THE SURVEY ASSOCIATION

CLIENT GUIDE TO **TOPOGRAPHICAL SURVEYS**

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Endorsed by:
chartered ices

The Survey Association's Client Guides are primarily aimed at other professionals such as engineers, architects, planners and clients in general. They are not intended to go 'in depth' into practical issues but to act as a basic guide on a particular topic and in particular, on procedures and regulations which may govern how a particular aspect of the survey is carried out.

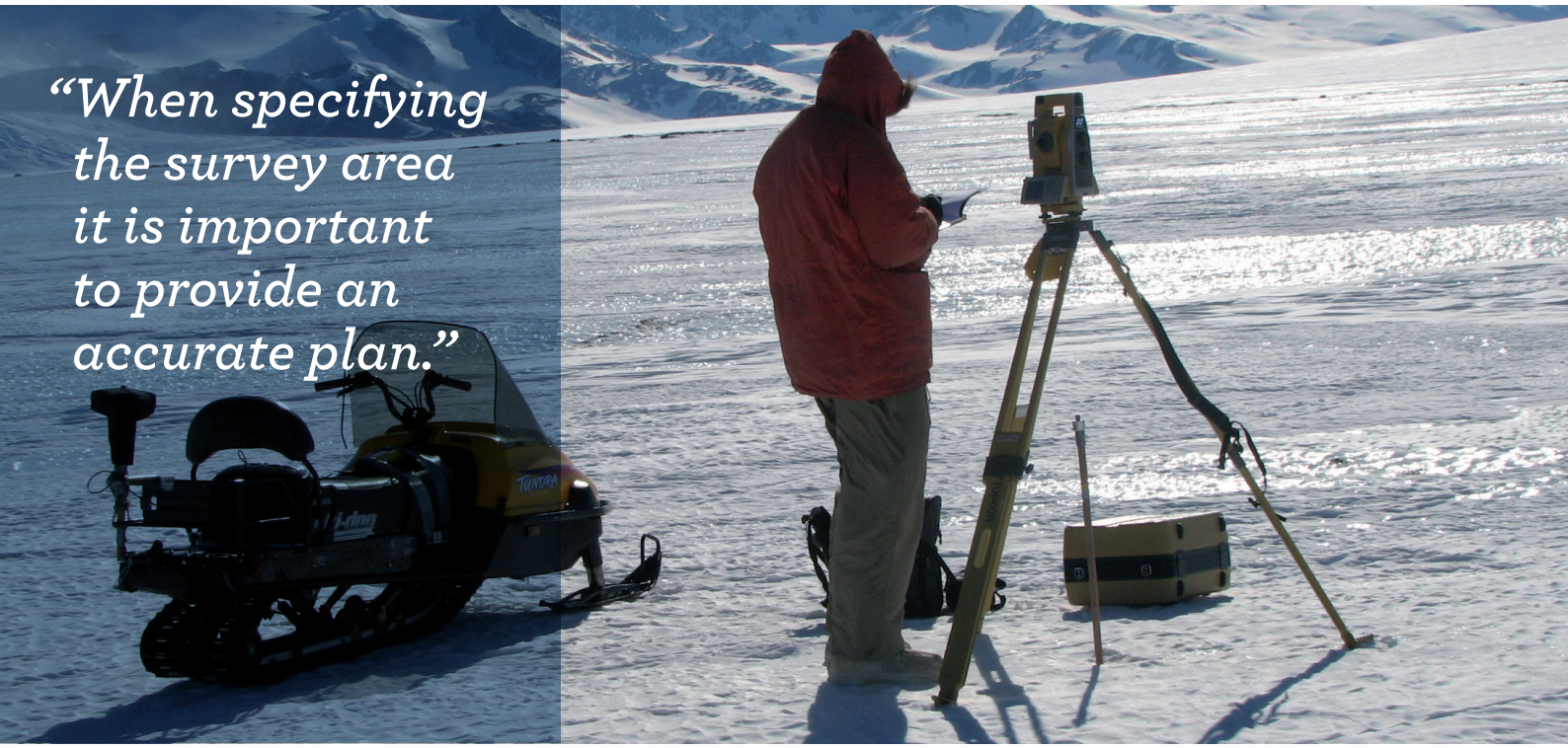
1. What is a Topographical Survey?

A Topographical Survey, sometimes referred to as a Land Survey, is the process required to produce an accurate and detailed map identifying both the natural and man-made feature within an area. The collected data may be presented in many formats, from a simple paper plan to a full three-dimensional (3D) digital model, depending on the client's requirements. Today the most common presentation is as a digital data set which is also plotted out as drawings.

2. Why is a Topographical Survey required?

The existing detail of an area may be required for either record or planning purposes. Other information, such as areas and volumes, may be calculated from a survey. Purposes to which a Topographical Survey may be used include:

- Housing estate or commercial redevelopment design layout
- Highway or railway design
- Location of neighbouring property details and boundaries for rights of light or party wall issues
- Cadastral Survey
- Sale or acquisition of land
- Locating specific items of detail
- Showing the existing layout of surface features and services (Underground services are in a separate guide)
- Development or alterations to land use
- Location of trees and tree canopies, on or off the site
- Modelling and visualization of the ground in 3D
- Historical records.



It is worth bearing in mind that a survey prepared for one purpose is not necessarily going to be of sufficient accuracy or detail to be used for another. For example, surveying the outline of buildings that are to be demolished is not carried out in the same detail as a measured building foot print.

Whatever the project being considered, accuracy in planning is the key. A thorough survey reduces the possibility of making costly mistakes at a later stage if unforeseen problems are uncovered.

3. Equipment used

The choice of equipment is often best left to the surveyor. The equipment chosen must be capable of meeting the accuracy requirements for the particular survey and of operating in the particular survey location.

"A thorough survey will lessen the possibility of making costly mistakes at a later stage."

In wide open areas of mostly soft detail, GPS Network RTK may be preferred, with a switch to Radio RTK where there is no mobile phone signal in the area.

In city areas close to buildings, when working under trees or other cover or when high accuracy is required, a total station is preferred. This can be to points occupied by a prism pole, or a non-direct laser shot to the detail. The total station may be operated as a robotic instrument by the surveyor alone if site conditions such as safety and security allow. All data is electronically logged and coded on the instrument to be processed and plotted out later from a computer. The time required for office processing is considerably shorter than the time spent on site. Survey control on site may also be established on site by either GPS or total station.

On some sites requiring a lot of complex detail and where the distance from the survey instrument and the detail is relatively short, a laser scanner may be used. Such surveys produce a lot of un-coded data and whilst this method requires only a very short time on site, considerably more time is required in the office to extract the required information for the survey drawing.

If high precision levels are required these may be observed with an optical level, manually booked, or electronically logged with a digital level. In both cases the levels require transferring to the drawing separately.

Minor additional detail may be surveyed with a tape measure or Disto – these are used for small distances to add detail not seen or missed by the other methods. This information may be manually booked and drawn in CAD. If there is existing survey information this information may be added on a field computer using suitable CAD or dedicated survey software.

4. Factors effecting a Topographical Survey

Topographical Surveys are defined by five main criteria:

1. **The area to be surveyed.**
2. **The detail required.**
3. **The accuracy required.**
4. **The grid and datum the survey is to be related to.**
5. **How the data is to be presented.**

4.1 The area to be surveyed

You may require detail beyond the boundary of your site. Think about the road in front of the site, the location of utility poles, manholes, trees, or buildings close by that may affect the project. These off site areas may require less detail than the main site. There may be issues of access that have to be considered. With today's non-contact total stations it may be possible to fix a visible building corner or to get a roof height without going onto the neighbouring land. When specifying the survey area it is important to provide an accurate plan that clearly identifies the area to be surveyed. There are now several online mapping websites which can help provide a suitable plan.

4.2 The detail required

The amount of information that needs to be recorded will affect the time the survey takes and therefore the cost of the survey. It is therefore important to carefully consider the information required when specifying a survey. For example, when spacing ground levels choose a distance apart that suits the ground and changes in ground level.

For flat areas one level every 100mm on the final drawing is good guide. Remember that a level grid of 20m spacing has 84% less points than one that has a 5m spacing and is therefore faster and costs less to survey.

The amount of detail and how it is shown is usually related to the scale. For example at 1:100 a manhole 0.6m wide on the ground will be 6mm wide on the paper and may be individually measured and plotted to scale whereas at 1:500 the same manhole will only occupy 1mm on the paper and a generic symbol could be used. As a general rule, items that occupy less than 1mm or 2mm on the paper, such as lamp posts and stop valves are represented by symbols. Scale will also limit the level of detail shown on items such as walls. For example at 1:100 scale a 0.22m brick wall will be shown as a double line (both sides) and a brick pier 0.45m on the end could be detailed. Whereas at 1:500 the same wall would be a single line and the brick pier, (less than 1mm on the paper), could be ignored.

"Spending some time discussing your requirements with your surveyor may avoid duplication of data."

4.3 The accuracy required

Computer aided drawing (CAD) can determine the exact distance between any two points, however all measurements will have a tolerance. In a topographical survey accuracy is related to scale e.g. a 1:100 based survey will be more accurate than a 1:200 or 1:500 scale survey.

The RICS specification for Surveys of Land, Buildings and Utility Services at Scales of 1:500 and Larger states that: "The accuracy of planimetric detail shall be such that the plan position of any well defined point of detail shall be correct to within 0.3mm r.m.s.e. at the plan scale when checked from the nearest permanent control station."

Therefore, using this specification, a point of detail on a 1:100 survey would be accurate to 30mm r.m.s.e and on a 1:500 survey would be accurate to 150mm r.m.s.e when checked from the nearest permanent control station.

4.4 Grid and Datum

A local survey grid with a scale factor of 1 (horizontal ground and map distances are the same), aligned approximately to north, is suitable for most surveys. These are often specified as needing to be related to Ordnance Survey National Grid (but not actually in National Grid). Surveying in Ordnance Survey National Grid with its variable Scale factor is best kept to large projects linking into other OS surveyed detail.

For most surveys levels should be related to the Ordnance Survey Newlyn datum, either by levelling from nearby Ordnance Survey Bench marks or by GPS. It should be noted that the Ordnance Survey no longer maintain benchmarks, therefore GPS should be used to relate a survey to Newlyn datum if it is important. The use of Ordnance Survey Newlyn datum makes it easier for levels on the survey to be related to levels provided by others such as statutory authorities. If you choose an arbitary level datum then the starting point and level of your site temporary bench mark (TBM) must be a stable feature that is easy to find and relocate after the survey, if further work is required.

4.5 Survey results and presentation

Spending some time discussing your requirements with your surveyor may avoid duplication and save money later on in the project. It is useful to specify some permanent survey markers on and close to the site to allow for future work, such as construction to be directly linked to the original survey.

5. Considerations when tendering

5.1 What specifications are available?

To save time and money it is important to tailor the survey to your needs and to have a survey specification. There are several specification documents available to help clients specify a Topographical survey, including those from TSA and the RICS (Royal Institution of Chartered Surveyors).

Should you wish to write your own specification your TSA survey consultant will be able to provide advice on a specification based on the items of detail and accuracy you need to achieve. It is important to include all the factors discussed earlier. If you are using an existing specification from a past job you should seek advice on whether it is still appropriate.

"Discuss your requirements at an early stage to determine the best way forward. It is very easy to over specify the level of detail needed."

If you can work in partnership with your survey company so that they know the requirements for the survey and what it will be used for, they will then be able to advise on the best method and the appropriate accuracy for the work.

5.2 What if I need to obtain competitive quotations?

Prepare an approved short list of established survey firms from the TSA's website.

Draw up a brief to include:

- Purpose of the survey
- Plan with survey area outlined
- Specification including any special requests
- Deliverable digital data format and hard copy if required

- Programme including phased delivery on large projects
- Site access and security arrangements.

When in doubt ask the survey firm for advice.

5.3 Who can advise me?

Land surveyors have methodologies that can lead to greater accuracy and efficiencies. It's important to discuss your requirements at an early stage to determine the best way forward. It is very easy to over specify the level of detail, density of points and the precision of the points. TSA members can advise the most appropriate and cost effective way to meet your requirements and add value to your survey data.

6. Summary

Draw up a specification for the work to include:

1. The extent of the survey area.
2. The detail required.
3. The grid and level datum to be used for the survey.
4. The scale of the drawings required and the accuracy of the survey.
5. Any areas of special interest or lesser interest.
6. Any site access or working restrictions.
7. Any contouring or ground modelling required.
8. Any special conditions regarding the establishment or location of survey control for future use.
9. How the final survey is to be presented

7. Further information

7.1 Specifications

Surveys of Land, Buildings and Utility Services (2nd edition) RICS Books.

The TSA Specification for Architects.

Environment Agency specification for Surveying Services version 3.1.

7.2 Publications

RICS Geomatics Guidance leaflet – "Virtually Level" (RICS/Ordnance Survey guide on the change from benchmarks to GPS heighting).

RICS Geomatics Guidance leaflet – "Scale" – (Once it's digital is not everything full size?)

RICS Geomatics Guidance leaflet – "Map Projection Scale Factor" (How to understand and avoid the potential dangers of scale factor)

RICS Geomatics Guidance leaflet – "Reassuringly Accurate" – (A guide to controlling accuracy)

The Survey Association

Formed in 1979 as The UK Land and Hydrographic Association, TSA is now established as the representative organisation for UK private surveying firms. The Association's aims are:

> To provide a vehicle for members to act effectively together on agreed courses of action

> To promote the interests of the profession to all those who determine the economic and social conditions in which the industry operates

> To identify and represent the views of the industry.

Using a TSA member

By using a TSA member you can be assured that your project will get off to the best possible start. Whatever the size of project, you can be certain that TSA member companies are expert in the provision and management of spatially related data on which to base your concept, design and construction.

Professional attention from a TSA surveyor will reduce risk, repetition, possibly save you money and will ensure that your project receives the best possible attention.

TSA Contact Details

If you would like any more information about the TSA or its members or about other Information leaflets then please contact Rachel Tyrrell at:

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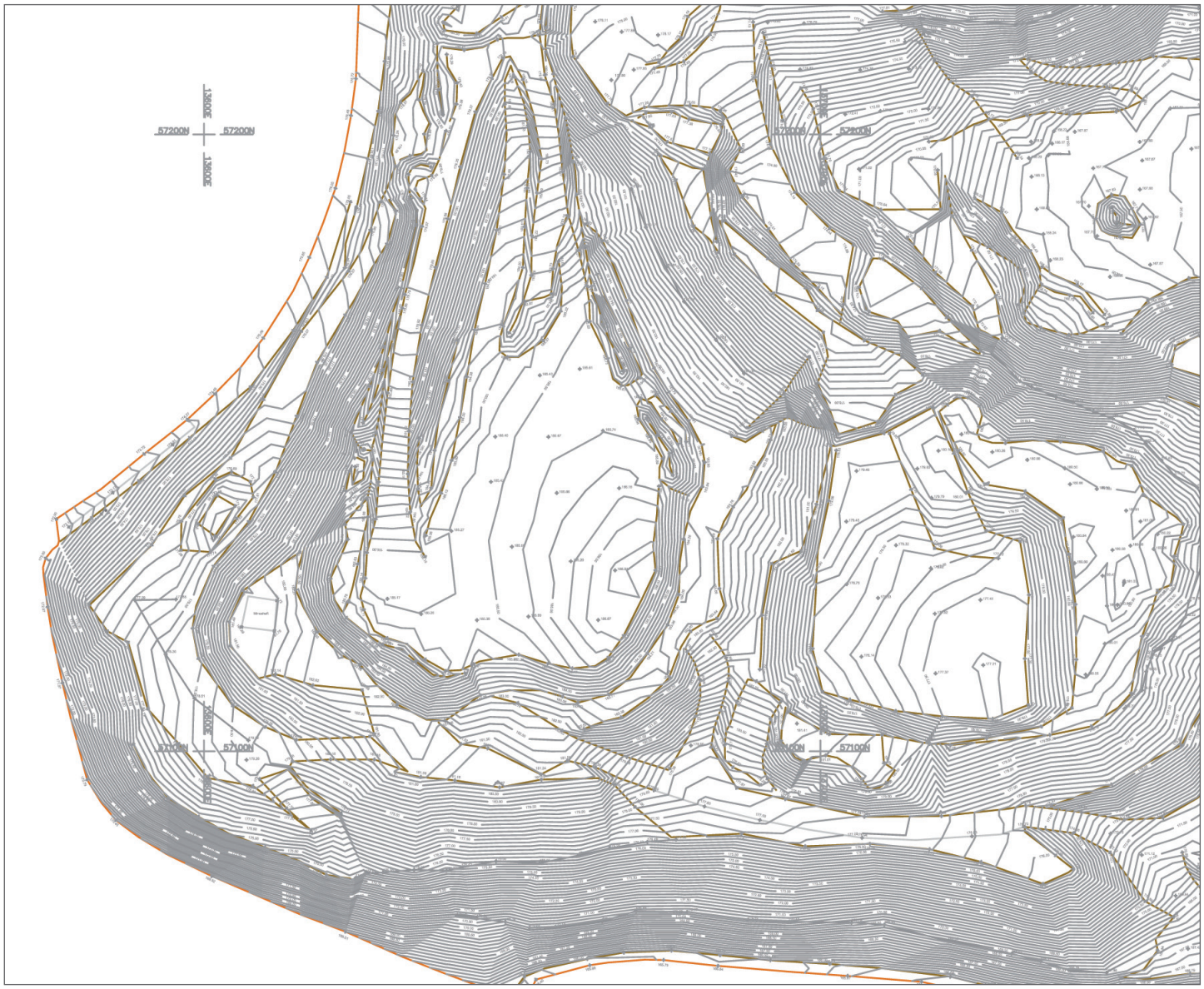
Glossary of Terms

TERM	EXPLANATION
Bench Mark	A mark made on a building or structure by the ordnance survey which has a published height – (these are no longer updated by The Ordnance Survey and should always be checked)
Cadastral Survey	A survey to determine and define land ownership and boundaries
Datum	A zero starting point for levelling
GNSS	Global Navigation Satellite System. GPS is such a system (see below)
GPS	A Global Position System using American satellites and often used to describe satellite positioning systems in general. Points can be fixed in a few seconds to several hours per point depending on the accuracy a method of observing chosen
Laser Scanner	An instrument that measures by laser thousands of regularly spaced points a second and giving to each point an X,Y,Z co-ordinate and a reflectivity value
Local Grid	A survey grid chosen for the size of site with relatively small numbers and usually a scale factor of exactly 1
Network GPS	The ability of a GPS receiver to obtain corrections over the mobile phone network and a subscription service
Radio RTK	The ability of a GPS receiver to obtain corrections over a radio link from another GPS receiver set up on a known point. Usually more accurate than Network GPS
Newlyn	The Cornish port where the Ordnance Survey tide gauge is sited and all levels on the main land are based on historic mean sea levels from this site
r.m.s.e	Root mean Square error – a normal statistical error distribution in which 68% of the observations conform to the r.m.s.e value and 99.9% of the observations conform to 3 times the r.m.s.e value
Scale Factor	A scale factor is created by using a map projection to represent the curved earth on a flat piece of paper. These are used on all surveys produced in the National Grid
Total Station	An instrument that measures horizontal and vertical angles and by laser slope distances to directed points, giving each a point number and a code if required. Several hundred points can be recorded a day
WGS 84	A survey co-ordinate system used by satellite receivers that usually gives position in terms of latitude and longitude. Satellite surveys convert the WGS 84 –ETRS 89 (European coordinate set) position into OS National Grid or local grid co-ordinates by software

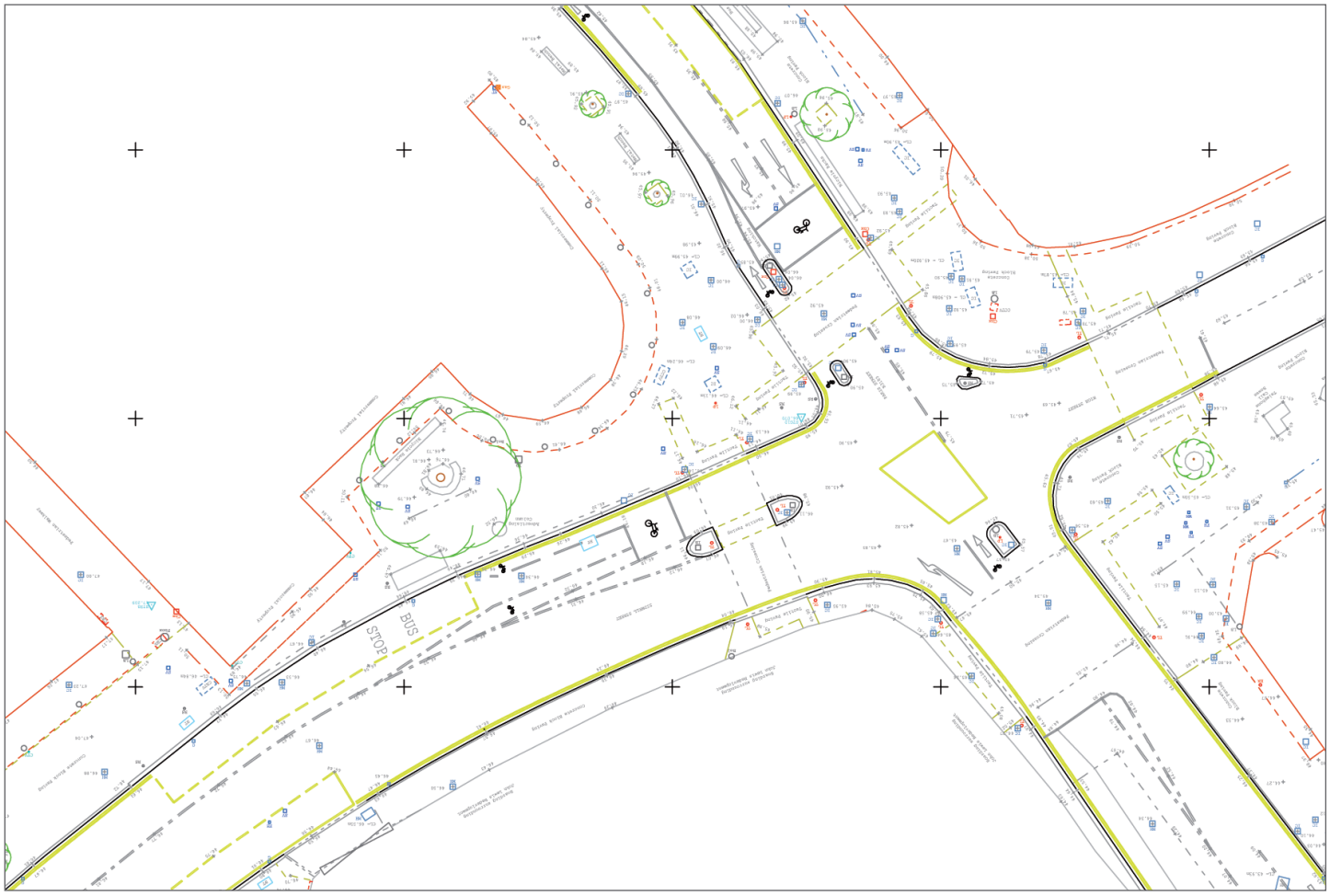
APPENDIX

The following are examples of finished topographic surveys shown as CAD plots.



An extract of part of digital terrain model (DTM) of a regeneration scheme in the English Midlands. A large earth moving exercise was undertaken by the local authority who asked the survey company to provide continual volumetric calculations of smaller areas to check the quantities the earth moving contractor was submitting. Periodically full surveys were required to check against the design model and check compaction against the original ground model.

The site used to be an old mining and dumping area. On the completion of the project the site will be used for a new school and sports facility.



Topographic survey of a section of Exeter High Street showing detail surveyed at a scale of 1:200.

The survey was conducted utilising the latest robotic total station technology with client specific legend and feature codes.

Document Revision History

Issue 1	March 2012	Original document
Issue 2	May 2015	TSA disclaimer added
Issue 3	April 2016	Text amendments