Global Positioning System (GPS) Inventory Standards

Standards and Techniques for Collecting Resource Grade Field Data from a moving vehicle using Trimble Pro-XRS GPS Equipment

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Version Date: April, 2001

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INTRODUCTION

This document was compiled during the Global Position System (GPS) development phase for ODOT's Road Inventory and Classification Services Unit. This document establishes a consistent method for collecting *resource grade** GPS inventory data, and is a summary of "lessons learned" from RICS Unit experience with the Trimble GPS equipment. The intent is to outline procedural standards for collecting resource grade GPS inventory data, and to serve as a supplement to the Trimble equipment manuals.

The document has been built so users with various levels of experience can reference this document. We recommend the document be used as a training guide for the inexperienced user. The more experienced user will find the Reference Guide, Optimal Settings, and Safety sections to be the most useful.

Many terms included in this document are specific to Trimble equipment and/or GPS data collection. These terms are defined in a *Glossary* in the Reference Guide. This document also includes a *Frequently Asked Questions* section to address common problems in the collection process.

A Note about Using the GPS Equipment outside the Vehicle:

The techniques described in this manual are specifically geared towards data collection from a moving vehicle. GPS equipment can also be used in a backpack while the operator walks the area to be collected.

The equipment settings in this manual are appropriate for walking GPS inventories. However, there are specific safety and collection issues associated with data collection outside your vehicle that are not covered in this document. Please contact ODOT Geometronics at (503) 986-3103 for more information concerning walking GPS inventories.

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*Resource Grade is a descriptive term for the accuracy of a GPS receiver, usually with an accuracy of sub-meter or better, but not considered appropriate for land surveying applications or establishment of GPS control stations. Normal uses include identifying locations of "resources", such as utilities, facilities, inventories, and so forth. (Source: ODOT Geometronics)

SAFETY

At ODOT, **Safety Comes First**. Working amongst highway traffic must always be done with the utmost preparation and care. It is the job of every ODOT employee to promote and practice safe work habits while on the job. The following section contains guidelines and hints for ensuring safety while collecting GPS data along state highways.
PLEASE pay special attention to all safety guidelines when consulting this document.

> *A more complete analysis of roadway safety issues and responsibilities can be found in the 1998 ODOT Survey Crew Safety Guidelines document.*

Driving Safety

Required safety equipment

- Seatbelts must be worn at all times when in a vehicle, even if the car is stopped, parked, or the traveling distance is short.
- Install the rotating light (rotobeam) on top of the vehicle.
- Install the safety sign on the back of the vehicle.
- If you have a cellular phone, know how to operate it in case of emergency.
- Make sure the GPS, DMI, cellular phone, and all other supplies are secured, to avoid shifting objects while the vehicle is moving.

Defensive driving guidelines

> *While driving a state vehicle, it is important to remember that the public eye is on you.*

- Drive courteously and respectfully.
- Drive with headlights on at all times.
- While collecting GPS data, it may be necessary to temporarily slow or even stop traffic. Do so cautiously and attempt to minimize the amount of time traffic movement is affected.
- Never exceed the posted speed limit.
- Always signal intent to turn, exit, or enter the roadway.
- Always use the rotobeam to warn traffic of your intent to slow down or pull off the roadway.
- Only stop in locations where your rotobeam can be seen by traffic in both directions.
- Refresh your defensive driving skills by taking ODOT's computerized Defensive Driving Course.

> *See diagrams in the back of this document for a few defensive data collection procedures.*

Highway GPS collection is a two-person job.

Always put on your safety vest and hat before exiting the vehicle.

- Always collect roadway field data in pairs.
- The driver should have no responsibilities other than operating the vehicle and avoiding hazards.
- The GPS specialist needs to operate the GPS and DMI and be able to collect data independently so the driver can focus on traffic and safety.
- The driver always stays at the wheel with seatbelt on, keeps the engine running and pays attention to traffic while stopped in the roadway or parked along highway shoulder.
- If outside inspection is required, the team should always stay within shouting distance of each other. Use hand-held radios when appropriate.

Techniques for Safety

Collecting highway GPS inventory can usually be accomplished at normal highway speeds. In fact, the faster the GPS antenna is moving, the more accurate the data will tend to be. Consequently, most of the collection process will only include the dangers of driving in the normal flow of traffic. There will of course be times where pulling off the roadway or stopping in the roadway is required. For these times, extreme caution must be used. A rotobeam and turn signals will help alert other traffic, but good judgement and awareness will be the most important safety tools.
Due to the dangerous nature of roadside data collection, it is helpful to develop standard procedures for these activities. The following are tips for completing the more hazardous tasks.

Always use turn signals and the rotobeam to give other vehicles warning that you will be slowing or stopping.

Stopping to reset the DMI, nest, or quickmark

- Be aware of upcoming structures and anticipate GPS coverage problems so that you can prepare for a stop.
- Always use turn signals and the rotobeam to give other vehicles warning that you will be slowing or stopping.
- Pull over only when traffic allows. Make sure the vehicle is completely off the road to minimize interference with other traffic.
- After collection or reset is completed, use signal to safely pull back onto the roadway, resume speed and turn off the rotobeam.

> *Since bridges are always dangerous places to stop or pull over, extreme caution and judgement must be used.*

Stopping on or under bridges

Bridges make excellent control points for post processing of GPS data. It is best to pause for a moment on the bridge, so that you can get a good GPS point location, and also enter any available information about the bridge.

- If the bridge to be marked is wide and on a straightaway (where you can safely pull over), it is recommended to nest the bridge for 10 seconds. Nesting takes repeated readings, which statically averages the position for better accuracy. During this time, you will be able to enter any useful bridge information you wish.
- If it is not safe to pull over for a full 10 seconds, it is recommended to quickmark the bridge and move on as soon as possible. Bridge number and milepoint can be inserted through Pathfinder Office later.
- At times there will be bridges that are too unsafe to stop at all. If the bridge is on a curve or grade break, or you anticipate danger for any reason, **SKIP IT!** Bridges are marked only for use as control points, and skipping one won't degrade the quality of your data.

Hazardous Weather

> *It is important to use good judgement when working in foul weather. If conditions are hazardous it is better to postpone field collection until the weather improves.*

- Foul weather will not influence the readings of the Trimble GPS, but it can easily affect driving safety conditions.
- Visibility is often an issue during inclement weather. It is important to remember that if your visibility is compromised, other drivers on the road may have difficulty seeing you.
- Do not attempt field collection in severe weather, or when ice is present. If ice is present, minor hazards can become very dangerous.
- When collecting data on icy or wet pavement, remember that stopping distance are greatly increased for you <u>and</u> for others.
- Make sure it is light enough to see upcoming structures and tree coverage. <u>Do not collect data at night.</u>
- A good resource for assessing weather conditions for regions throughout Oregon is the **Road Condition Report at 1-800-977-6368.**

CPR and First Aid Training

Agencies such as the American Red Cross offer CPR and First Aid Training if courses through ODOT cannot be scheduled.

1. Even though ODOT does not require field personnel to be CPR and First Aid certified, certification is *highly recommended.*
2. First Aid courses are offered through ODOT, and other state agencies.
   Information concerning CPR and First Aid courses offered by ODOT can be found at
   http://intranet.odot.state.or.us/hr/

OFFICE PREPARATION

Trip Preparation

Careful planning is the most important aspect of successful fieldwork. You may wish to create an itinerary and schedule hotel reservations, or make those decisions in the field.

Things to Consider
- It is best to plan a travel route that will allow you to collect GPS data on the highway during good satellite coverage in both directions. With good planning, backtracking might be avoided. Situations will arise when backtracking cannot be prevented, so it is best to budget enough time each day for some backtracking.
- Avoid urban areas during rush hours.
- Plan high elevation trips during the warmer months of the year, due to ice at high elevations.
- Consider time of year and amount of daylight available.
- For longer highways, determine an appropriate stopping point for each day.
- Always make sure that you have the essential equipment and materials needed before departing. A checklist is provided on Page 12.

Use Your Planning Resources
- Use Pathfinder's *Planner* feature to find a good time to collect data. It can show you when the PDOP will be low and when there will be enough satellites in the sky.
- Check the weather forecast for the area in which you will be traveling. An accurate weather forecast can help you set priorities and avoid hazardous conditions.
- Use the AAA Hotel Guide or the Oregon Traveler's Guide to schedule hotel reservations for your team. Setting an itinerary and prioritizing your work will allow you to make the best decisions for lodging. Local phone books and the Internet may also be helpful for making reservations.
- An Oregon road map is a useful tool to plan which highways to collect GPS data and to choose a travel route for the trip.
- An ODOT Highway Inventory Summary will show the length and complexity of the highway, and will help plan each day's work.

- Review the video log of each highway. The Road Inventory and Classification Services Unit maintains a video log for each state highway in both directions. Make notes of landmarks that will help you find points in the field. Make special note of beginning and ending points, so you will be able to find them in the field.
- Topographic maps will show elevations and help to avoid wintertime weather hazards.
- ODOT Travel Guide is also useful in planning for a trip. It is found at *http://www.tripcheck.com/*

To purchase or make an appointment to view ODOT Video Logs, contact Erick Cain at (503) 986-4182.

Highway Inventory Summary Report

The Road Inventory and Classification Services Unit provides a half-day training course on inventory techniques. To schedule an appointment, contact Dave Barker at (503) 986-3158.

Using the Highway Inventory Summary Report
- A detailed milepoint inventory for all Oregon highways can be found at: *http://www.odot.state.or.us/TransView/highwayreports/index.cfm*   This inventory is essential for accurately locating roadway features.
- Prior to going out in the field, print out a Highway Inventory Summary report for each highway.
- Go through the inventory summary and highlight the bridges, beginning and end of the highway, milepoint equations, and any attribute with an Engineering Station.
- The inventory summary is used to enter a beginning milepoint into the DMI, track upcoming structures, and give official milepoints for the bridges being nested.
- The Highway Inventory Summary is also used to ensure that DMI readings are accurate, and to provide milepoint information when DMI correction is needed.

Understanding Milepoint Equations and Z-mileage
When using the Highway Inventory Summary report to assess roadway distances, it is important to understand milepoint equations and z-mileage. Both are roadway locations that have two different milepoints, one describing the milepoint relationship forward and the other describes the relationship backward.

Milepoint Equations are a result of shortening the total distance of a highway. For example, if a highway is shortened three miles by construction, those three miles will have to be removed from the inventory record. The result will be an equation such that milepoint 7 is the same location as milepoint 10. In the highway inventory summary, it will be shown as 7.00BK = 10.00AH.
- It is possible to identify where an equation exists on the Highway Inventory Summary report by looking for an *"E"* in the roadway codes. An equation will also have a description that reads a milepoint *"BK"* = a milepoint *"AH"*

- It is important when going through the summary report to locate and highlight any equations.
- To maintain correct DMI location through an equation:
    a. Stop where the equation occurs if safety allows.
    b. Clear your DMI and set your new ahead milepoint.
    c. If you are unable to stop at the equation milepoint, stop and set the DMI at the next available roadway feature that has an engineering station listed.

- Z-mileage results from lengthening a section of highway due to realignment.
    a. When looking for Z-mileage, a *"Z"* will appear in the mileage type column.

> *For more assistance look under the Field Preparation section, under Setting up Nitestar Distance Measuring Instrument (DMI).*

Checking Battery Levels

It is important to check your Collector battery level before leaving to collect data. The Trimble, ProXR/XRS is powered by two different batteries. The datalogger power comes from a internal battery and the receiver is powered by the external battery. Both power levels may be checked through the datalogger. The datalogger has a backup battery to ensure that the memory does not loss data if the main power source runs low.

How to check battery levels
- Go to *Configuration* in the Main Menu, and press the Enter key.
- Scroll down the list until you find *Hardware* and press enter.
- Find *internal battery* and view the right hand column. This column displays the percentage of battery power left using a scale. *100* is the highest level and *0* signifies that the battery is dead.
- The *external battery* level will be displayed only when the datalogger is connected to the external batteries through the receiver.

Creating a Data Dictionary in Pathfinder Office

> *If you plan to export your collected data to a database, be sure to check with your system's data architect before creating a data dictionary. A well designed data dictionary may eliminate database compatibility problems.*

In preparation for collecting GPS data, it is necessary to set up a data dictionary in Pathfinder Office. The data dictionary is a list of features and attributes that may need to collect.
- Select *Utilities / Data Dictionary Editor*.
- A data dictionary dialog box will appear.
- Name the new dictionary in the specified box. Give the dictionary a specific name related to the task. Naming conventions will help organize multiple dictionaries.
- Press the box labeled as *New Feature*.

- Select what classification you are going to assign for the features, either *line*, *area*, or *point*.
- Press **OK**.

Creating a Menu of Attributes in Pathfinder Office

1. Go to ***Utilities / Data Dictionary Editor***.
2. Click on ***New Attribute Type***.
3. Select ***Menu, Numeric, Text Value, Date, or Time,*** and then click on ***OK***.
4. Type in the ***Attribute Name***.
5. Select ***Normal, Required***, or ***Not Permitted***.
6. You can have numerous attributes for each feature you are collecting.
7. To add in new attributes, simply click on the box labeled as ***New***.
8. When finished adding attributes to the dictionary, click on ***Closed***.

__Equipment Checklist__

Trimble GPS Equipment
____	Trimble Datalogger	____	12-channel Pro XRS Receiver
____	Trimble Integrated GPS Antenna	____	Antenna Cable
____	TSC1 Data Cable	____	Trimble Vehicle Magnet
____	Dual Battery Cable	____	Datalogger Carrying Case
____	Data Power Cable	____	Trimble GPS Carrying Case
____	NMEA/RTCM Cable	____	Range Poles *(4 various lengths)*
____	Camcorder Batteries (Charged!!!)		

Nitestar DMI
____ DMI Instrument
____ Power Cord (*located on dash board*)
____ DMI Manual

Safety Equipment
____	Safety Vests and Hats	____	Cellular Phone
____	Rotating Safety Light	____	Tire Chains
____	Rear Safety Sign	____	First Aid Kit
____	Road Flares	____	Slow/Stop Paddle
____	Sunglasses		

Miscellaneous Items
____	Pencils *(standard and colored)*	____	Calculator
____	Pens	____	Gas Card
____	Pencil Sharpener	____	Highway Inventory Summary
____	Compass	____	Extra Clothing *(coat)*
____	Paper	____	Food
____	Highlighters	____	Water
____	Tape Measure	____	Keys
____	Road Maps	____	ODOT Phone Book
____	Paper Clips	____	Marking Paint
____	Clip board		

FIELD PREPARATION

Installing the Trimble GPS

SAFETY NOTE…
1. *Find a safe place to pull off the road to install the Trimble GPS antenna and safety equipment.*
2. *Put on safety vest and hat.*
3. *Install rotobeam on the top of the vehicle, and the safety sign on the rear of the vehicle.*

1. First open the GPS case, making sure that the case opens with the latches pulling up. If the case is upside down, it will spill equipment out onto the ground.
2. Locate the Trimble Magnet Antenna Mount; then connect the Trimble Antenna to the magnet using the 3" antenna adapter with quick release.
3. Carefully attach the magnet to the center of the roof of the vehicle.
4. Find the yellow bag containing the Trimble GPS Receiver, 2 batteries, power adapter, batteries power cable, data cables, and antenna cable.
5. Connect the antenna cable to the antenna located on roof of the vehicle. Attach the other end of the cable to the receiver.
6. Next, connect the data/power cable from the receiver to the TSC1 datalogger.
7. Connect the datalogger cable into to datalogger outlets located on the bottom, or backside of the datalogger.
8. Finally, secure the cables by rolling up the window until the cables are held stationary. Be careful not to roll the window up too tight and damage the cables.

Setting up Nitestar Distance Measuring Instrument (DMI)

The Road Inventory and Classification Services Unit provides a half-day training course on how to use a DMI during field inventory. Call Dave Barker at (503) 986-3158 to schedule an appointment.

1. Connect dashboard power/data cable into the power slot on the left side of the DMI.

2. Use the following steps to perform distance and interval measurements.
- Stop before the desired starting point.
- Press the key labeled **ON/OFF** on the DMI to get power.
- Press the key labeled **CLR/RST** to set the DMI to 0.000.
- Press the key labeled **Run/Hold** to freeze that milepoint in the DMI.
- Resume driving and press **Run/Hold** as you pass over the starting point. This will activate the DMI at the desired milepoint as you pass over it and measure the distance away from that point.
- The DMI will display your current milepoint as you drive. To freeze the display, press **Run/Hold**.

3. Because highways don't always begin at milepoint 0.00, you will often need to set any milepoint required.
- Stop the vehicle at the desired position.
- Push the **CLR/RST** key on the DMI to clear the screen to 0.00.
- Press the **3 key,** which is also the **PD key**.
- Enter in the desired milepoint. Milepoint must be entered to the thousandth place (such as 56.570 or -1.680).
- Press the **Mark/Enter** key to accept the new number.
- If you are driving in the non-add direction and want the DMI to count down in milepoints, press **4↓**.
- Press the **Run/Hold** key to release the counter and begin driving again.
- The DMI will display your current milepoint as you drive. To freeze the display, press **Run/Hold**.

Calibration of Nitestar DMI

The Nitestar DMI, like any electronic measuring device, may slip out of calibration from time to time. In addition, vehicle performance and tire air pressure may influence the data fed into the DMI. For these reasons, it is important to regularly calibrate the DMI for your vehicle.

Instrument–Calibration Automatic
- Push the **ON/OFF** key to turn the DMI on.
- Double check to make sure that the units are set to *MI* and the speed is set to *MPH*. The units can be changed using the **2-unit** key and the speed can be changed using the **7-speed** key.
- Press the **1-cal** key to display CAR NUMBER choices.
- The DMI can store the calibration up to four different vehicles. These are stored in the DMI as CAR NUMBERS. Toggle through the 4 different CAR NUMBER by pressing **DISP/HOLD** and select the CAR NUMBER you wish to calibrate.
- Make sure that the **count hold** is displayed on the left of the screen. If count hold is not displayed then push the **RUN/HOLD** key.
- Enter the length of the calibration course when your screen reads **LEn**.
- Drive the vehicle to the start of the calibration course.
- Press the **MARK/ENTER** key. The DMI will let you know that you may now begin driving the calibration course by displaying **ROLL**.
- Drive to the end of the calibration course. Make sure that you accurately stop were the course ends for the best accuracy.
- When you reach the end of the calibration course press **MARK/ENTER** to store the calibration number.
- Now press the **ON/OFF** key to store the calibration number for future use.

> *For more help with the DMI, consult the nu-metrics Nitestar Manual.*

Calibration Course

Always calibrate the DMI where the highway shoulder is wide enough that you won't be a traffic hazard. Use turn signals and the rotobeam to give other drivers warning that you will be slowing or stopping.

- The most convenient place to calibrate the DMI in the Salem area is the course on Hwy 162 (ORE 22) at add-mileage milepoint *2.42*. This one-mile long course is located a mile east of the Lancaster overpass. You will recognize the beginning and ending points of the course as painted stripes surrounding a survey pin on the right shoulder.
- If you need to recalibrate the DMI in a different part of the state there are a few options you can use.
   a. Find a local airport. There are often marked distances that can be used for calibration.
   b. Find an ODOT maintenance station. They often have marked distances that you may use.
   c. Another option is to use a distance wheel, and measure your own course in a safe location.

Creating a Rover File

When the datalogger power button is turned on, the GPS system will automatically attempt to connect with all available satellites and identify your current location.

1. Under the *Main Menu* select **Data Collection** as it is highlighted and push Enter. (The arrow key allows menu selections.)
2. You will get 3 choices, *Create rover file, Reopen rover file, and Create base file.*
   a. Select *Create rover file* and press **Enter.**
3. You are in the menu Create file.
   a. Arrow to the line labeled *File*, and enter the name of the file.
   b. Arrow down to **Data dictionary**. Push the ***Right Arrow*** and arrow to the desired data dictionary and push ***Enter***.
   c. The *Storage disk* line should read *TSC1*.
   d. The *Free space* line displays the amount of memory the collector has left.
   e. When you have finished, press the ***Enter*** key.

4. This will take you to the **Antenna Option menu**.
   a. Arrow down to *Height*, which is the height of the vehicle, you are driving.
   b. The RICS unit inventory vehicle is a Jeep and is 1.654 meters tall.
   c. The rest of the setting should remain as default.
   d. The *Measure line* should read *Uncorrected.*
   e. The *Confirm line* should read *Per feature*.
   f. The *Type line* should read *Integrated GPS/Beacon*.
   g. The *Part number* should read *29653-00*.
   h. The *Measurement method* should read *bottom of antenna mount*.

      i.   If any of the features need changed, simply edit these features by highlighting the appropriate line. Then press the **Right Arrow**, and toggle to the proper setting.

      j.   After you have finished setting the Antenna Option menu press **Enter**.

5.   The Start feature screen should now be displayed.
   a.   Select highway and press enter.
   b.   Press the F1 key, which is labeled pause and will put the data collector in "logging paused". This will prevent collecting points until you are at the start of the road.
   c.   Name the highway on the highway ID: line.
   d.   Press the F1 key, now labeled resume, and the enter key to begin data collection.
   e.   Press the enter key to end the data collection feature.

Opening an Existing Data File

1.   When the Main Menu is displayed, highlight *Data Collection* and press **Enter**.
2.   Once you are in the Data Collection screen, highlight *Reopen rover file* and press **Enter**.
3.   Toggle down to the Highway ID: you wish to reopen, and press **Enter**.
4.   Antenna settings will be the same for rover file
5.   The Start feature screen should now be displayed.
   Use a - d from number 5 above.

Locating the Start of a Highway and Setting DMI

1.   There are a couple of methods for locating the start of a highway. Often the beginning will be obvious, such as the intersection with another highway.
   a.   Use notes taken from highway video logs. (see trip preparation - page 9)
   b.   Find the milepoint location of a joining highway or structure with an engineering station on the Highway Inventory Summary. Set your DMI at that location and drive the known distance back to the beginning of the highway.

GETTING UNDERWAY

Beginning Collection
1. Being prepared before starting the data collection process is essential for accuracy and safety.
   a. First determine if you are going to be collecting the data in the add or non-add mileage direction. Once this has been determined, enter in the appropriate milepoint for the highway in the DMI.
   b. After you have set up the datalogger for the highway being mapped *(see Creating rover file)*, make sure that the datalogger is reading at least 4 satellites and the PDOP is below 6. For optimal accuracy we have set the datalogger's configuration screen so collection will stop if the PDOP level goes above 6, or if the number of readable satellites falls below 4.
   c. Pull to the beginning of the highway and press the resume key (F1) and the run/hold key on the DMI.

Checking Milepoint Accuracy using the DMI and Highway Inventory Summary

1. Checking into features with engineering stations is an essential means of locating the attributes you are collecting data about.
   a. After beginning data collection you should verify the milepoint of the first available feature (i.e. road, bridge, undercrossing, or any other known feature located with an engineering station). Checking into a feature as soon as possible will ensure that the actual beginning of the highway was located at the start of data collection.
   b. Using the DMI will assist in locating bridges for nesting by comparing the milepoints from the DMI with Highway Inventory Summary of the highway being mapped.
   c. Using the DMI and Highway Inventory Summary will also assist in locating the end of the highway for an accurate termination point.

Monitoring the Datalogger

1. Monitoring the datalogger is essential to ensuring that data is collected in the most accurate and consistent manor.
   a. Always make sure the datalogger is counting. This can be determined from the beeping sound and by the counter in the bottom right corner of the screen.
   b. If collection stops, pull over as soon as safely possible to avoid large gaps in the data collection process. *(At times gaps in data cannot be prevented.)*

Changing the Datalogger Beep Volume

1. Changing the volume on the datalogger is a very simple process.
   a. From the main menu, go to *Configuration* and press ***Enter***.

b. Scroll through the list until you highlight *Hardware;* press **Enter**.
   c. Scroll down to *Volume* and press the **right arrow**.
   d. Highlight either *high, low,* or *off* for your volume preference. We recommend *high,* so that you will be able to hear the beeps over traffic noise.
   e. After you have chosen your volume, press the **ESC** to exit.

<u>Marking a Stopping Point on a Highway</u>

Some highways are too long and/or feature dense to be completed within one day. On long highways it may be necessary to locate a safe and convenient stopping point. You will need to be able to resume your collection within inches of where you stopped. There are two methods of setting a stopping point that will assure continuity of collection.

- Find a signpost or some other feature that will not move before you resume your collection.
- Pull completely off the road and line your right wheel up with the sign post.
- Note the DMI reading, and general information about where you stopped (i.e., what is written on the sign, etc.) on your Inventory Summary report so you will be able to find the location when you return to finish.

The signs along Interstate highways are too far away from the shoulder to accurately line up with. If you are on an Interstate or other highway where you may have difficulty finding a place to stop, use the following method.

- Find a place that will be easy to locate in the future. (Overpasses and underpasses can be good stopping points.)
- Pull completely off the road.
- Put on your safety hat and vest.
- Take out a can of marking paint, and paint a small mark next to the front tire.
- Write the DMI reading on your Highway Inventory Summary report and make notes about where you stopped, so you will be able to find the location when you return to finish.

POST PROCESSING

Transferring Data from Trimble Datalogger to Pathfinder Office

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Transfer data daily. Rover files in the datalogger cannot be reopened after one week.
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1. Connect the Trimble *TSC1 datalogger cable* to the *PC import cable* located on your camcorder battery charger.
2. Go to the Main Menu in the datalogger and arrow down to *File manager* press *Enter*.
3. Arrow down to *File Transfer* and press *Enter*. The datalogger will now display "Connecting to PC".
4. In Pathfinder, select *Utilities/Data Transfer*.
5. Find the *Data Type* dialog box, and select *data. Highlight the data file(s) in the Available Files: box and then click the add button in the Selected Files: box.* Click the *Transfer* button.
6. Accept the file. It will be changed to a .ssf file.
7. A bar will show that the data has been transferred.
8. To finish the data transfer, press the *Close* button.

Performing Differential Correction

1. Select the icon labeled *Differential Correction*. You may also select *Utilities* and *Differential Correction* from the menu bar.
2. Press the *Browse* key to select the file(s)to correct.
3. Click *Open* to confirm the selected files.

- Using base station files stored locally (on your PC)

4. Click on *Local Search* to select the base station files.
5. Now click *Search* to start the search.
6. Once the Search for a base station within 300 hundred miles is complete, Click *OK* to confirm the selection.
    or

- Using base station files off the Internet

7. Click on *Internet Search* to select the base station files.
8. Choose a Base Data Provider from the drop down list
9. Click *OK* to confirm the selection.
10. Click on *Yes* to continue with the existing Internet Setup
11. Listed will be the base files downloaded and how successful the coverage (should be 100%). Click *OK* to confirm the selection.
12. Click *OK* to confirm the reference position.
13. Click *OK* on the *Differential Correction* screen to start the correction.
14. After the *Differential Correction* process is complete press the map button located on the tool bar.

<u>Editing Data</u>

After differential correction is finished, there are often spikes in the data caused by multipath error. Fortunately, it is possible to correct for multipath error by editing the data. Pathfinder Office will not allow you to delete points from the data set, but it will allow you to erase unwanted nodes. By erasing these unwanted points, you are telling Pathfinder to ignore them, essentially correcting them out of the data set.

1. Erasing multipath spikes
   a. Map the data on your screen by pressing the *Mapping* button on the tool bar.
   b. By zooming into the drawing and panning along the line, you should be able too visually find multipath spikes.
   c. Go to the tool bar and click on the *Eraser*. Click on the peak of the spike.
   d. You will be asked if you are sure you want to erase this node. If you have chosen the correct node, click *Yes*.
   e. Continue doing this to every place you notice an atypical spike in the data.
   f. Be sure to zoom in. Adjusting your viewpoint by zooming and panning along the line will help you to erase spikes, without deleting a bridge or other stored features.

There will also be a need for labeling quickmarks and inserting missed features.

2. Labeling quickmarked bridges
   a. To add the milepoint and bridge number to a quickmark, simply click on the bridge with the arrow.
   b. Select *Data/Feature Properties*. Select *Attributes,* and you will be prompted to enter bridge information.
   c. After entering the milepoint and bridge number, click *OK*.

> *This process is not done for nesting, because the data is entered in at the time of collection.*

3. Inserting missed features
   a. Select *Data/Create Feature*. You will be given a list of possible features stored in the data dictionary.
   b. Highlight the feature you wish to create. Click *OK*.
   c. Type in the milepoint location of the feature that you wish to insert. Click *OK*.

> *For help exporting your collected data into a CAD or GIS system, call Jan Shearer of the Geographic Information Services at (503)986-3163.*

GPS BASE STATIONS

Pacific Survey Supply   <u>Lat. & Long.</u>
Brian German
908 N. Riverside Ave. Medford OR. 97501   42 20 08.7767 N
http://www.pacificsurvey.com   122 52 28.1673 W
pacsur@aol.com   377.03 (elevation)
1-503-858-8996

USFS/BLM
Ken Chamberlain   45 31 12.297 N
USDA Forest Service, Pacific NW Region   122 40 22.927 W
PO Box 3623, Portland, OR 97208   37.21(elevation)
http://www.fs.fed.us/database/gps/welcome.htm
/s=kchamber/r6pnw@fs.fed.us
1-503-808-2796

Portland State University (current month)
Kenneth M. Cruikshank   45 30 44.9906 N
Department of Geology   122 41 01.5907 W
PO Box 751, Portland State University, Portland, OR   46.7 (elevation)
97207-0751
http://www.geol.pdx.edu/Courses/GPS/BaseStation.htm
ken@ch1.ch.pdx.edu
1-503-725-3383

USFS/BLM
Ken Chamberlain   43 31 23.33 N
USDA Forest Service, Pacific NW Region   119 05 48.10 W
PO Box 3623 Portland, OR, 97208   1272.03 (elevation.)
http://www.fs.fed.us/database/gps/welcome.htm
Ken.Chamberlain/r6pnw@fs.fed.us
1-503-326-6627

OPTIMAL CONFIGURATION SETTINGS

The following is a flow list of how you will navigate in the Trimble data collector to change and confirm configuration settings.

Optimal Configuration are the settings that have been determined as the most advantageous for this project, by trial and error and by consultation with Trimble experts.

The following options have been listed as they are viewed on the datalogger screen. The bold/italicized words are the key descriptions for the various screens under Configuration and Data Collection. The easiest way to use these screens is to get the data logger and go into the Configuration menu or Data Collection menu and use the key words (BOLD and ITALIZED) to find the correct screen to change.

CONFIGURATION MENU

- *GPS rover options*
- *GPS base station options*
- *Communication options*
- *Coordinate system*
- *Units and display*
- *Time and date*
- *Quickmarks*
- *Constant offset*
- *External sensors*
- *Hardware (TSC1)*

GPS rover options

Logging options	*Logging options*	Login Intervals	
Position filter		Point feature:	1S
Antenna options		Line feature:	1S
Initial position		Not in feature:	Non
2D altitude		Velocity:	5
		Minimum positions:	1
		Carrier phase:	
		Carrier mode:	Off
		Minimum time:	10 min
		Dynamics code:	Land
		Audible click:	Yes
		Log DOP data:	Yes
		Log PRPT data:	Yes
		Log QA/QC data:	No
	Position filter	Position mode:	Manual 3D
		Elevation mask:	15 degrees
		SNR mask:	6.0
		PDOP mask:	6.0
		PDOP switch:	6.0
		Apply real-time:	Yes
	Antenna options	Height:Measure & enter here (ft/m)	
		Measure:	Uncorrected
		Confirm:	Per file
		Type:	Integrated GPS/Beacon
		Part number:	29653-00
		Measurement method	
		To:	Bottom of antenna mount
	Initial position	Lat:	Updated on start
		Lon:	Updated on start
	2d Altitude	Alt (HAE):	m
		Computed at	
		Time:	Time of last computation
		Date:	Date of last computation

GPS base station options

Base station is not needed as the data is post processed.

Communication options

Communication is not needed as the data is post processed.

Coordinate system

Latitude/Longitude	*Latitude/Longitude*	Datum:	WGS 1984
Argentina		Altitude units:	Meters
.		Altitude ref:	HAE

Units and display

Units
Distance: *Feet(ft)*
Velocity: *Miles/Hour (mph)*
Angles: *Degrees*
Angle fmt: *DD.MM.SSss*
Order: *Lat/Lon*
North reference: *True*
Magnetic declination: *Auto*
Null string: *?*
Language: *English*

Time and date

24-hour clock: *No*
Time: *(current time) 07:42:42am*
Date fmt: *MM/DD/YYYY*
Date: *(current date) 09/28/1999 Tue*

Quickmarks

Attributes: *Repeat*
Confirm: *No*

A feature offset of 8.00 feet left will map the centerline of a two-lane highway when the antenna is mounted in the center of a vehicle. A feature offset can be modified for other features. Add an additional 8.00 feet left for every lane to the center of the highway. Use the table below to help calculate the feature offset.

One lane in each roadway   =   *0.00 foot offset*
Two lanes in each roadway   =   *6.00 foot offset left*
Three lanes in each roadway =   *18.00 foot offset left*
Four lanes in each roadway   =   *30.00 foot offset left*

These distances are calculated off typical 12-foot lanes. These distances are subjective to the width of the lanes being inventoried by GPS.

Constant offset

Point offset	*Point Offset*	Bearing:	0 Degrees
Quickmark offset		Slope dist:	0.000ft
Line offset		Inclination:	0 Degrees
Area offset			
	Quickmark offset	Direction:	Left

	Slope dist:	8.000ft
	Inclination:	0 Degrees
Line offset	Direction:	Left
	Slope dist:	0.000ft
	Inclination:	0 Degrees
Area offset	Direction:	?
	Slope dist:	0.000ft
	Inclination:	0 degrees

External sensors
   None

Hardware (TSC1)
  Data collector information.

DATA COLLECTION MENU :

Create rover file
Reopen rover file
Create base file

Create rover file	*File:*	*HWY???*
	Data dictionary:	*HWY INVENTORY*
	Storage disk:	*TCS1*
	Free space:	*1719kb*

Reopen rover file
Opens a rover file that exists.

Create base file
Not needed

FILE MANAGER MENU:

Delete file(s)	*File(s) can be deleted after they are transferred to the PC.*
Rename file	*File(s) can be renamed.*
File transfer	*File(s) can be selected and transferred to the PC.*
File statistics	*File(s) information.*
Review file	*File(s) can be reviewed.*
Data dictionaries	*Generic* HWY INVENTORY
	ETC.

REFERENCE GUIDE

Frequently Asked Questions

1. What do you do if the datalogger gives you a **Position Dilution of Precision (PDOP)** too high 6.0 or higher? *Pull over at a safe area, and wait until the **PDOP** rate lowers. If you think that PDOP rates are not likely to improve, it is best to slowly carry on until they are acceptable.*

2. What do you do if there are not enough **Space Vehicles (SV)** *AKA Satellites*. *Pull over at a safe area, and wait until at least 4 **SV** are readable again. If recovery is unlikely, it may be necessary to continue on further up the road.*

3. What is the difference between **Quickmarking** and **Nesting**? *Nesting, is when you sit at a desired spot for a determined amount of time and take several readings.* ***Quickmarking*** *is when you take one quick reading at a desired spot and then move on.*

4. How do you know if the Trimble GPS has stopped collecting data? *It will stop counting and beeping.*

5. What is the furthest base station that should be used when differentially correcting data? *The furthest away a base station should be is 300 miles.*

6. What is differential correction? *Differential correction is the process of adjusting your data to achieve greater accuracy.*

7. What is the Highway Inventory Summary Report? *The Highway Inventory Summary Report is a report of the milepoint locations of roadway features. This report is run from the Transviewer,* *http://www.odot.state.or.us/TransView/highwayreports/index.cfm that is continually updated by ODOT's Road Inventory and Classification Services Unit.*

8. Where do you find the Highway Inventory Summary Report?
http://www.odot.state.or.us/TransView/highwayreports/index.cfm

9. How often do you calibrate the DMI? *You should calibrate the DMI weekly. It is important to remember to get an accurate calibration prior to overnight travel where checking the calibration may not be available.*

10. What should you do if a bridge is located where you can not get any GPS signals? *If after waiting and it seems that you cannot pick up signals from this location, the best thing to do is skip it and move on to the next location.*

11. Why post process data? *Post processing data is important to ensure geographical positions that are consistent with the accuracy potential of the equipment being used when beacon or satellite differential correction is not available.*

12. How often do the datalogger settings need to be checked? *The settings should be checked regularly, but the settings should not change by default. The settings should be checked after someone else has used it.*

13. Does tire pressure affect the DMI? *Extreme tire pressure changes can affect the DMI readings. Normal air pressure changes in the tires are not a major concern, and regular DMI calibration will compensate for the differences.*

14. What is the difference between external and internal batteries? *The internal battery is the battery that powers the datalogger. The external batteries power the receiver.*

15. Where can I get more information about troubleshooting problems, with for the Trimble GPS and Pathfinder Office? *Suggested resources for troubleshooting problems not addressed in this document, are the Trimble user Manuals and the Trimble Internet Site. Troubleshooting help can be found at* http://www.trimble.com/support.html

16. How can you compensate for multipath? *Raise the Sound Noise Ratio (SNR) to a higher rate. Or you can raise the velocity rate*. This setting can be changed in the GPS Rover Option, Logging Option, under velocity.

17. What is the lowest degree that the elevation mask should be set*? For the best accuracy, the elevation mask should never be set below 15°.*

18. How many satellites are there for performing GPS? *There are 27 satellites orbiting the Earth that are available for GPS data collection.*

19. What is the minimum number of satellites that should be used while collecting data? *You should never go below four satellites when collecting data.*

20. What has happened when the datalogger reads: Unable to append to a file over one week old. *To prevent the creation of huge rover files, Trimble rover files cannot be accessed after one week of creation.*

21. What has caused all the data collected as a line feature to become point features? *While collecting the data, you may have pushed the ESC key instead of Enter.*

22. Why post process data instead of performing real time data collection. *Post processing data has a higher rate of precision than real time. There are also areas in the state where it is difficult, if not impossible to detect the U.S. Coast Guard beacons.*

23. The datalogger message indicates "The File has become corrupt! You should download all data and reformat the disk drive." *Make sure you have downloaded all data into Pathfinder, and have a copy of your data dictionary. Perform a COLD BOOT.*

System Information Contacts and Useful Web Sites

Name	Phone	Internet Site / E-mail
Heather King (RICS Manager)	(503) 986-4157	*heather.l.king@odot.state.or.us*
Darrell Haugeberg (ITIS Programming Coordinator)	(503) 986-3161	*darrell.f.haugeberg@odot.state.or.us*
Erick Cain (Video Log Coordinator)	(503) 986-4182	*erick.j.cain@odot.state.or.us*
Dave Barker (Inventory Specialist)	(503) 986-3158	*david.l.barker@odot.state.or.us*
ODOT Travel Advisor	1(800) 977-6368	*http://www.tripcheck.com/*
NOAA National Weather Service		*http://nimbo.wrh.noaa.gov/*
Trimble Training	1(408) 481-7997	*www.trimble.com/training.html*
Trimble Customer Support	1(800) 767-4822	*www.trimble.com/support*
Trimble Navigation Limited	1(800) 827-8000	*www.trimble.com*
Geometronics	(503) 986-3103	
Nu-metrics (Nitestar DMI)	1(800) 346-2025	

- Highway Inventory Summary
  http://www.odot.state.or.us/TransView/highwayreports/index.cfm

- ODOT Training Courses
  http://intranet.odot.state.or.us/hr/

- National Geodetic Survey (NGS)
  http://www.ngs.noaa.gov

Snap Commands for the Datalogger

Function Key (Fn)		Letter to Key		Symbol
Fn	+	Z	=	!
Fn	+	S	=	"
Fn	+	X	=	#
Fn	+	K	=	%
Fn	+	Y	=	&
Fn	+	M	=	'
Fn	+	H	=	(
Fn	+	I	=	)
Fn	+	A	=	-
Fn	+	B	=	+
Fn	+	C	=	*
Fn	+	D	=	/

Fn	+	Sp	=	Insert a character
Fn	+	Bksp	=	Delete a character
Fn	+	L	=	Turns internal light on
Fn	+	E	=	lightens the screen
Fn	+	F	=	darkens the screen

Glossary

Add Mileage Direction: Generally applies when milepoints have increasing values in the direction of travel.

Automated Milepoint Log: *See ITIS*

Calibration Course: Mile-long courses where the Distance Measuring Instrument (DMI) can be adjusted for accuracy.

Data Dictionary: A description of features and attributes to be collected during a collection project.

Data Collector: See Datalogger.

Datalogger: The piece of GPS hardware associated with Trimble that is used to collect data.

Defensive Computerized Driving Course: A computerized course for the experienced driver. It helps refresh your defensive driving skills.

Differential Correction: Using GPS data from a known geographical location to statistically correct for errors in GPS field data.

Distance Measuring Instrument (DMI): A calibrated distance measuring instrument that works like an odometer to accurately measure distance traveled by the inventory vehicle.

External Batteries: The camcorder batteries that power the receiver.

Features: A physical object, an event, or phenomenon.

Global Positioning System (GPS): A collection of satellite signals that are detected by a GPS receiver. The receiver interprets the data sent by the satellites to determine a specified geographical location.

Highway Inventory Summary Report: A report showing detailed milepoint inventory for a specified Oregon highway. The Highway Inventory Summary report is a presentation of information from ITIS.

Integrated Transportation Inventory System (ITIS): A database that contains information about Oregon State Highways, their features, and the location of those features. Information specific to GPS: engineering stations, structures, equations, beginning of highways, end of highways and intersecting roads. The Highway Inventory Summary Report is a presentation of information from ITIS.

Internal Batteries: The batteries that power the datalogger.

Milepoint Equations: A roadway location that has two different milepoints attached to it, one describing the milepoint relationship forward, and one describing the relationship backward.

Multipath: An error that occurs when the radio waves bounce off surrounding objects.

Nesting: Nesting is a function in the Trimble GPS collector that allows you to collect several readings at one location and average them for one point record. By collecting the average of multiple readings, accuracy is increased for that point.

Nitestar: The brand of DMI that is used for the field collection.

Non-add Mileage Direction: Roadways with one direction of travel and milepoints that decrease in the direction of travel.

Pathfinder Office: The Trimble software used to correct, view, edit, and export GPS data collected in the field.

Pro-XRS: The model of Trimble GPS receiver addressed in this document. The "R" indicates that it can receive radio signals for real-time correction, and the "S" indicates that it is equipped to receive real-time-correction data from a satellite broadcast.

Quickmarking: A process of telling the data collector that a certain point on a line feature has a significant meaning.

Position Dilution of Precision (PDOP): A number indicating the strength of the position solution. The value increases when the data collector senses poor satellite alignment.

Post Processed Differential Correction: The process of using GPS data from a known base station to correct field data after the data has been collected.

Real Time Differential Correction: The process of using a beacon or satellite service provider to differentially correct data while it is being collected.

Resource Grade: A descriptive term for the accuracy of a GPS receiver, usually with an accuracy of sub-meter or better, but not considered appropriate for land surveying applications or establishment of GPS control stations. Normal uses include identifying locations of "resources", such as utilities, facilities, inventories, and so forth.

Rotobeam: A set of safety lights that are placed on the top of a vehicle and used to alert other motorists of your presence.
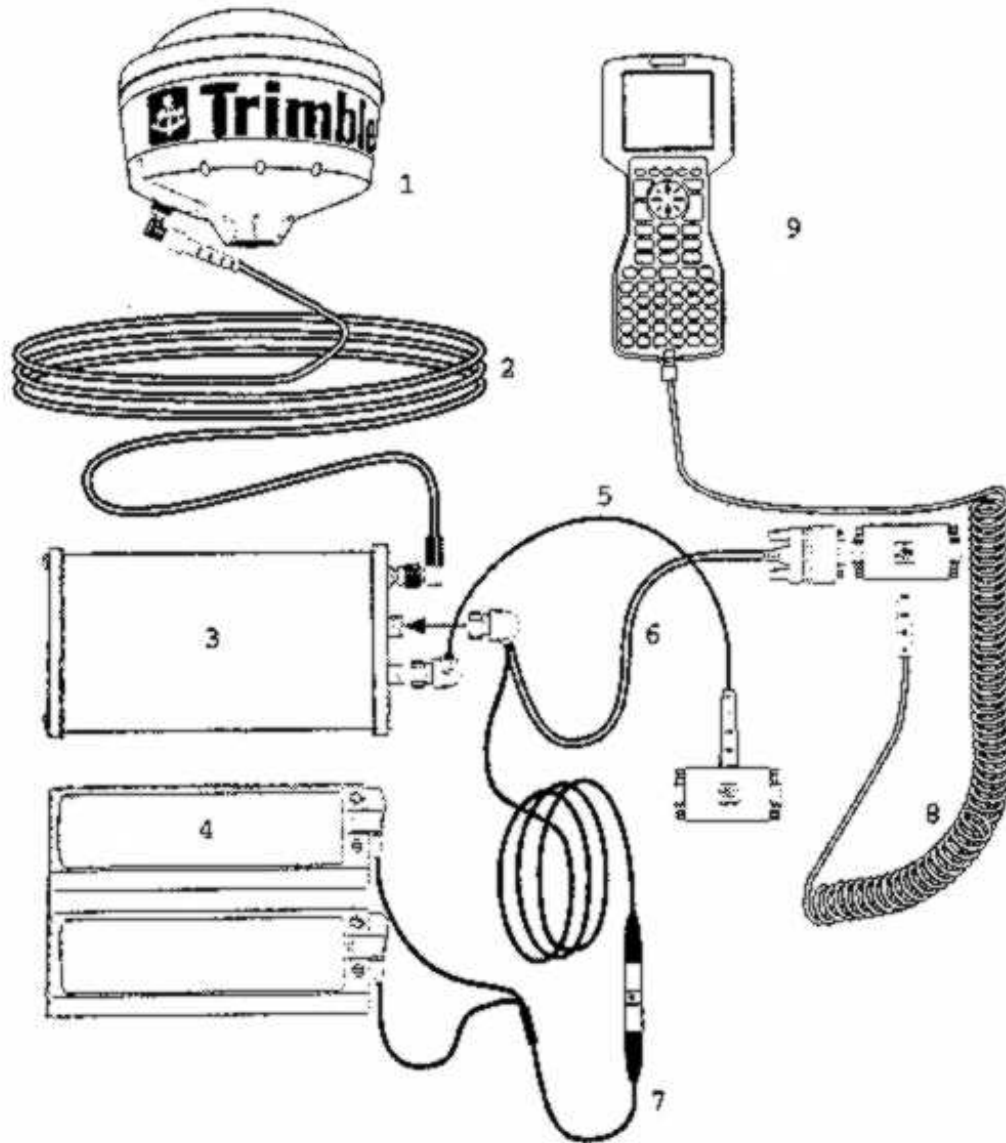
Space Vehicles (SV): The satellites that transmit signals for GPS positioning.

Trimble: The brand of GPS equipment and software addressed in this document.

<u>Video Log:</u> A videotaped collection of all the state highways. Each highway is taped in both add and non-add directions.
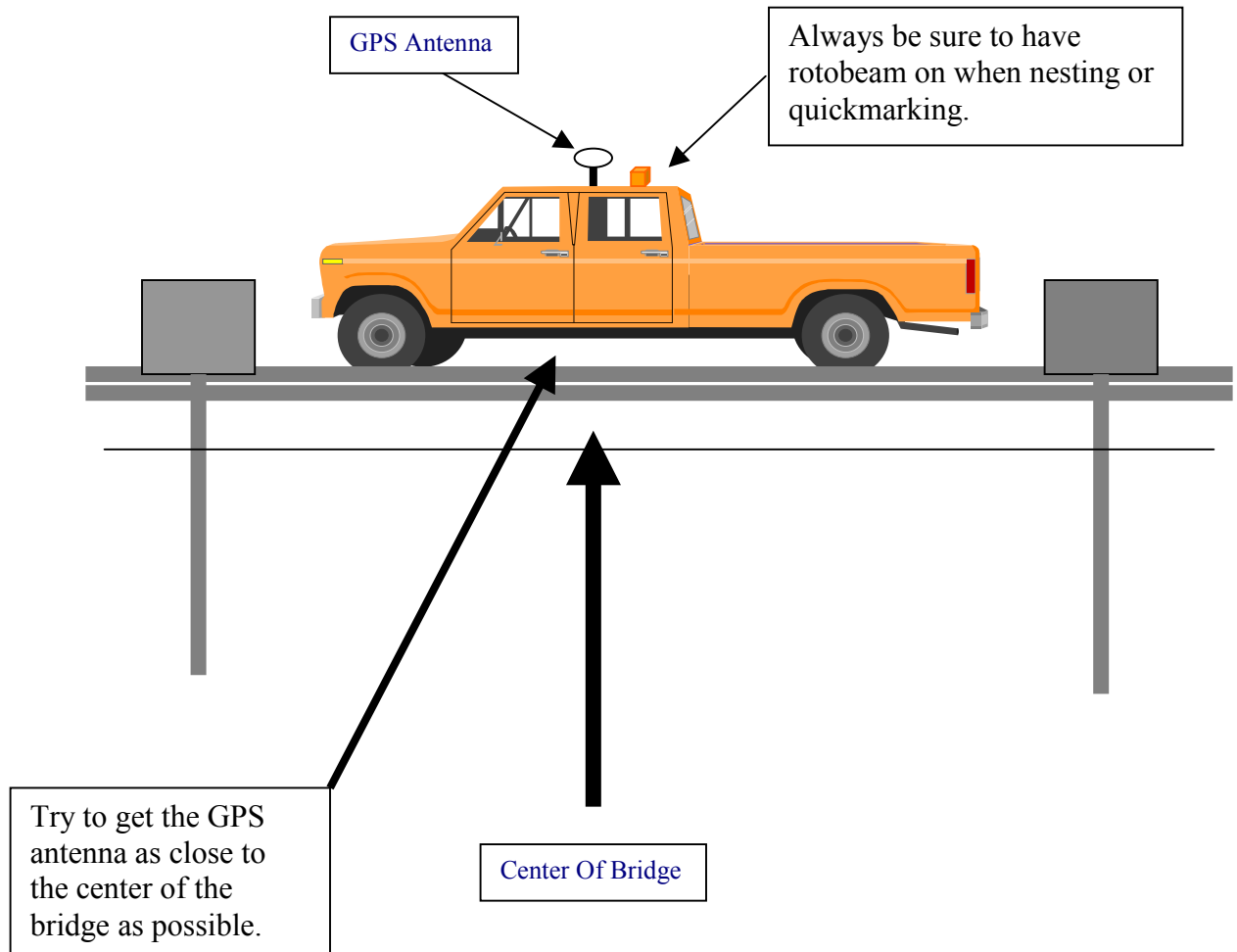
Equipment Diagram

1. Trimble GPS Antenna

2. Trimble Antenna Cable

3. Trimble Receiver

4. Camcorder Batteries

5. NMEA/RTCM Cable

6. Data Logger Adapter Cable

7. Battery Power Cable

8. Data Cable

9. Datalogger

Quickmarking Diagram

Centering GPS on a Bridge for Quickmarking and Nesting

GPS Antenna

Always be sure to have rotobeam on when nesting or quickmarking.

Try to get the GPS antenna as close to the center of the bridge as possible.

Center Of Bridge

Diagram Showing Vehicle Positioning along the Road

Positioning the Vehicle along the Road

Always be aware of weather conditions.

Always make sure that your vehicle is completely off the highway.

Always be aware of other motorist's ability of seeing you.

Always be aware of traffic.

Always use the rotobeam and safety sign when pulling off the road.