TRAINING MANUAL
FOR

As-Built for Earthwork Quantities

NOTE: This manual provides a written account of how certain activities are performed and is designed to guide and assist staff members in performing their functions.
When appropriate, there may be deviations from these written procedures due to changes in personnel, policies, interpretation, law, experimentation with different systems, or simply evolution of the process itself.

This manual may be changed at any time. Staff members are encouraged to review this manual periodically and suggest changes in the manual to keep the manual current and to minimize differences between the manual and actual practices.

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Reasons for As-Built Surveys

One of the many tasks required of survey crews is to gather field data for the purpose of generating quantities for the state to pay contractors and to keep track of plan compliance. With current surveying practices, this is done by gathering Digital Terrain Model (DTM) data of the area before any work is done (**Original**) and then to gather new DTM data after work has been performed (**Final**). The DTM data generated by as-built surveys can be a very useful tool if done correctly and is the most accurate means of quantity calculation.

Data Collection (what, where, & when)

It is best to review plans and discuss what materials need to be surveyed for quantities. For further information on data collection refer to the Data Collection manual. Following are the primary DTM data that will be needed.
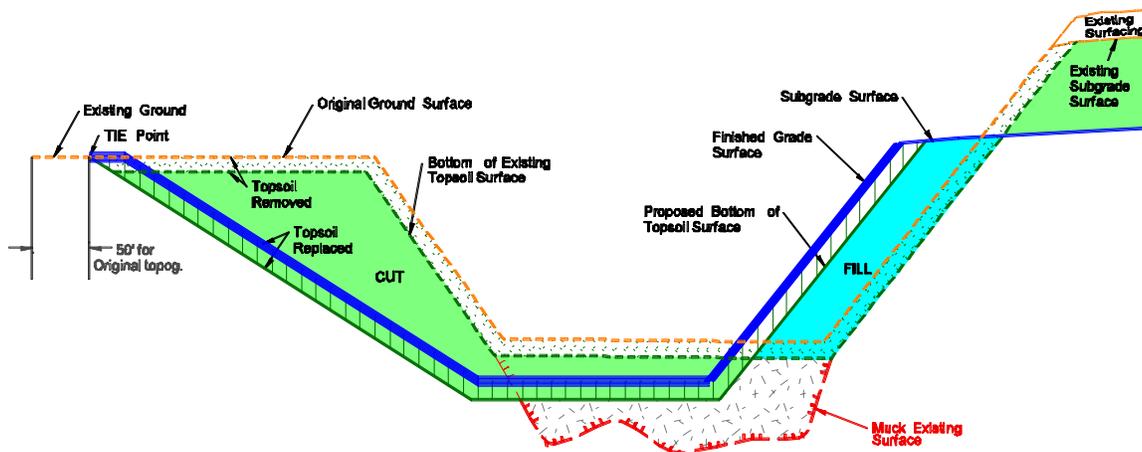
Post Surface Removal

It may be necessary to collect data for the calculation of quantities of the old roadway surface being removed. The original DTM for this process would be the preliminary DTM performed prior to design. As will be mentioned multiple times it is vital that when collecting data to make sure you tie to the original DTM. Make sure to collect data 50' beyond the disturbed are of construction. Data collected after the roadway surface is removed will become the Final DTM data.

Subgrade and Subcuts

Subgrade data will typically be considered an Original topog. This may also lump in subcut areas or it may require a separate survey for those areas depending on the fill material being used. Make sure to communicate with the field engineer and review the plans to prepare for these instances. Make sure to extend this Original topog. to cover all base material areas that will be placed and outside the disturbed construction limits by 50'. The subgrade DTM generated from the subgrade topog. will also be used as an original DTM using the construction Final DTM as described later. This subgrade Original DTM will also be helpful in checking the contractors plan compliance and if the subgrade was in fact brought to blue-top grades.

Base Material

The base material topog. will generate a DTM that will be used as both a Final to the subgrade DTM for base quantities and as an Original for the construction final DTM in the future.

Borrow Pit Areas

The first step will be collecting data for the Original DTM. The procedure is as follows:

1. Set a minimum of two control points to establish a set up station and a backsight at minimum for possible use of Total Station equipment. Be sure coordinates and elevations are tied to the primary control of the project. Locate all control points where they will not be disturbed by the work. It is best to visit with the contractor to get an idea for these locations.

2. Begin by staking out the limits of the borrow area and collect the necessary data within the limits and beyond 50' to insure the needed coverage. Make sure the contractor knows that the borrow area must not be extended beyond the staked limits. If the contractor needs additional area the original topo will need to be extended and restaked before proceeding.

3. Be sure to view your map in order to insure there are no voids in the topog. This will be addressed in a following chapter (Data Collector Data Map). Once an area is disturbed, you will not be able to collect the needed data.

4. Use NDDOT standard survey codes.

5. Download, edit, backup, and submit for the creation of the DTM.

For the Final DTM data, collect data as you did for the original taking care to pick up any terrain changes from the original ground (first DTM). Tie shots to the original ground will also be needed. If the final DTM does not fully tie to the original DTM, quantity calculations can not be made accurately. Be sure to note in the field book what point numbers were used for the final.

Stockpiles

The volume for pay quantity will be determined by computing the volume between the original ground surface and the stockpile surface using Digital Terrain Model (DTM)
techniques as stated for borrow areas. Before the survey crew begins establishing areas for the needed stockpiles. It is best to determine the following before proceeding:

• Number of stockpiles required for various materials.

• Which materials are to be surveyed for pay quantity.

An on-site review of the stockpile area with the project inspector and contractor will determine where the best stockpile locations are in relationship to the various construction operations before staking original limits. Make sure the contractor keeps sufficient distance between the various stockpiles to prevent mixing the various materials. The procedure for staking stockpile areas is as follows:

1. Find out the area needed for the stockpile and stake the limits. Make sure the contractor knows that the stockpile area must not be extended beyond the staked limits. If the contractor needs additional area, the original topog. will need to be extended and restaked before proceeding.

2. Set a minimum of two control points to establish a set up station and a backsight at minimum if using Total Station equipment. Be sure coordinates and elevations are tied to the primary control of the project. Locate all control points where they will not be disturbed by the work. It is best to visit with the contractor to get an idea for these locations.

3. Set up a new "topo" job in the data collector. This will be addressed in a following chapter (Data Management). Be sure the new job name indicates what it is for. It should be also noted in the field book what point numbers were used for the original.

4. Begin to collect data for the Original DTM within the limits and beyond 50' to insure the needed coverage. Be sure to view your map in order to insure there are no voids in the topog. This will be addressed in a following chapter (Data Collector Data Map). Once an area is disturbed, you will not be able to collect the needed data.

5. After the stockpile is complete, collect data for the Final DTM as you did for the original, taking care to pick all necessary data to best represent the stockpile. Tie shots to the original ground will also be needed. Be sure to note in the field book what point numbers were used for the final.

Construction Final

The Construction Final DTM has many uses. It will be used as the Final with the Base Material Original DTM. This will allow calculations of the new roadway surface placed. It can also be used with the Subgrade DTM to generate quantities for topsoil placed along the slopes and ditches. This is the reason for the need to collect data outside the construction limits. This Final data will also be helpful information for any future improvements on the project or adjacent to it.

For data collection procedures refer to the Data Collection Manual.

Point Number Designation and Ranges

Duplicate point numbers can NOT be used within a project. Downloading data with a duplicate point number will eliminate the previous data. The following table gives the point number ranges for certain areas. All collected data done during construction must use the letter "A" preceding the number. The "A" must come before the number to insure proper advancement of point numbers in the Trimble data collectors. The use of the "A" in the point number will represent As-Built. This will insure that construction numbers will not be mistaken or overwrite preliminary survey points. The following is the list of point ranges:

A1 - A499	Control Points
A500 - A9,999	Staking As-Built Data
A10,000 – A19,999	Subgrade Data
A20,000 – A29,999	Base Material Data
A30,000 – A39,999	Post Roadway Surface Removal
A40,000 – A49,999	Stockpiles and Borrow Areas
A50,000 – A59,999	Construction Final
A60,000+	Survey Data Overflow

It is important to not collect duplicate points. If a duplicate point is processed the first will be lost. Communication between crews is vital. **ALL** project personnel should know what point numbers have been used and what is still available.

Data Management

Data management is a critical part of electronic surveying. Keeping with a common procedure for describing and storing data can alleviate problems in the future. With multiple people working on projects everyone needs to know where to find data and where the last person stopped the survey. Project information needs to be noted, both electronically and in the field books.

Create New Project File
To create a new project in the TSC2, follow the steps below.

Step 1: Select **File** then **New Job**.

Step 2: The following window will appear.

At this point type in the **Job Name** of the file you want to create. Select the coordinate system (**Units**) for your project and International feet. You may **Link** another file to this new project, such as a control file or staking file. If your control data is in a large file it is best not to link it into the new file. The next steps can be used to copy select points and projections from other files.

Select **Enter** to complete the new job.
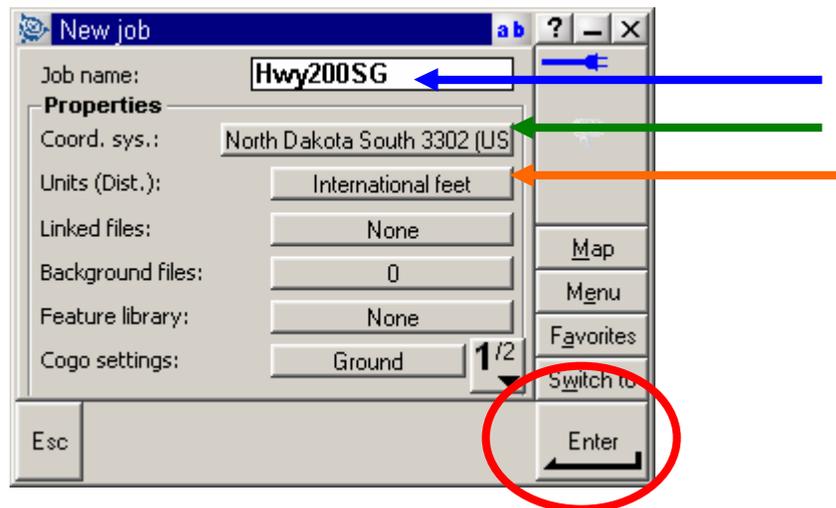
Copy Points and Projection to New Project File

In the following steps you will find the process to copy information from one file into another. There are a few different options that can be used in the process. But will be showing only the one typically used.

Step 1: Select **File** and **Copy Between Jobs**.
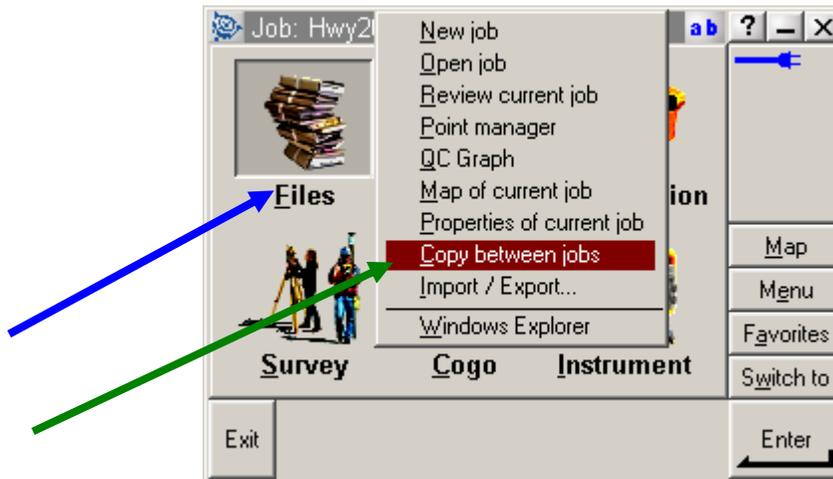
Step 2: The following window will appear.

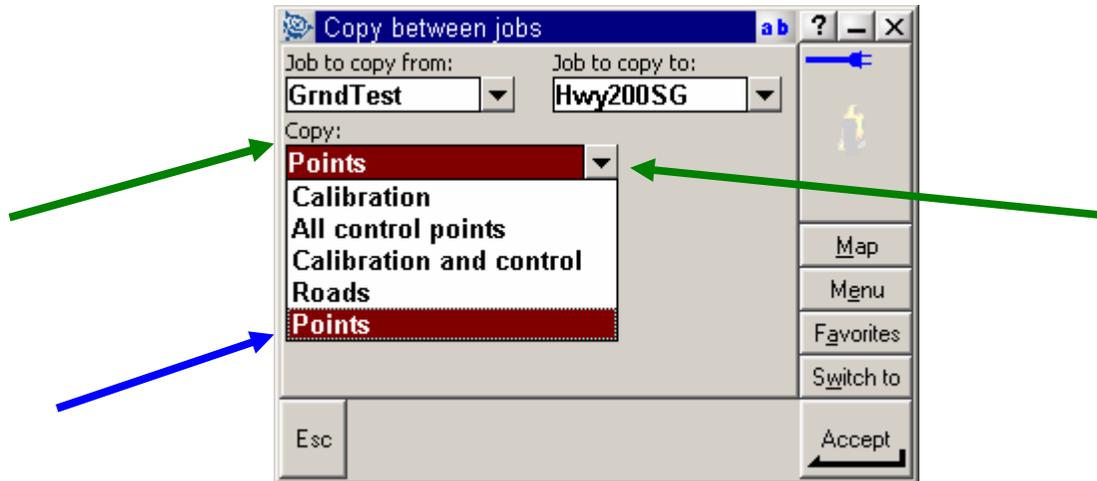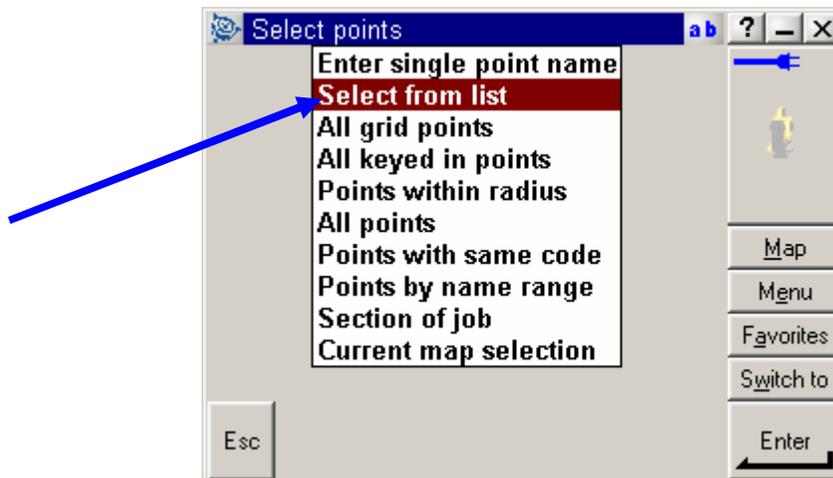At this point select the **Job to Copy from** and the **Job to Copy to**.
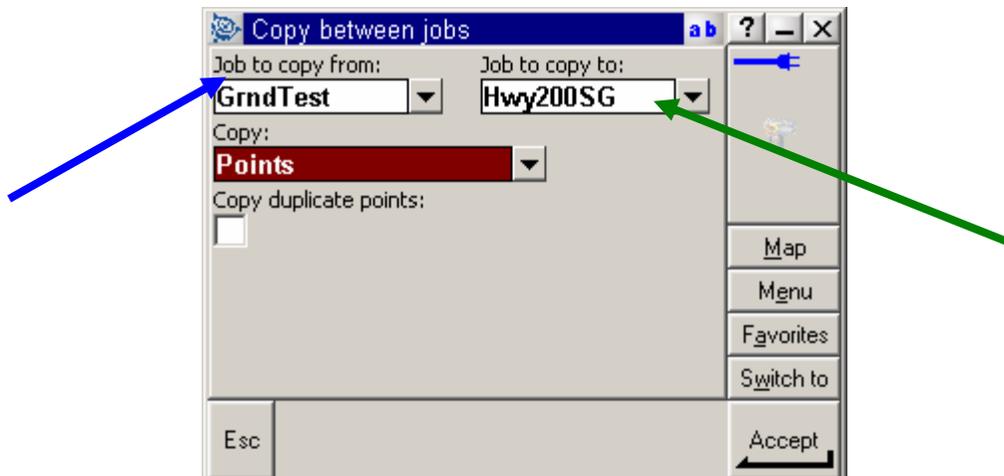
Step 3: Next select what you want to copy. For this example select **Points** from the **Copy** pull down menu.

Step 4: From the next window use **Select From List**.

Step 5: This will list all points in the "Copy From File". **Select the points** needed in the new file and hit **Enter**.
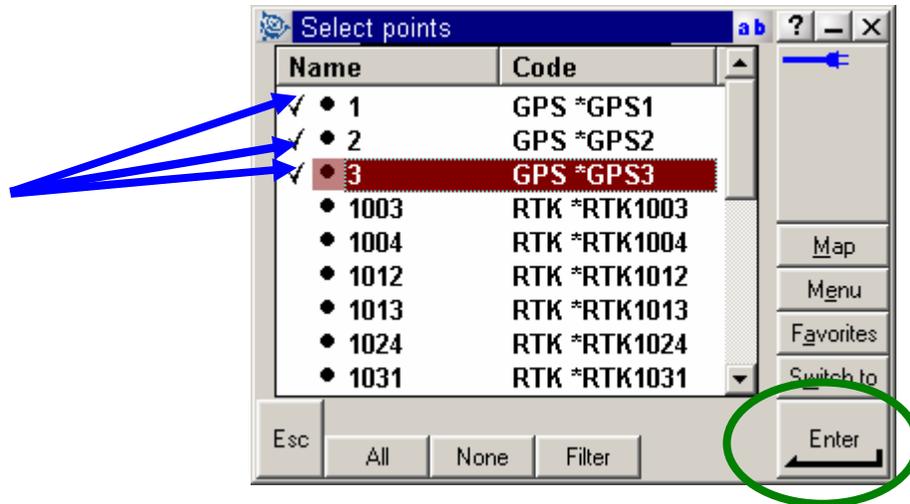
This will complete the process.

Project File Naming Convention

A common project file naming convention is a vital part of data management. The name should describe the project, data collector it came from, and what the file is for. Following are examples of how files are to be named.

Hwy200SG1302.dc or .job

Hwy200 describes the project
SG describes that it is a file for Subgrade as-builts
1302 is the last four digits of the data collectors serial number.

In doing this it will help associate what project it is for, what the data is for, and what user (if the collector is user specific) and equipment used for the survey.

Field Books

It can't be overstated the necessity of field books. Electronic surveying and electronic notes are a good way to storing data, but with litigation and arbitration a written document of procedures and basic notes are still needed. Field books need to contain at a minimum date, names of people working at that time and their task, project name, equipment used, point numbers used, what the task entailed, and any other pertinent information that may be needed for future referral.

Data Collection Codes for As-Built Surveys

There are designated codes for as-built surveys. These are to be used along with any other codes needed from the full listing. It is mandatory that these codes be used and no others. If you cannot find a suitable code a new code may need to be requested. Only the standard EFB codes are set in the GeoPak/Microstation software for data reduction to CADD. The comment delimiter (being *) or note feature can be used to further describe what the feature is that you are collecting data on. Remember that non-standard features that require additional description needs to be recorded in the field book also.

See EFB Code List Appendix C of the Data Collection manual.

Overview of Codes

Following is an outline of codes specifically used for as-built surveys:

ATSEB	As-built bottom of existing topsoil break line
ATSES	As-built bottom of existing topsoil spot
AMKB	As-built bottom of muck excavation break line
AMKS	As-built bottom of muck excavation spot
AFGB	As-built finished grade break line
AFGS	As-built finished grade spot
ATSPB	As-built PPSD bottom of topsoil breakline
ATSPS	As-built PPSD bottom of topsoil spot
TIE	As-built tie point line

See following cross section example for explanation of code locations.
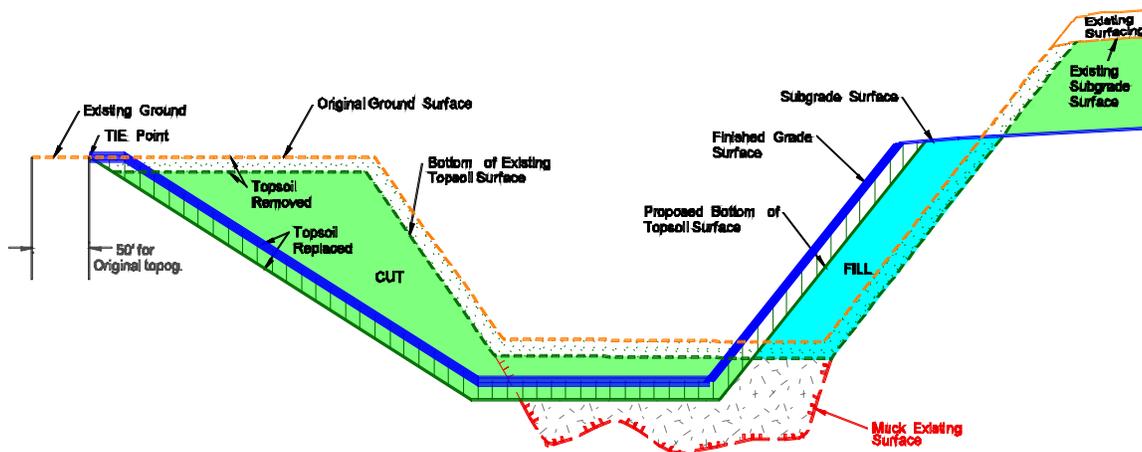
Data Collector Data Map

The Map feature is a very useful tool to view points that have been collected, any void areas that need to be collected, lines created, Roadlink features, and linked .dxf files. This is a very interactive map that can be used for more that just viewing. Holding the stylus on a point will bring up a list of other commands that can be used such as Review of point number, Stakeout point, List selection, Clear selection, and Delete.

How to View

Reviewing the map is simple by selecting the Map button located on the left of the data collection main menu.

The following map screen will appear:
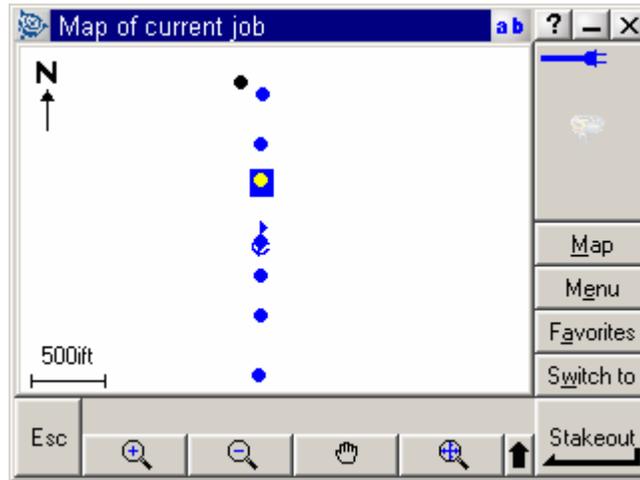
Options

The bottom buttons for the map as shown on the above screen shot are self explanatory. To locate, view, and edit the options for the map select the arrow up key ![up arrow].
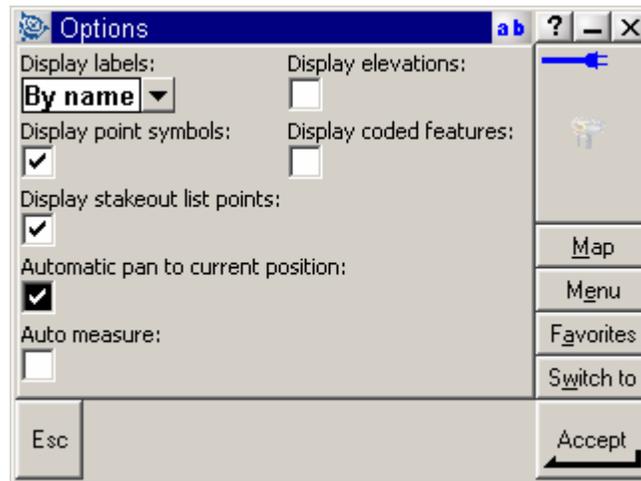
This will display the following window:

Filter – this will give you the ability to select what type of points and features you want diplayed.

Pan to – this allows you to enter a point number on the next screen that you want to pan to.

Options – this will bring up the following window and choices:

XS – this is the stakeout button. By selecting the point on the screen and either holding on it to display the commands as described above or by selecting this button to stake out.

Linked Background Maps

Background maps can be brought into the data collector in a .dxf format. It is best to eliminate any items in the drawing that are not needed to reduce the size of the file. Large files will bog down the data collector. These maps are useful to see where you are on the project and to see where data needs to be picked up and your location on a project. The .dxf file needs to be saved in the Trimble data collector in the Trimble data folder.
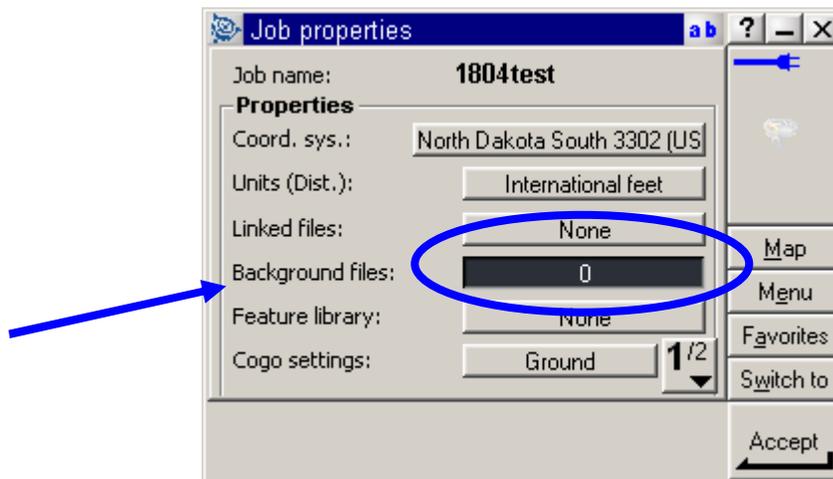
Step 1: To associate the background map with the project open the data collection software and select **Files** and **Properties of Current Job**.

Step 2: The following window will appear. Select the **Background Files** tab.
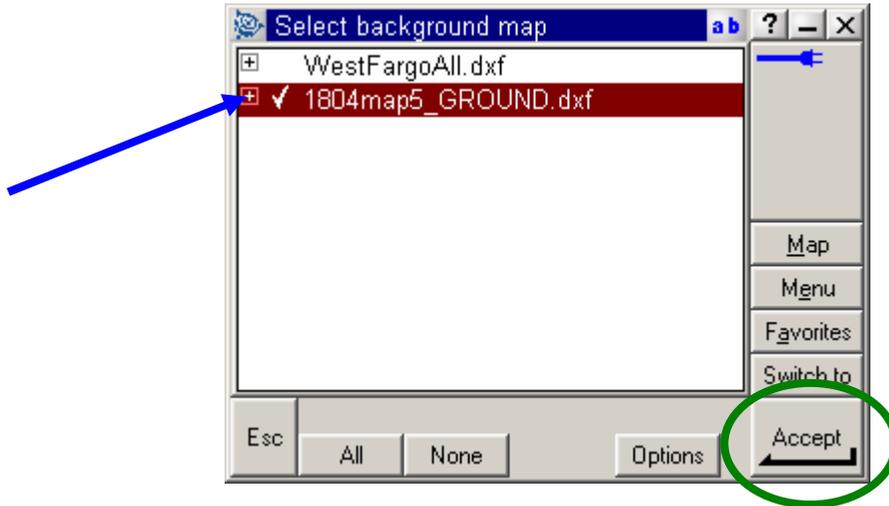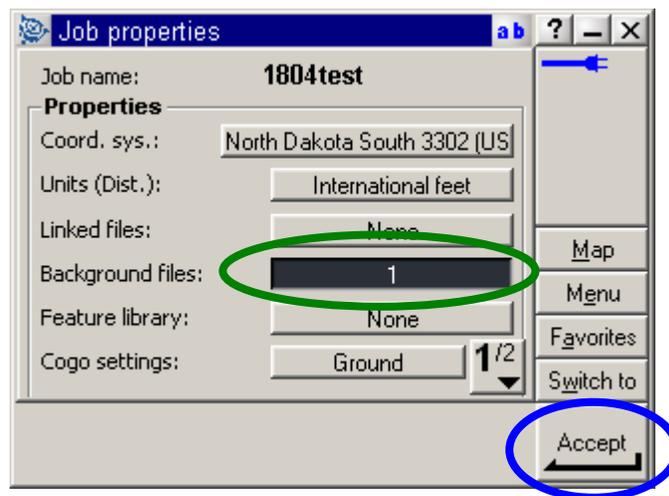
Step 3: Select the **.dxf** map listed for your project then select **Accept**.

Step 4: This will bring you to your original Job Properties screen indicating the number of background files (**1**) that have been linked. You will again need to select **Accept**.

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Step 5: You may then view your map by selecting **Map** on the right hand side of your data collector screen.

The following is an example of a linked Background Map: