the potential dangers of scale-factor

Scale: Avoid tripping up over step changes in scale

Virtually level: Transition from traditional benchmarks to heighting using GNSS

Virtually real: terrestrial laser scanning: Understanding an evolving survey technology Reassuringly accurate: Controlling accuracy for better results

Virtually right? – Networked GPS: A useful guide from RICS on aspects of cost-effective networked GPS correction services

Delivering confidence

We are RICS. Everything we do is designed to effect positive change in the built and natural environments. Through our respected global standards, leading professional progression and our trusted data and insight, we promote and enforce the highest professional standards in the development and management of land, real estate, construction and infrastructure. Our work with others provides a foundation for confident markets, pioneers better places to live and work and is a force for positive social impact.

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