CLIENT GUIDE ON COMMISSIONING SURVEYS OF WATERCOURSES

THE SURVEY ASSOCIATION

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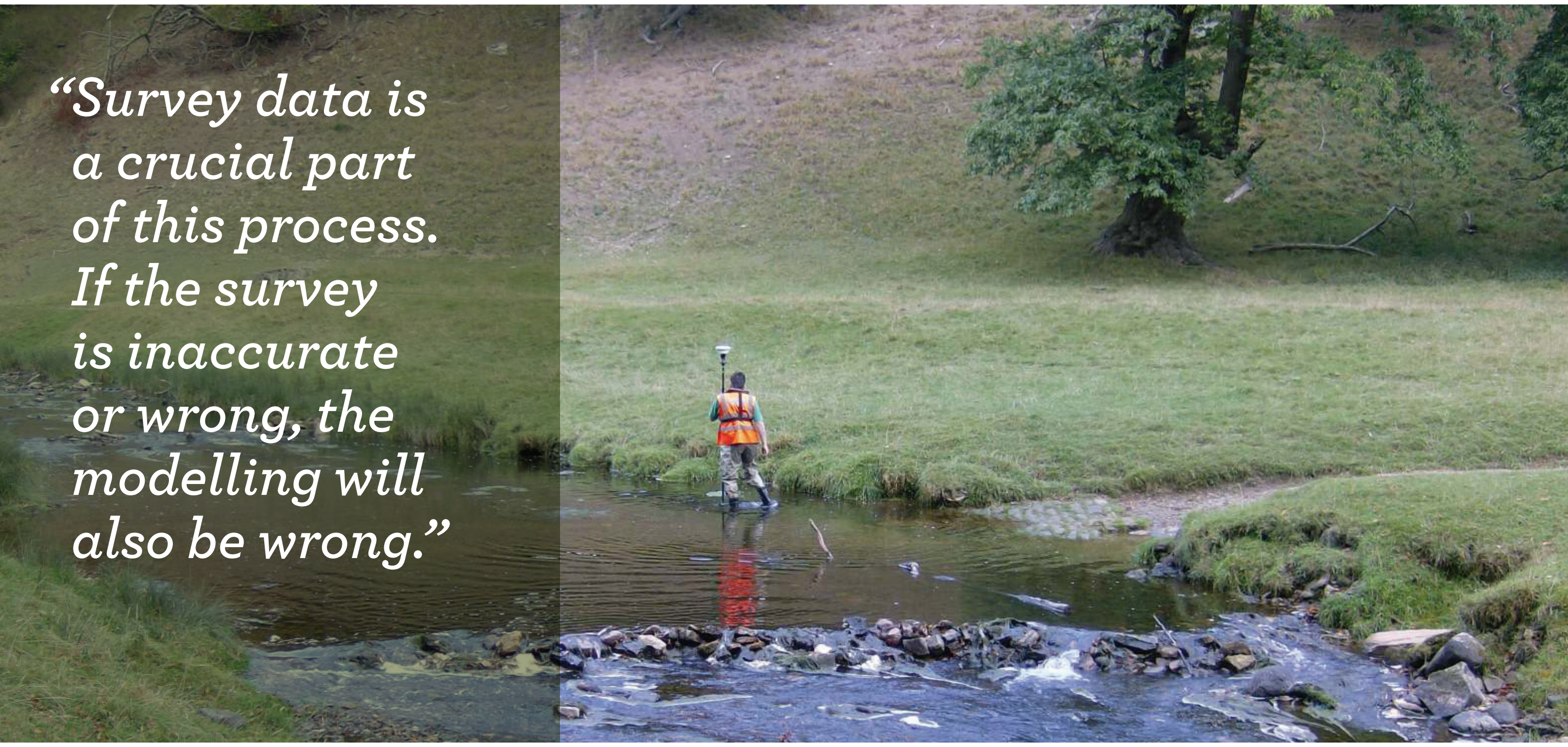
Endorsed by:
RICS
chartered ices

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 deal in depth with practical issues but to act as a basic guide on a certain topic and in particular, on procedures and regulations which may govern how certain aspects of the survey is carried out.

This document is predominantly a guide for anybody commissioning the survey of a fluvial watercourse and highlights the key factors to be considered when procuring the survey. This guide also outlines the processes that a survey company will follow to ensure that the client receives the information required to carry out a hydraulic modelling study successfully.

1. What is a watercourse survey?

A river survey is the collection of geometrical and descriptive data that describes the watercourse. The data is generally used for computer modelling and usually presented as drawn long-section and cross-sections and text files of digital data that can be read directly into river modelling programs.



2. Why do we need to survey watercourses?

Flooding from watercourses is a major problem in the UK. In order to plan flood defences and flood warning services, we need to know what happens during flood events but because, thankfully, severe floods are rare, we use computer modelling to simulate and predict the effects of floods.

Flood modelling is also used by developers to ensure that proposed developments properly take flood risk into account. These models generally cover a small area and form part of the Flood Risk Assessment which is required to support planning applications in the flood plain.

Survey data is a crucial part of this process. If the survey is inaccurate or wrong, the modelling will also be wrong.

River flood modelling is a two-stage process. Firstly the modeller models the behaviour of the river 'in-bank' and secondly looks at how water flows across the flood plain when the river breaks its banks. For out of bank modelling the modeller generally uses topographic mapping which is made using airborne survey techniques, such as LiDAR or photogrammetry. For in-bank models, ground based survey data is used and this is the subject of this guide.

The objective of the survey is to describe the shape of the river channel. This is normally done by observing a long section along the river that includes bed and bank levels and by observing cross-sections of the channel. This is the data required as input to the flood modelling programs. The observed cross-sections are effectively samples of the river cross-section, so they have to be observed in locations and at intervals that ensure they are representative of the channel. The surveyor also observes sections at structures that affect the flow of the river, such as mills, weirs, bridges and any other obstructions to the flow.

The modeller will usually specify the distance between observed cross-sections. It is nearly always preferable to observe cross-sections directly, but when the required interval between sections is less than about 20m, it may be more practical to produce a full 3D model of the watercourse and for the surveyor to interpolate cross-sections from the model in the required locations.

The interface between the in-bank and out-of-bank model is important, particularly where the river banks are raised above the flood plain. In these situations it is not uncommon for the surveyor to record continuous lines of coordinated levels along the crest of the river bank – also known as the spill line – taking particular care to survey low points where flood water will first 'break' the river banks.

3. Procurement of river surveying services

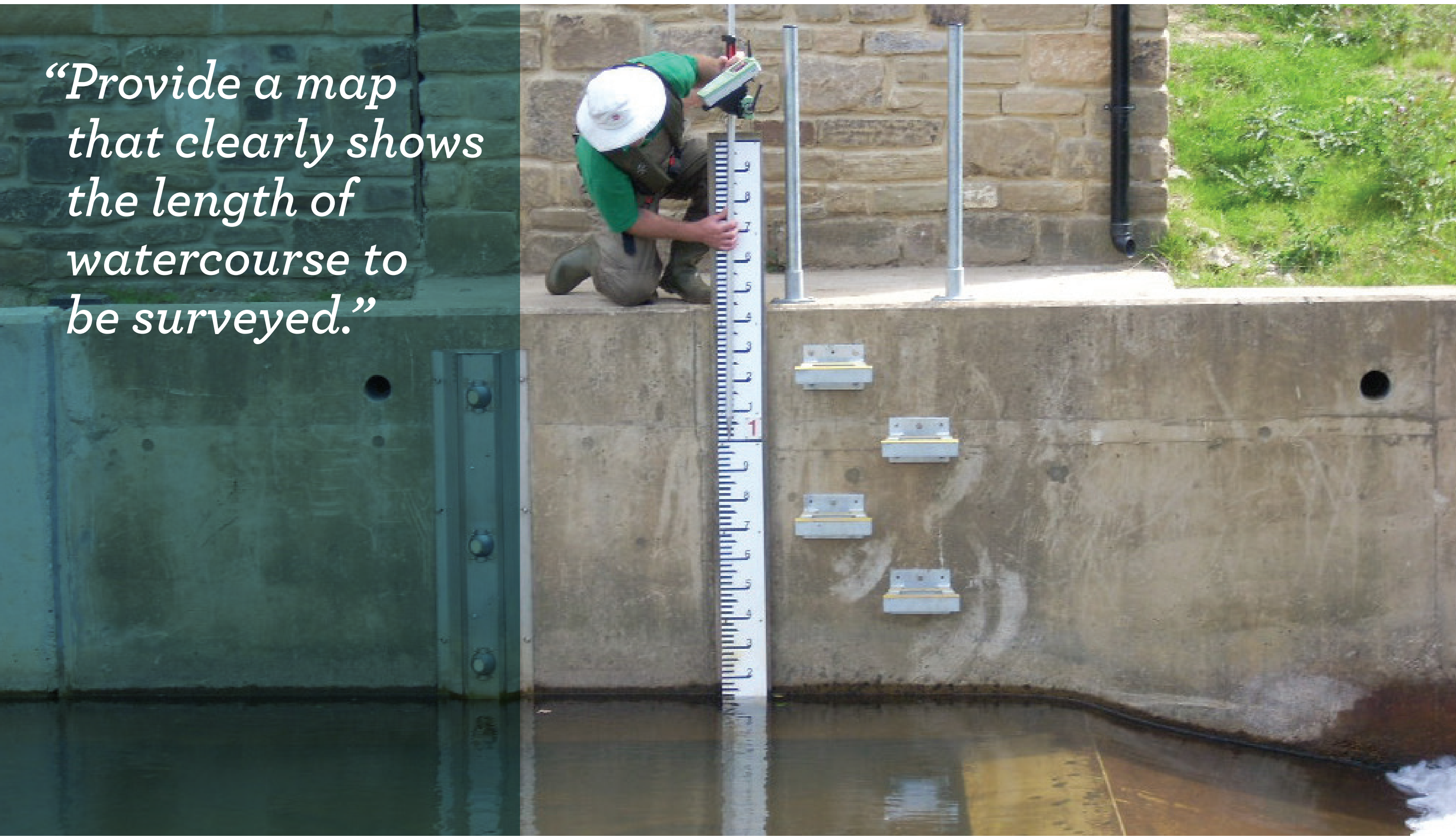
3.1 The survey company

Whilst most land surveying companies would have the capability to carry out river channel surveys, this is a specialised branch of geomatics and experienced companies will be more efficient than those that rarely operate in this market. Surveyors should be familiar with specialised data processing software that has the capability of producing output data in the required format for input into the flood modelling package required by the modellers.

It is also beneficial for surveyors to have knowledge of river structures, channel morphology, flood modelling methods and techniques. It is therefore prudent to use surveyors who are experienced in this work and have a proven track record. There are also courses available for training surveyors for this specialist work. Clients could request evidence of competency.

3.2 The survey specification

In almost every case it is best to ask the survey company to provide a quotation that is based upon the latest Environment Agency Standard Contract and Specifications for Surveying Services as a technical guide. This is a comprehensive document which covers most methods of survey work used for river engineering. One reason to use this specification for river surveys is that, in the event that your project requires a consultation with the Environment Agency (EA), they are only likely to accept the survey content if it is produced to their standards. This is an important point to note and if missed can be very costly, as you will have to re-commission the survey. If the river that you are modelling is not controlled by the EA (i.e. not main river) it is still advisable to use the EA specification as the chances are that it will fall into main river further downstream. This will enable fluvial models from different tributaries and streams to be compatible should they need to be joined.



"Provide a map that clearly shows the length of watercourse to be surveyed."

3.3 Contract Documents

The EA documents also include a standard survey brief (available from the Environment Agency website). It is possible to select optional requirements using 'cut and paste' to incorporate into the client's contractual documentation. The survey brief should state the purpose of the survey and, if available, provide land owner/ occupier information with preferred access points or alternatively, instruct the surveyor to investigate land ownership and liaise with land owners. The client should provide a letter of introduction to assist with this.

The client (or client's consultant) should also provide a map that clearly shows the length of watercourse to be surveyed and the required cross-section positions (extended into the floodplain if required) or other instruction as to where cross-sections are to be observed. If the requirements are described clearly it should be possible to let the contract on a fixed fee basis.

The deliverables should be specified and generally consist of a survey report, key map showing cross-section positions, drawn long and cross-sections, photographs of each section and digital channel survey data in a format that can be read automatically into the consultant's flood modelling program. The client should also request digital copies of field notes and computations as these may be used to validate the survey or investigate problems at a later date.

3.4 Health and Safety considerations

River surveys should never be carried out as a one-person operation. Normally a two-person team will perform the task but if the survey team has to use a boat, a three-person team will be required, with two people in the boat and one person on the bank.

Experienced river surveyors will take health and safety very seriously. Upon request and before commencement of the work, the surveyor will supply a method statement and a combination of generic and site-specific risk assessments to cover normal hazards as well as any special conditions on site.

Personal Protective Equipment (PPE) is an important part of health and safety in the river environment. Normally river surveyors will wear chest waders with studs in the soles to minimise slipping, a hi-viz jacket/vest/shirt and an automatic life jacket. The life jacket will inflate when submerged in water and will bring the surveyor to the surface with nose and mouth above water. Buoyancy aids are not considered safe to use for river work as they do not turn the victim towards the sky and if unconscious this could cause drowning.

Rivers can also carry disease such as leptospirosis or Weil's disease which can be fatal. Experienced surveyors have good hygiene routines to avoid accidently making contact with contaminated substances.

Fast flows, currents and tides can pose a serious threat to life and the experienced river surveyor will respect difficult conditions. Weirs and sluices are particularly dangerous and the surveyor might have to use a harness to survey them safely. It may be that work has to be delayed due to poor site conditions and this will normally be explained to the client as soon as the decision is made.

Overall, a survey company that has a background of surveying water-based projects will have a robust health and safety policy and will be able to demonstrate this through both documentation and project history.

3.5 Surveying Techniques

The surveyor may use various techniques to carry out the survey. Generally he will take total station observations to a target on a pole to measure river detail on long and cross-sections, but on unvegetated watercourses, survey-grade GNSS equipment may be more suitable. When the water is more than waist deep and depending on the flow, it may not be safe to wade across, so a boat will be used and the bed will be surveyed either using a long pole or an echo sounder.

Clients frequently require both the top of silt and the hard bed of the river to be surveyed. If the top of silt is required it may be necessary to use a flat-bottomed pole to 'find' the top of the silt accurately.

Surveyors should leave control stations along the river as references for future work or checking. These points normally take the form of nails drilled into concrete and are supplied on witness diagrams to make their recovery easier.

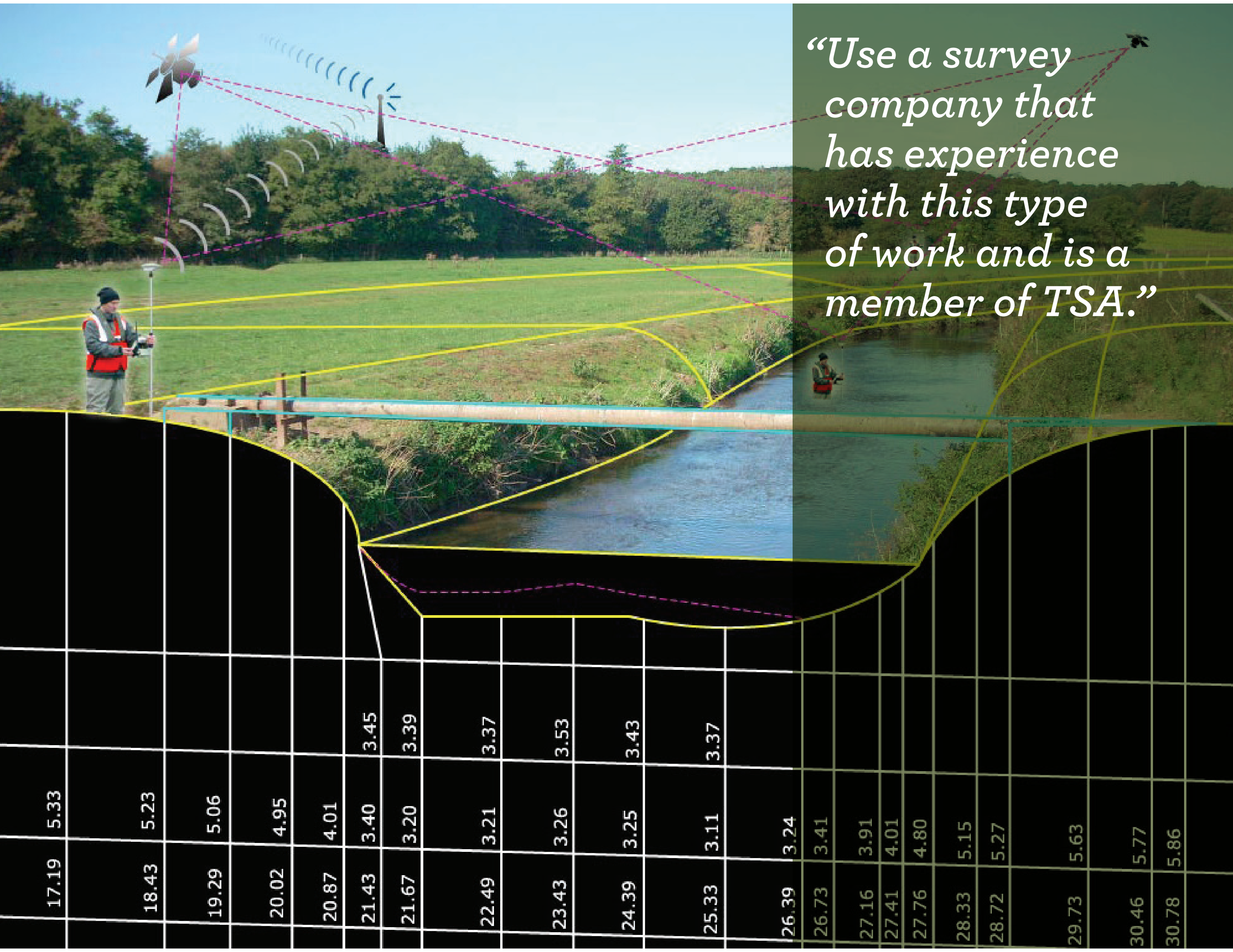
"Flood plains are best surveyed from late summer to early spring when the crops are low to the ground or have just been harvested."

If LiDAR or photogrammetric data is not available for the out of bank model, the modellers may require the surveyor to extend cross sections across the floodplain. These may be observed by taking additional observations using the total station or using GNSS equipment as appropriate for the conditions. Flood plains are best surveyed from late summer to early spring when the crops are low to the ground or have just been harvested.

Most surveyors feel personally responsible for their work and appreciate any feedback that may support the quality of what they do or help improve their service in the future. Surveyors are generally keen to talk about the rivers they have surveyed and clients should feel free to make contact to discuss queries or complex areas with them. They will have spent a lot of time surveying your reach of river and will be a useful source of information should any questions arise.

4. Conclusion

The process of commissioning and successfully completing a river survey is straightforward and simple if the guidelines above are followed. One key element is to use a survey company that has experience with this type of work and is a member of TSA. This will ensure that your river survey data contains everything that you need to complete your study. If you give your project the best possible start then it has more chance of being successful throughout. Companies within TSA will work with you towards this goal.



5. Further information

5.1 Survey Specification

Environment Agency Specification for Surveying Services
(Available by contacting the Environment Agency)

5.2 Flood Risk Assessment and other general advice for planning applications

http://www.environment-agency.gov.uk/research/planning/93498.aspx

6. Acknowledgements

Thank you to Richard Groom MRICS, technical specialist for land survey at the Environment Agency, for his consultation on this document.

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 or Rory Stanbridge at:

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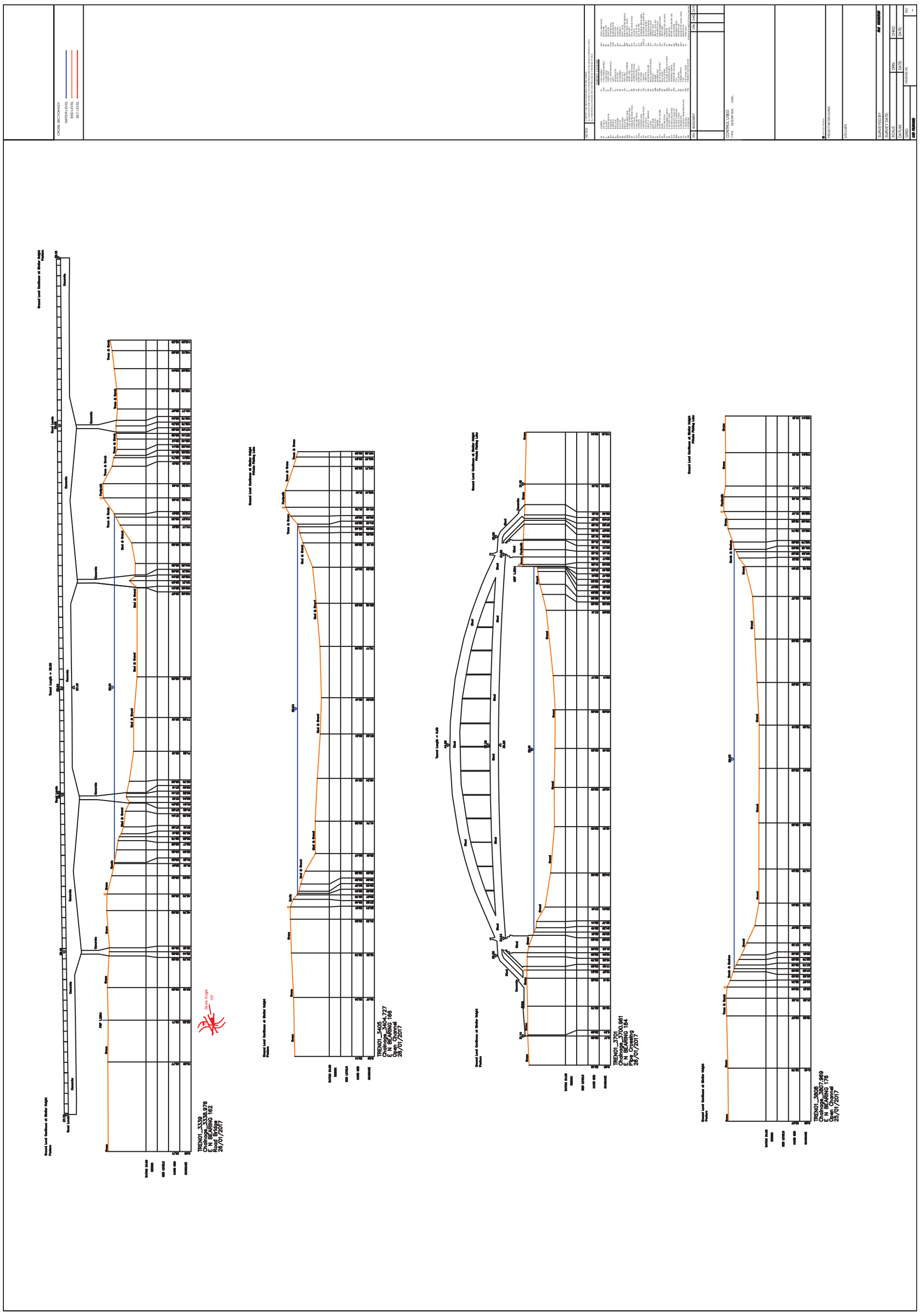
Glossary of Terms

TERM	EXPLANATION
CAD	CAD is Computer Aided Design software for 2D and 3D design and drafting
Datum	A zero starting point for levelling
Geomatics	A science concerned with using mathematical methods on data about the earth's surface
GNSS	Global Navigation Satellite Systems (GNSS) is the standard generic term for satellite navigation systems that provide geo-spatial positioning with global coverage
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 and method of observing chosen
HEC-RAS	Hydrologic Engineering Centres River Analysis System. Software that allows the performance of one-dimensional steady flow, unsteady flow, sediment transport/mobile bed computations and water temperature modelling
ISIS	A suite of modular software solutions used for simulating water flow, hydrology, water quality changes and sediment transport in rivers, floodplains, canals, estuaries, catchments and urban areas
Leptospirosis	A disease that humans can become infected by coming into contact with urine from infected animals such as rats. The disease can range from very mild and symptomless to more serious, even life threatening (Weils disease)
LIDAR	Light Detection And Ranging is an optical remote sensing technology that can measure the distance to, or other properties of a target by illuminating the target with light, often using pulses from a laser
PDF	A file format that provides an electronic image of text and graphics that looks like a printed document and can be viewed, printed and electronically transmitted
RTK GPS	Real-Time Kinematic GPS. The relative positioning technique whereby carrier phase measurements or corrections are transmitted in real-time from a Reference or Base Station to the users roving receiver
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

APPENDIX 1
DRAWING EXAMPLES

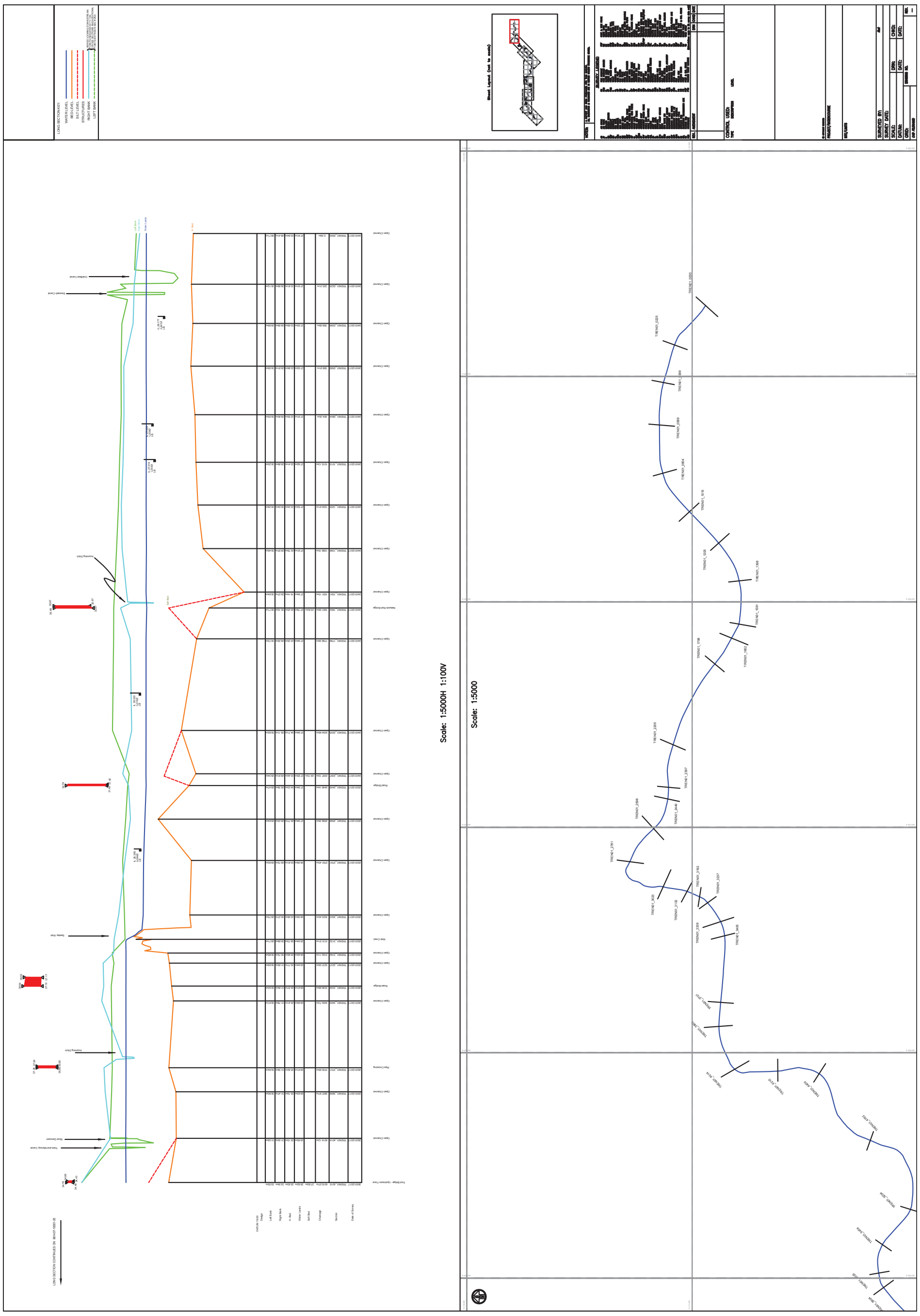
Cross Section Drawing

The object of the survey is to describe the shape of the river channel



Long section and cross section location plan (without OS background mapping)

Cross sections are normally taken at intervals and locations that show a good representation of the channel geometry



Example model data file – Hec-Ras

Choose a survey company that is capable of producing output data in your required format

```
CROSS-SECTION:
    STREAM ID: River Kelvin
    REACH ID: KELV01_
    STATION: 0.105
    BANK POSITIONS:  0.0000,  1.0000
    REACH LENGTHS:        51,         51,         51
    CUT LINE:
      256135.256,      666322.874
      256135.323,      666353.695
    SURFACE LINE:
      256135.256,      666322.874,      6.689
      256135.256,      666322.886,      3.443
      256135.258,      666324.118,      3.384
      256135.268,      666328.680,      1.447
      256135.272,      666330.413,      1.169
      256135.275,      666331.906,      1.259
      256135.280,      666334.008,      1.317
      256135.285,      666336.309,      1.179
      256135.292,      666339.543,      1.159
      256135.296,      666341.274,      1.347
      256135.301,      666343.665,      0.828
      256135.303,      666344.475,      0.524
      256135.305,      666345.645,      0.246
      256135.307,      666346.347,-     0.224
      256135.309,      666347.457,-     0.404
      256135.312,      666348.563,-     0.753
      256135.314,      666349.616,-     1.072
      256135.318,      666351.348,-     1.239
      256135.320,      666352.320,-     1.470
      256135.321,      666352.871,      0.542
      256135.322,      666353.102,      0.565
      256135.322,      666353.137,      0.828
      256135.322,      666353.385,      2.647
      256135.323,      666353.695,      5.761
  END:

  CROSS-SECTION:
    STREAM ID: River Kelvin
    REACH ID: KELV01_
    STATION: 0.143
    BANK POSITIONS:  0.0000,  1.0000
    REACH LENGTHS:        38,         38,         38
    CUT LINE:
      256173.741,      666319.659
      256169.423,      666353.591
    SURFACE LINE:
      256173.741,      666319.659,      8.296
      256173.415,      666322.224,      6.496
      256173.052,      666325.075,      4.645
      256173.010,      666325.406,      2.437
      256172.973,      666325.697,      2.415
      256172.718,      666327.701,      2.140
      256172.445,      666329.847,      1.852
      256172.285,      666331.099,      1.625
      256172.099,      666332.562,      1.577
      256172.054,      666332.917,      1.438
      256171.851,      666334.515,      1.299
```

Example model data file – ISIS

Having survey data supplied in the correct river modelling format will save your company time and money

```
RIVER Road Bridge (Benalder Street)
SECTION
KELV01_143
    37.841
30
     0.000      8.296      0.040*     1.000         256173.74 666319.66
     2.586      6.496      0.040      1.000         256173.41 666322.22
     5.460      4.645      0.040      1.000         256173.05 666325.07
     5.794      2.437      0.040      1.000         256173.01 666325.41
     6.087      2.415      0.040      1.000         256172.97 666325.70
     8.107      2.140      0.040      1.000         256172.72 666327.70
    10.270      1.852      0.040      1.000         256172.44 666329.85
    11.533      1.625      0.040      1.000         256172.29 666331.10
    13.007      1.577      0.040      1.000         256172.10 666332.56
    13.366      1.438      0.040      1.000         256172.05 666332.92
    14.975      1.299      0.040      1.000         256171.85 666334.51
    16.472      1.112      0.040      1.000         256171.66 666336.00
    17.011      1.344      0.040      1.000         256171.59 666336.53
    18.450      1.328      0.040      1.000         256171.41 666337.96
    19.970      1.329      0.040      1.000         256171.22 666339.47
    20.470      1.059      0.040      1.000         256171.16 666339.97
    21.081      0.727      0.040      1.000         256171.08 666340.57
    23.049      0.645      0.040      1.000         256170.83 666342.52
    23.863      1.362      0.040      1.000         256170.73 666343.33
    26.093      1.382      0.040      1.000         256170.45 666345.54
    27.925      1.474      0.040      1.000         256170.22 666347.36
    29.050      1.125      0.040      1.000         256170.07 666348.48
    29.812      0.840      0.040      1.000         256169.98 666349.23
    32.002      0.705      0.040      1.000         256169.70 666351.41
    32.796      0.857      0.040      1.000         256169.60 666352.19
    33.626      0.933      0.040      1.000         256169.50 666353.02
    33.672      1.577      0.040      1.000         256169.49 666353.06
    33.765      1.935      0.040      1.000         256169.48 666353.15
    34.138      4.930      0.040      1.000         256169.43 666353.52
    34.206      5.972      0.060*     1.000         256169.42 666353.59

RIVER Open Channel
SECTION
KELV01_105
    51.396
24
     0.000      6.689      0.040*     1.000         256135.26 666322.87
     0.012      3.443      0.040      1.000         256135.26 666322.89
     1.245      3.384      0.040      1.000         256135.26 666324.12
     5.806      1.447      0.040      1.000         256135.27 666328.68
     7.539      1.169      0.040      1.000         256135.27 666330.41
     9.032      1.259      0.040      1.000         256135.28 666331.91
    11.134      1.317      0.040      1.000         256135.28 666334.01
    13.435      1.179      0.040      1.000         256135.29 666336.31
    16.669      1.159      0.040      1.000         256135.29 666339.54
    18.401      1.347      0.040      1.000         256135.30 666341.27
    20.792      0.828      0.040      1.000         256135.30 666343.67
    21.602      0.524      0.040      1.000         256135.30 666344.48
    22.772      0.246      0.040      1.000         256135.31 666345.65
    23.474     -0.223      0.040      1.000         256135.31 666346.35
    24.583     -0.403      0.040      1.000         256135.31 666347.46
    25.689     -0.752      0.040      1.000         256135.31 666348.56
    26.742     -1.071      0.040      1.000         256135.31 666349.62
    28.475     -1.238      0.040      1.000         256135.32 666351.35
    29.446     -1.469      0.040      1.000         256135.32 666352.32
    29.997      0.542      0.040      1.000         256135.32 666352.87
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    30.821      5.761      0.060*     1.000         256135.32 666353.70
```

Document Revision History

Issue 1	March 2012	Original document
Issue 2	May 2015	TSA disclaimer added
Issue 3	April 2016	Text amendments
Issue 4	July 2017	Updates to Appendix 1 Drawing Examples