Construction Surveying

Phillip R. Johnson, PE, PLS
Area Roadway Construction Engineer
Division 5 and 6
GPS Construction Surveys

- Where are we?
- Where do we want to be?
- How do we get there?
Where were we in 2008?

- Some RE offices use GPS daily.
- Some RE offices use GPS occasionally.
- Some RE offices have never used GPS.
Where do we want to be?

• Every RE office with GPS survey capability.
• Every RE office with proper field and office software.
• Every RE office with proper training on GPS equipment.
• Every RE office with a support system (Location and Surveys) or a User Group.
Where are we in 2010?

- Some RE offices use GPS daily.
- Some RE offices use GPS occasionally.
- Some RE offices rarely use GPS.
How did we get here?

• New 2008 GPS survey equipment purchase. Done
• Training from Location and Surveys and the Construction Unit. Done
• Patience from RE to allow employees to learn and utilize new technology. ???
GPS
In Construction
Construction Stakeout and Establishing Photo Controls
GPS
In Construction

Horiz Accuracy ~ 0.03’
Vertical Accuracy ~ 0.07’

Note:
Due to Reduced Vertical Accuracy of GPS - Use Total Stations or Levels for Critical Elevations
NC VRS Network 2010
GPS

Any Questions?
Earthwork

• How does a Resident Engineer’s office handle earthwork when Photogrammetry is not involved?
Several Options

1. Average End Volume using Computation Sheets
2. Trimble Geomatics Office
3. Geopak
Average End Volume using Computation Sheets

<table>
<thead>
<tr>
<th>TATION</th>
<th>EARTH EXCAVATION</th>
<th>ROCK EXCAVATION</th>
<th>EMBANKMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DIST.</td>
<td>AREA</td>
<td>AVE. AREA</td>
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</tbody>
</table>
Trimble Geomatics Office

• Graphic view of surface.
• Calculate volumes for borrow or unclassified excavation.
• Generate volume report for file.
Graphic view of surface.
Calculate volumes for borrow or unclassified excavation
Generate volume report for file

**Void volume**

**Project vol**

- **Project name**: vol
- **Surface**: finvolume
- **Units**: Meters
- **Date**: 3/13/2008 10:01 AM

**Surface: finvolume**

- **Base elevation**: -3.764 meters
- **Plan area above base elevation**: 1541.1 sq. meters
- **Surface area above base elevation**: 1921.7 sq. meters
- **Volume above base elevation**: 3810.407 cu. meters
- **Centroid of model above base elevation**: 254077.851 Northing 623186.031 Easting
- **Upper elevation**: 0.000 meters
- **Plan area above upper elevation**: 26.9 sq. meters
- **Surface area above upper elevation**: 26.9 sq. meters
- **Volume above upper elevation**: 0.024 cu. meters
- **Plan area between base elevation and upper elevation**: 1814.2 sq. meters
- **Surface area between base elevation and upper elevation**: 1894.7 sq. meters
- **Void volume between base elevation and upper elevation**: 3157.139 cu. meters

[Image of the void volume report]
• January 23, 2009
Used Cub Cadet with Trimble R8 mounted on the Cadet. Topo of 14 acres = 3500 points collected.
Actual GPS time = 2 hrs.
*Office time with TGOoffice = 1 hr.*

• June 16, 2009
Walking pit slopes and bottom for volume check on truck count. Topo of 9 acres = 1120 points collected.
Actual GPS time = 7 hrs.
*Office time with TGOoffice = 1.5 hrs.*

• November 24, 2009
Location & Survey assisted with GPS and sonar setup to Topo bottom of pit. Used motor boat with their people and equipment. Actual GPS time = 2 hrs.
*Reminder: Location and Survey is available to assist in collecting survey data underwater utilizing sonar technology*
**TGO/DTMLink (stock pile)**

The purpose of this document is to transfer DTM data from Data collector to TGO and calculate volumes.

1. **Create a New Project or Open Project**
   
   When TGO is opened you will have the option to create a *New Project* or *Open Project*, To create a new click in *New Project* and the *New Project* window will open, use the Folder key to select the location where the project is going to be stored, select the appropriate *Template*, be sure to *Project* under the *New* options and type a *Name* and click *OK*. 

![New Project Window]
Automated Machine Guidance
Automated Machine Guidance

• Provision Currently being used on a Design Build Project in Div. 8
• Developed Draft Special Provision for Bid-Build Projects
  – Model Provided by NCDOT
    • (Corridor Modeling)
  – Guidance for Stakeout
  – Survey Equipment provided by Contractor
  – Training provided by Contractor
AMG Committee Members

- Ron Hancock NCDOT Construction Unit
- Phillip Johnson NCDOT Construction Unit
- Ted Walls NCDOT Roadway Design Unit
- Jim McMellon NCDOT Roadway Design Unit
- Charlie Brown NCDOT Location and Surveys
- Emory Kincaid NCDOT Location and Surveys Unit
- Emilio Gilarranz NCDOT Location and Surveys Unit
- Keith Johnston NCDOT Photogrammetry Unit
- Carl Storch NCDOT Photogrammetry Unit
- David Weir Barnhill Contracting Company
- Mark Eakes Barnhill Contracting Company
- Gerhard Pilcher H. B. Rowe & Co., Inc
- Brett Calcutt R. E Goodson Construction Co., Inc
- Jonathan Bivens S. T. Wooten Corporation
- Jeff Morris S. T. Wooten Corporation
AUTOMATED MACHINE GUIDANCE

CONSTRUCTION REQUIREMENTS AND SUBMITTALS

Electronic Information. Electronic information, consisting of survey and design information including but not limited to cross-section models, alignments, and plan view geometry, does not constitute part of the bid or contract documents. The information, used for project design and quantity estimation purposes, is provided for the bidder's use in automation of bid as needed, grading and construction taking if provided in the contract. Furnishing the information does not relieve a bidder or contractor from the responsibility of making an inspection of conditions to be encountered. The bidder or contractor shall assume the risk of the information is used for any purposes for which the information was not intended. Any assumptions the bidder or contractor may make from the electronic information is at the bidder or contractor’s risk. The bidder or contractor assumes the risk of liability or loss if the bidder or contractor does rely on the electronic information in determining their bid.

If the Contractor elects to use the Global Positioning System (GPS) machine control grading and shall be used in accordance with Section 801 of the Standard Specifications for Roads and Structures. The use of this technology is advanced as Automated Machine Guidance (AMG).

All equipment using AMG shall be able to generate and store data that meets the Standard Specification. Parameter variations for each type of work to be completed with AMG to demonstrate that the system has the capability to achieve acceptable results. Acceptable results include the requirement for contract documents.

The Department will provide a Digital Terrain Model (DTM) of the design surface. If the Contractor elects to use the DTM, submit the revised DTM to the Department for review and approval 40 days prior to the grading/paving operation. The submittal shall include an animation depicting changes to the original DTM.

30 days prior to the grading/paving operation, the Contractor shall submit to the Engineer an AMG work plan to include, but not limited to, GPS calibration, calibrations, and methods for machine automation and local GPS base station used for broadcasting differential data to operator units.

INSPECTION

The Engineer will perform quality assurance checks of all work associated with AMG. If it is determined that work is not being performed in a manner that will assure accurate results, the Engineer may require corrective action at the Contractor's expense.

The Contractor shall provide the Engineer with a GPS survey unit for use during the duration of the contract. The survey unit shall be used with the same model that is used with the AMG and have the same capability as survey units used by the Contractor. The survey unit shall be returned to the Contractor upon completion of the contract. Any resulting maintenance required for the survey unit will be the responsibility of the Contractor. Formal training of at least 16 hours shall be provided to the Engineer by the Contractor on the use of the proposed AMG system.

SUBGRADE AND BASE CONTROLS

If the Contractor elects to use AMG for the grading and placement of aggregate base or other roadway materials, the GPS shall be supplemented with a laser or robotic total station. Include details of the proposed system in the AMG work plan. In addition, the following requirements apply for the use of AMG for subgrade and base construction:

1. Provide control points established along the project route at intervals of 1000 ft. The horizontal portion of these points shall be determined by static GPS surveys or by traverse connection from the original base line control points. The elevation of these control points shall be determined using differential leveling from project benchmarks. Fore displaced points shall be properly maintained. A copy of all control point information shall be provided to the Engineer prior to construction activities.

2. Provide control points and construction survey guidance points such as, but not limited to, FC's, FC's, and intersectional points, and other control points as requested by the Engineer.

3. Provide data at the top of the finished subgrade on the cross-sections 500 feet intervals. These links shall be available using conventional survey methods for use by the Engineer to check the accuracy of construction.

MEASUREMENT AND PAYMENT

No direct measurement will be made for work required to utilize this provision. All work will be considered incidental to the grading operation.
Automatic Machine Guidance

Questions?
Construction Stakeout Manual
Revisions In Progress

• GPS
• Permit Stakeout – Safety Fence
• Automated Machine Guidance
• Additional Topics???

Distribution May 2010
SAFETY FENCE

• Stakeout of safety fence is covered in Section 801.

• Required to stakeout limits of the permitted area according to the permit drawings.

• Some Divisions prefer to perform this important task with its own survey forces.
SAFETY FENCE

• The Roadside Environmental Unit revised the safety fence drawings
  – assist in the stakeout of safety fence.
  – delineate permitted areas.
• The accurate stakeout of the safety fence is critical in our efforts to ensure environmental stewardship.
• The revised drawings are located on the Construction Unit Website.

www.ncdot.org/doh/operations/dp_chief_eng/constructionunit/formsmanuals
The revised drawings provide guidance for stakeout of the orange safety fence in the following permit situations:

- Jurisdictional Stream – Riparian Buffer Zone
- Jurisdictional Stream- High Quality Water (HQW)
- Jurisdictional Stream- No High Quality Water / No Buffer
- Wetland – Mechanized Clearing
- Wetland – Hand Clearing
The drawings should be used with the environmental permit drawings located in the contract and also with the ESA locations shown in the erosion control plans. Electronic permit drawings are available from the Hydraulics Unit; these Microstation drawings will provide coordinates for the permit limits and will greatly increase the accuracy of the safety fence layout.
Permit Drawing

Safety Fence
Additional Survey Training?

• Earthwork?
• Recommend Survey User Groups!
• Provide training requests to the Construction Unit.