



Site Recorder Technical Note 3

3D Survey Procedure

This technical note is to be used with Site Recorder 4 and Site Recorder 4 SE Version 4.23.10 although the principles apply to all versions of these programs.

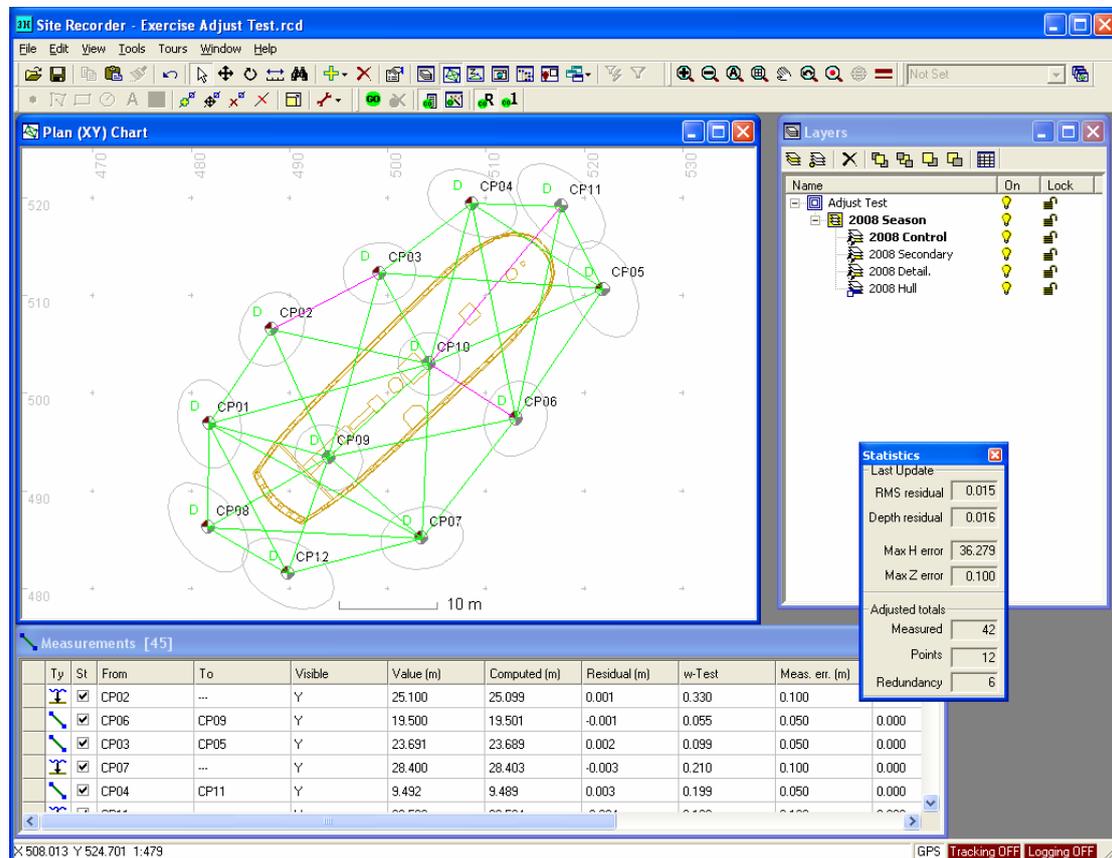
Introduction

This technical note describes the procedure used to process measurements from a 3D trilateration survey. For this type of survey, direct distance measurements are made between survey points in and around the site to be recorded. This method provides the highest positioning accuracy and should be used for pre-disturbance surveys and all excavation recording.

The basic principle of this method of surveying is to record distance and depth measurements between survey points and then use Site Recorder to calculate the best position of the points. Distance and depth measurements are often recorded incorrectly and the procedure below describes how Site Recorder can be used to find any mistakes.

The technique described here uses the Control / Detail method where a few survey control points are used to position many survey detail points which are in turn used to position artefacts and structure. This method is preferable to the 'Everything' method where all survey points are treated equally and measurements are made between all of them. The Control / Detail method uses fewer measurements and is easier to find mistakes.

Depth measurements MUST be added for all survey points, both control and detail. Typing in the depth of the survey point is not enough and a separate depth measurement must be added. Failure to add depth measurements may result in the position calculation not working correctly.



Adding Control Points

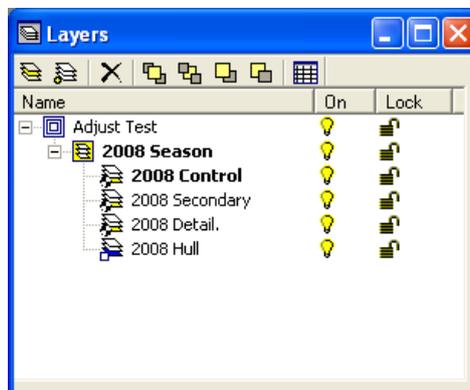
The first step is to add a network of survey control points around the outside of the site. As few points should be used as possible and they should all be within 15-20m (50 - 65ft) of the other nearby survey points.

Survey Points can only be added to Survey type Layers

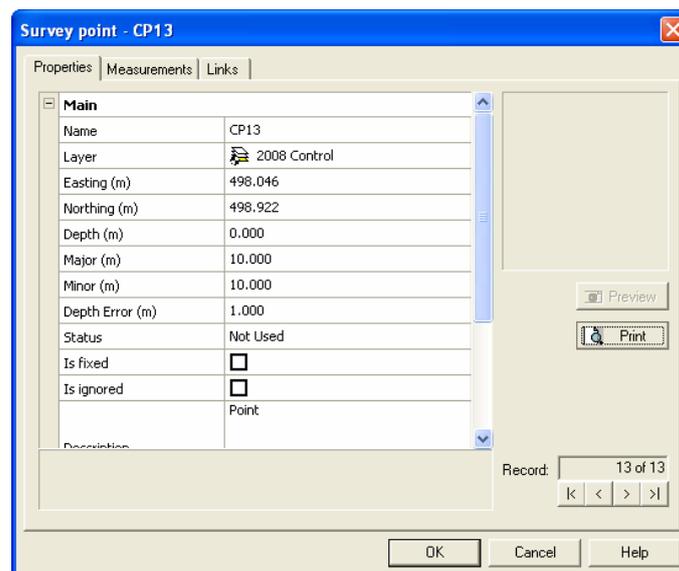
- 1 Show the Survey Toolbar. From the **View Menu** select **Toolbars** then **Survey Toolbar**



- 2 Select a Survey Layer for control points as the current Layer in the **Layer Display**. Click on the Layer in the list then click the **Set Current** button .



- 3 On the **Survey Toolbar** click the **Add Survey Point** button .
- 4 Click on the chart in the approximate position where the new point should be added. The **Properties Pages** for the new Survey Point will be displayed.



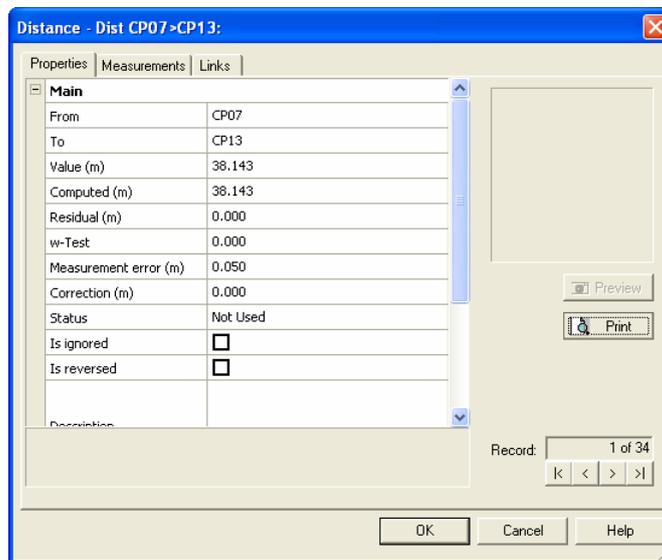
- 5 Type in a new name for the point or use the default.

- 6 Set the **Depth** of the point and click **OK**
- 7 Click again on the chart to add another Survey Point repeating steps 4 to 6. Or click the **Select** button  on the **Main Toolbar** to stop adding points.

Adding Distance Measurements

Added between two Survey Points

- 1 On the **Survey Toolbar** click the **Add Distance** button 
- 2 Left click and hold down the mouse with the cursor on the Survey Point to measure from.
- 3 Drag the mouse cursor to the Survey Point to measure to and let go. If the measurement was added successfully the property Pages for the new measurement are shown.



Main	
From	CP07
To	CP13
Value (m)	38.143
Computed (m)	38.143
Residual (m)	0.000
w-Test	0.000
Measurement error (m)	0.050
Correction (m)	0.000
Status	Not Used
Is ignored	<input type="checkbox"/>
Is reversed	<input type="checkbox"/>
Description	

- 4 On the Properties tab, type in the recorded distance measurement in the Value property then click **OK**.
- 5 Click and drag again between two Survey Points to add another distance measurement repeating steps 2 to 4. Or click the **Select** button  on the **Main Toolbar** to stop adding measurements.

The default Value shown when the measurement is first created is the expected measurement based on the current positions of the two Survey Points.

Adding Depth Measurements

Adding depth measurements is very important and a measurement should be added to every survey point.

- 1 On the **Survey Toolbar** click the **Add Depth** button 
- 2 Click on the survey point to add the depth measurement to. If successful then the Property Pages for the depth measurement will be shown.
- 3 On the Properties tab, type in the recorded depth measurement into the Raw Depth property then click **OK**.

- Click on another Survey Point to add a new depth measurement repeating step 3. Or click the **Select** button  on the **Main Toolbar** to stop adding measurements.

The default Raw Depth shown when the depth measurement is first created the current depth of the point.

Calculating Positions

We can now calculate new positions for the Survey Points using the measurements added earlier. The measurements are used to calculate the best estimate of the positions of the points and we can also calculate how well all of the measurements fit together.

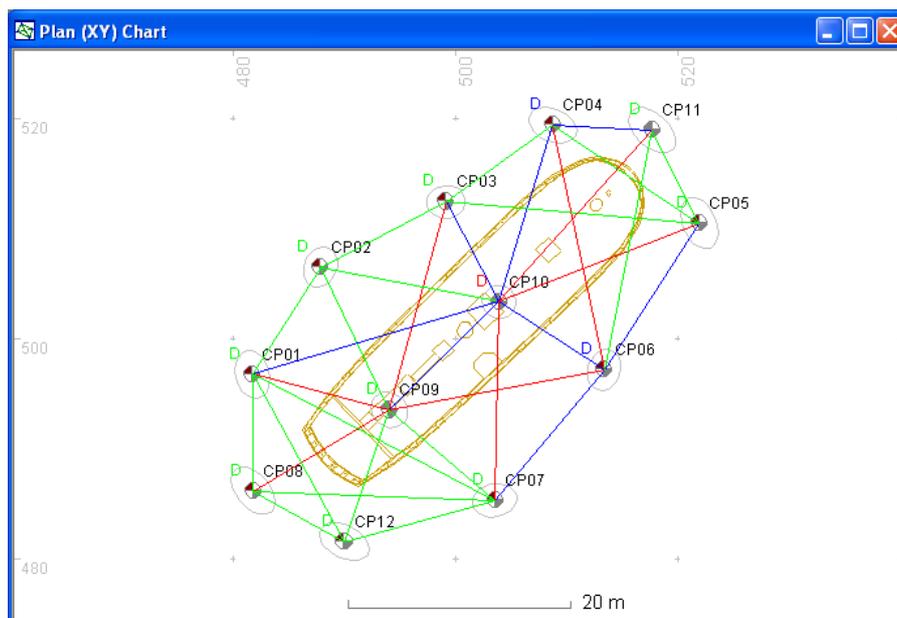
To calculate the positions of the points:

- Click the **Adjust** button  to compute positions for the points from the measurements. If successful the message 'Adjustment completed OK' will be shown along with the **Statistics** display.

The Statistics display shows the RMS Residual, a value showing how well the measurements fit with each other. Any value below 0.050 is acceptable but values of 0.015 or lower is considered good. Larger numbers show that some of the measurements that have been added are mistakes and need to be removed.

Statistics	
Last Update	
RMS residual	0.015
Depth residual	0.016
Max H error	37.212
Max Z error	0.100
Adjusted totals	
Measured	42
Points	12
Redundancy	6

After positioning the best position for the points the software can calculate what each distance or depth measurement should be to fit with those positions. The measurement residual is the difference between the measured value and the calculated value for that measurement. For each measurement added earlier we can calculate what the value should have been to best fit with the others then work out the difference between that and the value we typed in. The average or RMS of those residuals gives us a figure to show how well the measurements fit together and how accurately we have recorded the positions of the points. The computed value and residual for each measurement is shown alongside the recorded measurement in the measurements' Property Pages.



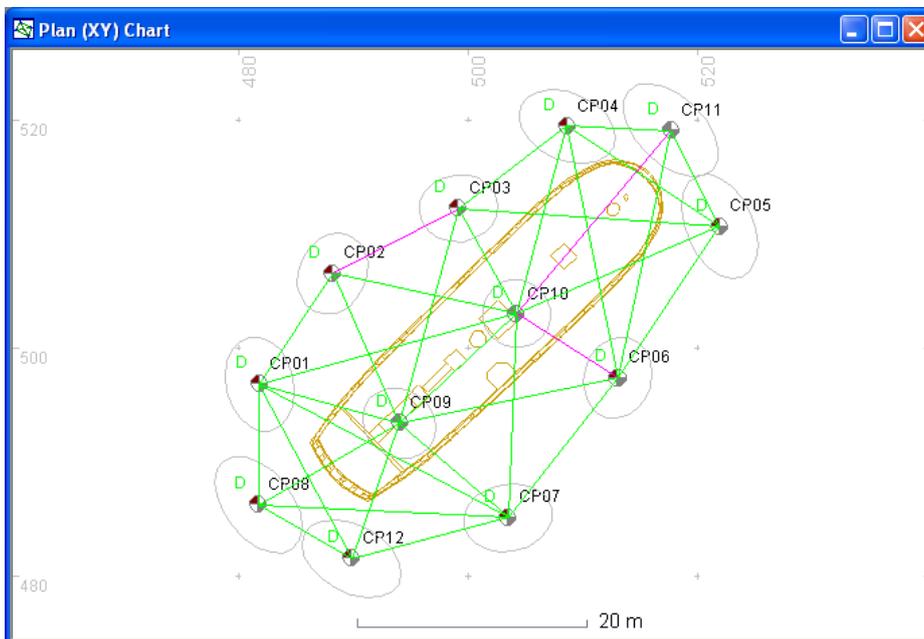
On the chart the measurements are coloured according to whether they are too long or too short. Recorded measurements that are too long (residual is a positive number) are shown in blue, those that are too short are shown in red and those that are correct are shown in green. Ideally all measurements should be green however it is common to have a mix of colours at the start.

We can improve on this result by allowing the software to automatically remove the measurements that are wrong using the Auto Rejection Tool.

To use the Auto Rejection Tool:

- 1 On the **Adjust Toolbar**, click the **Auto Rejection** button 
- 2 Click the **Adjust** button  to recompute the positions of the points

After using the Auto Rejection tool the results have improved:



The measurements now include some that are coloured magenta as these have been rejected by the Auto Rejection tool. The RMS of residuals value will also have reduced showing that there are now fewer bad measurements being used in the calculation. Measurements that have been highlighted in magenta should be remeasured or set to be not used in the calculation.

To select a measurement not to be used:

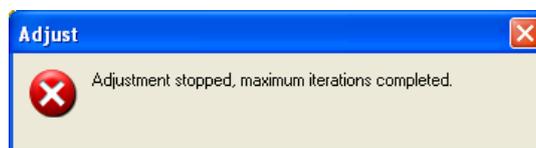
- 1 Double click the measurement on the chart or in the measurements list to show its **Property Pages**
- 2 On the **Properties** tab, click the **Is Ignored** property check box so a tick is shown
- 3 Click **OK**

Measurements that are set to be ignored are shown in black on the chart. These measurements are not used in the position calculation.

This part of the processing is complete when there are sufficient measurements added and the RMS Residuals value is below 0.050m.

Adjustment Problems

Occasionally the position calculation does not work properly. If after pressing the Adjust button the program shows this message then the positions of the points cannot be calculated from the measurements.



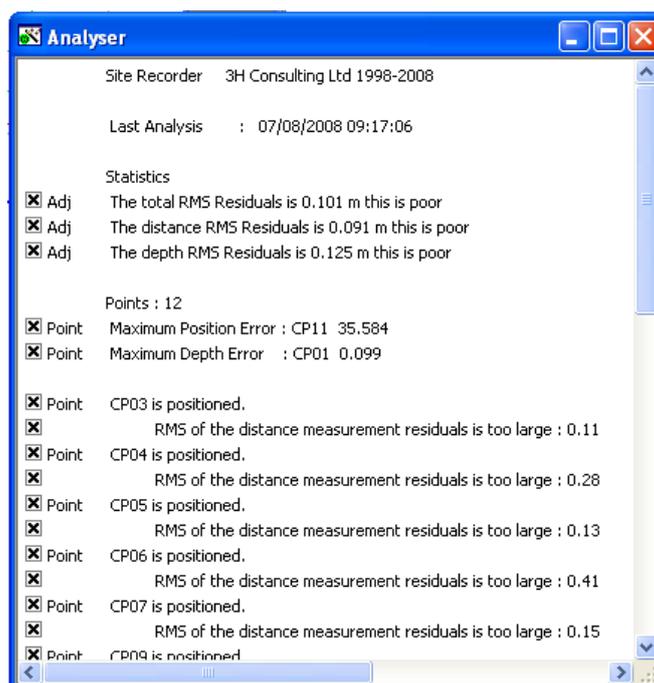
The problem is that something is wrong with one or more of the measurements and this can be caused by a number of reasons:

- Not enough points have depth measurements
- More than one measurement has been added between the two same points and the measurements are very different.
- All measurements to one point are too short, shown in red on the chart

Assistance with identifying problem measurements is given by the Analyser Tool; this looks at the points and measurements and suggests where problems may be found.

To show the Analyser Tool:

- On the Adjust Toolbar, click the Analyser button 



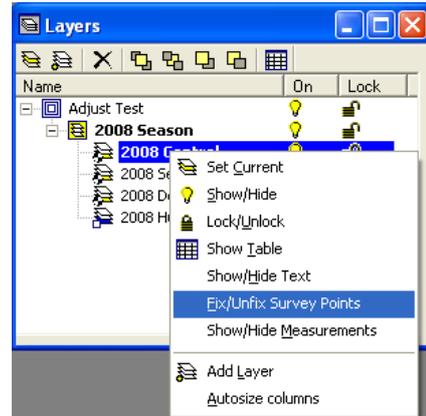
More information about the Analyser and solving adjustment problems can be found in the manual, accessed via the Help menu in Site Recorder.

Fixing the Control Points

With the survey control points positioned correctly we can now fix their positions. The positions need to be fixed so the addition of any detail points and measurements does not affect the control point positions.

To fix the Survey Points:

- 1 On the **Layer Display**, click the Layer containing the Survey Points then right click to show the context menu
- 2 In the context menu click **Fix/Unfix Survey Points**



To confirm that a point is fixed, double click it to show its properties and ensure that the Is Fixed property check box is ticked.

The measurements between the fixed control points are now no longer used in the adjustment so can be hidden.

To hide the measurements between points on a Layer:

- 1 On the **Layer Display**, click the Layer containing the Survey Points then right click to show the context menu
- 2 In the context menu click **Show/Hide Measurements**

Adding Detail Points and Measurements

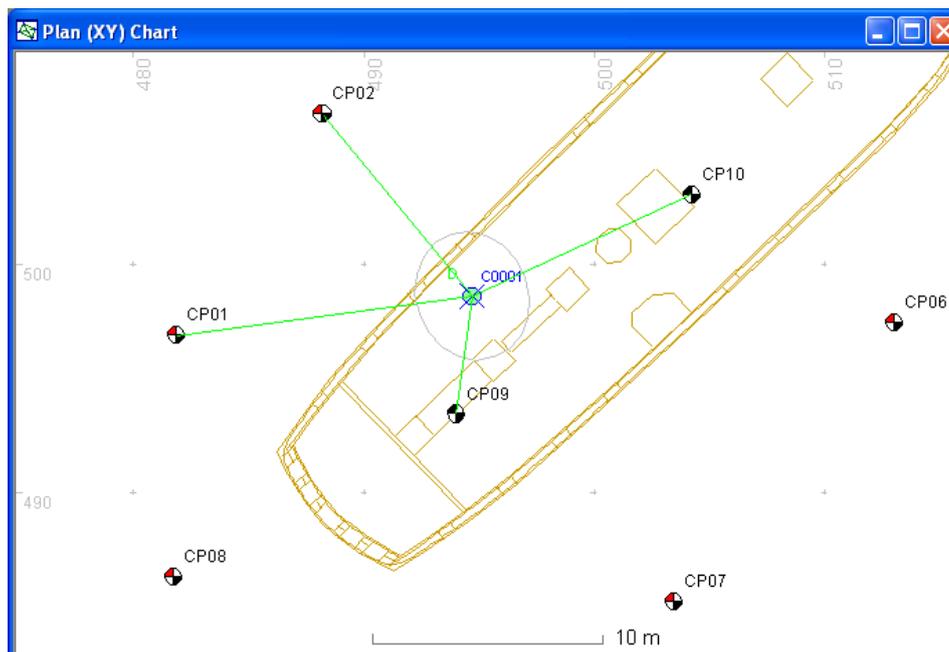
With the control points added, positioned and fixed we can now add the survey detail points used to record the positions of artefacts and structure. The procedure for adding detail points and measurements to them is the same as described above used for survey control points.

- 1 Select a Survey Layer for detail points as the current Layer in the **Layer Display**. Click on the Layer in the list then click the **Set Current** button .
- 2 Add a detail Survey Points as described earlier using click the **Add Survey Point** button  on the Survey Toolbar.
- 3 Add distance and depth measurements to the detail survey points using the **Add Distance** button  and **Add Depth** button  on the **Survey Toolbar**
- 4 Adjust the positions of the detail points using the Adjust button  on the **Adjust Toolbar**
- 5 Re-measure any measurements that are identified as mistakes by the adjustment

Small finds can be positioned using a single survey detail point but longer objects such as guns and anchors should be positioned with two or more so the orientation of the object can be shown. Vessel structure should be positioned using multiple detail points.

Avoid making measurements between detail points unless they are points on the same object such as the two end points used to position a cannon.

Separate the detail points on different types of objects onto different layers, so put the points used to position artefacts, guns and anchors on separate layers.



Technical Support

The online help document in provides further information on this subject. To show this document, select **Help Topics** from the **Help** menu.

More information about survey point network design can be found in the Nautical Archaeology Society Handbook 2nd Edition.

More information and example Site files can be found on the 3H Consulting web site found at:

<http://www.3HConsulting.com>

Faults and software problems should be reported to 3H Consulting Ltd by email, describing the nature of the problem and if possible the steps taken to reproduce it.

In some instances it is helpful to know the configuration of the computer showing the reported problems. The full configuration can be found using the System Information tool found on the **About** dialog available from the **Help** menu.

Support can be obtained directly from 3H Consulting Ltd. by sending an email to:

info@3HConsulting.com

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