

## Trail Mapping with GPS and Mapping Software

### Introduction

Since the development of the approach to mapping described in OCTA's Mapping Emigrant Trails (MET) Manual, remarkable improvements in the technology available at reasonable cost to non-professionals have occurred. The satellite-based Global Positioning System (GPS) permits an individual to locate a position on the surface of the earth within a few feet (or less). The information gathered by hand-held GPS units costing less than \$150 can be downloaded to mapping software in personal computers to generate maps identical to the USGS 1:24,000 scale topographic quadrangles (quads).

The methodology described in the MET Manual includes techniques for researching, identifying and classifying trails as well as the transfer of this information to printed quads. An understanding of that process is a prerequisite for understanding what follows. The MET methodology is sound and widely accepted. The approach described herein exploits modern technology to facilitate the MET process. However, the manual process described in the MET Manual remains valid and can be used by those not comfortable with the "high tech" approach.

The essential elements of the information recorded on a MET quad are (1) trail location, (2) trail condition, and (3) trail documentation (notes that support the trail location and condition assessment). Trail condition is defined by the five MET classes as described in the MET Manual. When OCTA began documenting trails, location data was originally acquired during field visits by relating the topography and evidence on the ground to a position on the paper map. A line representing the trail was drawn on the map. Later, GPS units were used to record the data which was plotted on the paper map. The objective of the new approach is to acquire and record this same information using computer-based software.

Before discussing the technique in detail, some words on the GPS devices and software are appropriate. Any GPS unit that is capable of recording and storing "tracks" and "waypoints" is appropriate<sup>1</sup>. All consumer-grade units provide similar accuracy which is more than adequate for trail mapping. The most popular brands are Garmin, Magellan and Trimble. Higher priced units add "bells and whistles," but do not provide significant improvements in the capabilities used for our mapping projects.

An OCTA survey of mapping software in 2008 resulted in the identification of MapTech's (now MyTopo) Terrain Navigator Pro as the preferred software package. However, any software that can provide the output described in the sections that follow may be used.

Separately, the National Park Service has developed a Graphics Information System (GIS) approach using more sophisticated (and costly) hardware and software. The system is part of a

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<sup>1</sup> Both the terms "waypoints" and "markers" are used by manufacturers to describe points recorded by a GPS. This paper uses the term "waypoint" to describe recording of a point rather than a track or area. As shown later, a GPS may use the term "mark" in a menu to record a waypoint. Also, a waypoint in the OCTA context may be a marker, i.e., a carsonite post.

much larger effort to document National Trails of all types. It is OCTA's objective to provide compatible information to the NPS system using the procedures described in this paper.

## GPS Operations

Mapping projects can be placed in two broad categories. The first is a research project where the GPS and mapping software is a tool in determining the trail's location and condition. The approach is iterative and may result in many changes over time as more becomes known. Some portions of the somewhat more rigorous process described in this paper may not be appropriate for this activity. The approach for a research project may be defined by the needs of the particular project and the inclinations of the researcher.

The approach described herein is focused on "final documentation" after the trail has been found and classified. The approach attempts to replicate what is included in a "final" MET map. Standard electronic formats are defined that will facilitate exchange between OCTA members and the NPS.

For the purpose of discussion, a Garmin eTrex<sup>2</sup> is used as an example. The discussion will focus on major functions and is not intended as an instruction manual for the unit. The best way to learn about and maintain proficiency with a GPS is through continued use.

From a functional standpoint, the two things to be accomplished are (1.) to record the route of the trail and (2.) to record selected features or characteristics. This is accomplished by recording "waypoints" and "tracks." The "Main Menu" display for the Garmin eTrex is shown below. For our purposes, the icons of interest are "Mark" and "Tracks."



Figure 1. Main Menu – eTrex Legend GPS

<sup>2</sup> Garmin eTrex Legend Cx purchased in 2008.

A waypoint is recorded when something changes or a defining trail feature appears. It is a discrete point described by its coordinates, typically in latitude and longitude or Universal Trans-Mercator (UTM) coordinates. With an eTrex Legend a point is marked by going to the main menu, selecting “Mark” and then selecting “OK.” To mark successive point the process is repeated. Note that the result is a series of unconnected points, not a continuous line. The display for a waypoint on the eTrex is shown below.

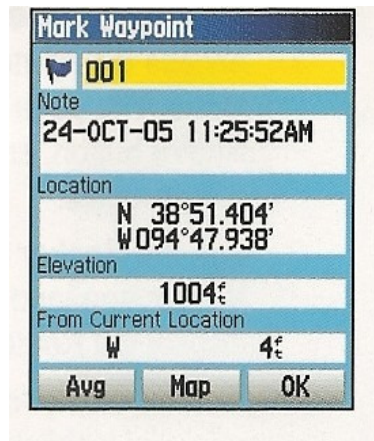


Figure 2 – eTrex Screen for Marking Waypoints

The waypoint numbers (001 above) are assigned automatically and can be edited in the field, but it is probably better done after the data is downloaded to a computer. Supplementary field notes should be used to record the event that Waypoint 001 is recording (such as a change in trail classification).

A “track” is a continuous line recorded as you walk down the trail. With the eTrex Legend it is recorded by selecting “Tracks” from the main menu and then turning the track log on. Recording is continuous until the track log is turned off with the same menu selection. The continuous nature of the GPS’s track recording means that everywhere you walk is recorded when it is “on.” If you are walking and recording a defined trail trace and divert off that trace to examine and interesting feature, that diversion will be recorded. A degree of discipline is required to record an accurate track. An example is shown later.

In summary, after a field trip the GPS contains data in the form of tracks and waypoints. The process of data collection is as follows:

1. Assuming all useful information from previous field work has been downloaded or recorded elsewhere, the GPS unit should be initialized to remove old tracks and markers.
2. At the start of the segment to be recorded, the first waypoint is recorded. The field notes would record the start and that the trail is Class 1 (or whatever is appropriate). If there is some feature at that point it would also be noted.

3. At the same time (and position) the track recording is started. The track and waypoints should be recorded in the direction of the emigrant's travel on the westward journey.
4. The next waypoint would either be some feature (trail marker, unique landmark, etc.) or a change in trail classification. The track logger need not be stopped when this waypoint is recorded, although it may be a good idea to stop and start the logger if significant time is being spent at one location.
5. The process is continued until the entire segment of interest is recorded.

Theoretically, the entire segment could be recorded as one track with waypoints along the track. However, it may be more convenient to record the track in segments so that it will be easier to re-do a segment if a problem arises.

Next we will transfer that information to the mapping software.

### **Terrain Navigator Pro (TNP)**

Again, the text that follows is not intended as an instruction manual for TNP. We will focus on those capabilities needed to meet our objective of "final trail documentation."

Transfer of data is initiated by connecting the GPS to a computer through a cable (usually a USB or serial port connection)<sup>3</sup>. The mapping software is opened with maps in the appropriate area. With TNP you need the state software for the state in which you are working.

At this point it is assumed that the user is familiar with the map functions of TNP software. You will want to know how to move (navigate) through the maps in different areas at different scales and zoom levels. A set of tools for working on the map is provided in toolbars in the upper left corner. The magnifying glass with a plus and minus sign, the hand, and the bull's eye are the primary tools for navigation.

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<sup>3</sup> On first use, initialization of the interface is required. The software will automatically search for the GPS you are using.

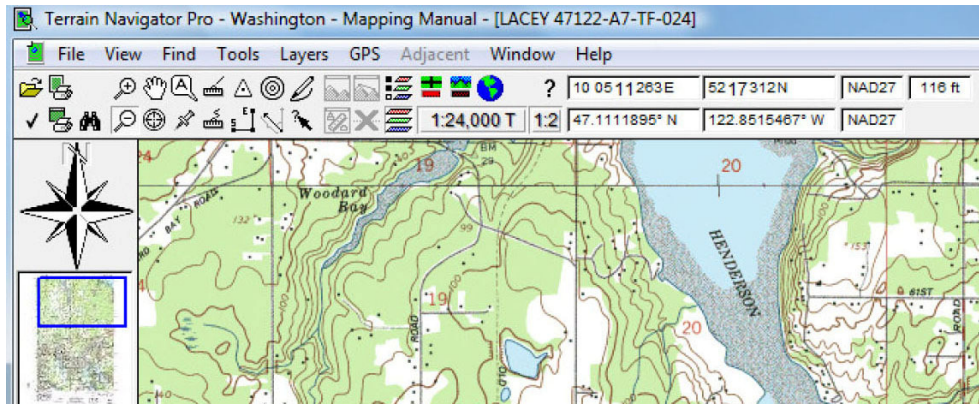


Figure 3 – Map and Menu Display for Terrain navigator Pro

In the second menu bar near the center is an item labeled “GPS.” A sub-item in this menu allows you to download information (“Receive from GPS”). Once this has been done, the information will appear on the map as shown below. If you do not see the expected tracks and waypoints, then the selected map may not be in the area of the tracks. Move the background map to the appropriate area.

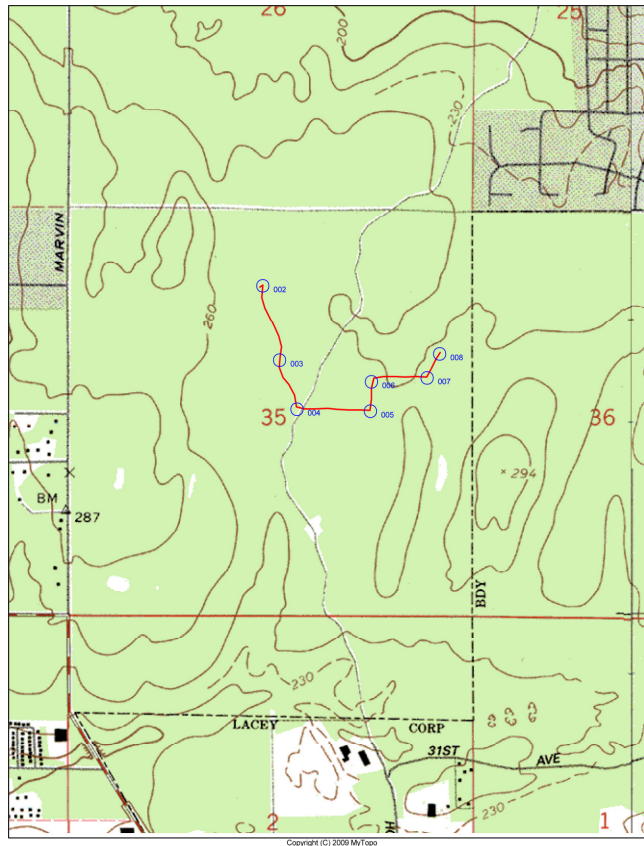


Figure 4 – Map Showing Downloaded Track and Markers

The example shows a track (red line) and seven waypoints (numbers 002 through 008). In this instance, the track was recorded continuously. The GPS was switched to waypoint recording to record a point of interest. The numbers assigned to each waypoint are those automatically assigned by the GPS in the field.

Next, select the item in the second menu bar labeled “Layers” and then the sub-item “Markers.” (See menu display in Figure 3) This will display the dialog box for editing the names of the markers as shown below.

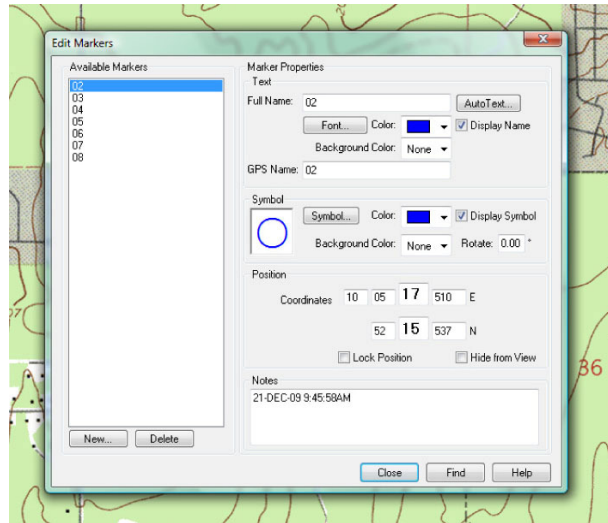


Figure 5 – Editing Marker Information

Two fields can be used to add the information we need: “Full Name” (upper right) and “Notes” (lower right). The proposed convention for naming a waypoint (“marker” in TNP terminology) is:

Township-Range-Section-Waypoint Number-Type

Example: T019N-R001W-35-01-A1

The trail types are:

- A1 Start trail Class 1
- A2 Start trail Class 2
- A3 Start trail Class 3
- A4 Start trail Class 4
- A5 Start trail Class 5
- B OCTA marker with no change of class
- C Other feature or marker with no change of class

Note that both township and range are given as three digit numbers to accommodate numbers in the 100’s if necessary. Other types may be identified in the future.

The marker labels have now been changed to reflect the naming convention. The revised map is shown in Figure 6. The long labels result in clutter on a printed map but two options are available to reduce this effect. First, in TNP under “View” there is an option to control layer visibility and size. The item for “Markers” can be unchecked so that only the track is displayed or the size of the marker labels can be altered with the slide at the bottom of the window. Resized labels are shown in Figure 7.

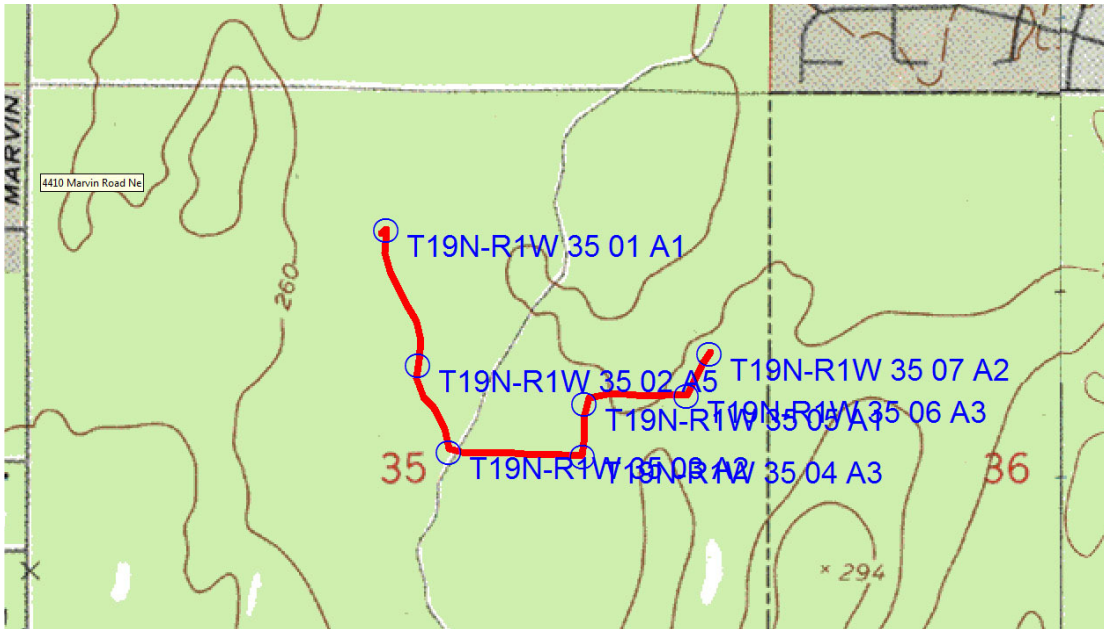


Figure 6. Trail with Revised Marker Labels and Clutter

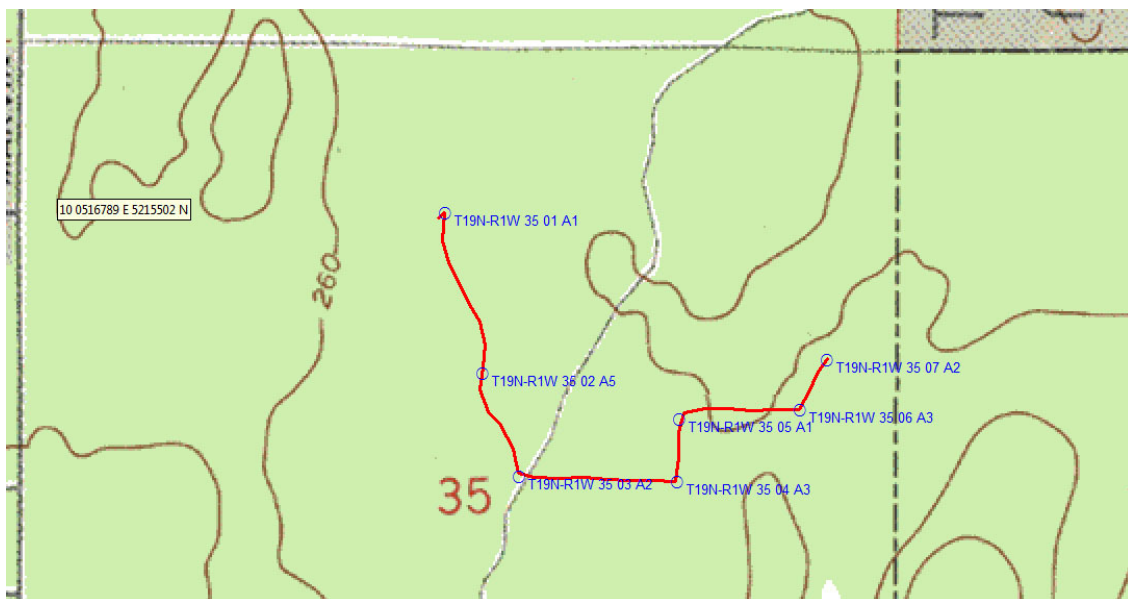


Figure 7 – Revised Waypoint/Marker Display

Next we will add documentation to the tracks and markers. In the third menu bar (see menu in Figure 3) there is a “balloon” like those used to add speech in a comic strip. The balloon has an “A” inside of it. Select this tool and then click a point on the map where you wish to add a note. This may be done off to the side with its final position determined after you have completed the note. Both the note itself and its attach point may be adjusted easily. The map with notes is shown below.

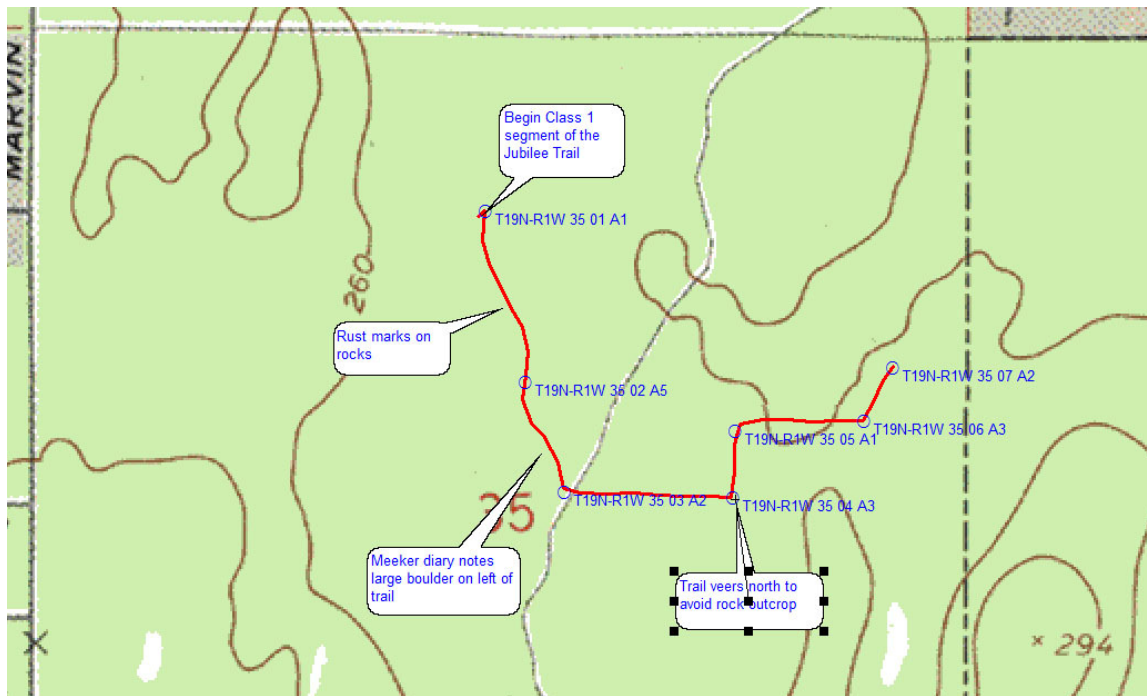


Figure 7 – Display with Labels

If more extensive annotation is desired, then a word file should be developed in parallel with the map. The word file text and the map should be cross-referenced. The cross-reference should include the researcher’s initial (DJW), date (ddmmyy or 021710) and number (001, 002, etc.). If it is linked to a waypoint, that identifier should be included also.

The map and documentation is now complete. The next step is to export the data so that it can be shared with others.

### Exporting and Importing Data

There are different options depending upon whether the data is being exported by another TNP user or to a user with other software. For the first case we can use the file formats provided by TNP. They are TXF for tracks, MXF for markers, and LXF for labels.

To export a track, in the second menu bar, select “File” then “Export” followed by “Tracks.” Select the track or tracks to be saved, then click “Save.” Give the track a descriptive name such as “ONHT DJW 001” and then select the TXF format in the “Save as type” at the bottom of the window if it is not the default option. Repeat the process for waypoints and markers.

For exporting to a non-TNP user, the process is the same, but it uses a different export format (GPX) that is selected in the format line. This is the format to be used to send data to the NPS as well as non-TNP users. Both markers and tracks are saved in GPX format. Labels are saved in the LXF formats. Selection of the correct format is essential for the completion of the exchange with the National Park Service.

Tracks	Format GPX
Markers	Format GPX
Labels	Format LXF

The contents of these files may be viewed in a text program such as WordPad. For transfer to other researchers, these files may be attached to an email. The files for the examples used in this paper are in Appendices A (TXF), B (MXF), C (LXF), D (GPX tracks) and E (GPS markers).

In TNP data is imported by selecting “Import” under the “File” menu and then selecting each data set. If you have a project open, the new data is added to that project. This may or may not be appropriate for the task at hand. To start a new project in TNP before importing data, select “Layers” and then “New Project.”

## **Conclusion**

The process of collecting and processing trail data is challenging. It often requires multiple efforts to get the product “just right.” However, when the project is completed, the result, whether it is a paper MET map or this computer-based documentation, surely justifies the effort.

The results when done with care and precision are one of OCTA’s finest products. Please join with others in this important work.

## Appendix A – Jubilee Trail Track (TNP TXF Format)

47.09481488, -122.77067017, "Jubilee Trail", ff, 1261417530  
47.09489778, -122.77051377, "Jubilee Trail", ff, 1261417564, 0.009324, 34  
47.09444524, -122.77056758, "Jubilee Trail", ff, 1261417594, 0.031371, 30  
47.09408264, -122.77040782, "Jubilee Trail", ff, 1261417624, 0.026157, 30  
47.09373530, -122.77015653, "Jubilee Trail", ff, 1261417654, 0.026753, 30  
47.09339289, -122.76990708, "Jubilee Trail", ff, 1261417684, 0.026408, 30  
47.09305410, -122.76966644, "Jubilee Trail", ff, 1261417714, 0.026003, 30  
47.09267540, -122.76953233, "Jubilee Trail", ff, 1261417744, 0.026916, 30  
47.09231088, -122.76959193, "Jubilee Trail", ff, 1261417774, 0.025343, 30  
47.09194609, -122.76965093, "Jubilee Trail", ff, 1261417804, 0.025357, 30  
47.09158668, -122.76944809, "Jubilee Trail", ff, 1261417834, 0.026604, 30  
47.09135140, -122.76914148, "Jubilee Trail", ff, 1261417864, 0.021733, 30  
47.09096055, -122.76885524, "Jubilee Trail", ff, 1261417894, 0.030177, 30  
47.09055897, -122.76873722, "Jubilee Trail", ff, 1261417924, 0.028297, 30  
47.09049083, -122.76834428, "Jubilee Trail", ff, 1261417954, 0.019076, 30  
47.09048672, -122.76774128, "Jubilee Trail", ff, 1261417984, 0.028368, 30  
47.09049820, -122.76711046, "Jubilee Trail", ff, 1261418014, 0.029686, 30  
47.09046124, -122.76656002, "Jubilee Trail", ff, 1261418044, 0.026020, 30  
47.09044146, -122.76599911, "Jubilee Trail", ff, 1261418074, 0.026423, 30  
47.09044590, -122.76542972, "Jubilee Trail", ff, 1261418104, 0.026787, 30  
47.09043274, -122.76486981, "Jubilee Trail", ff, 1261418134, 0.026356, 30  
47.09082124, -122.76480871, "Jubilee Trail", ff, 1261418164, 0.026997, 30  
47.09122919, -122.76480527, "Jubilee Trail", ff, 1261418194, 0.028188, 30  
47.09157109, -122.76467678, "Jubilee Trail", ff, 1261418224, 0.024385, 30  
47.09162582, -122.76414712, "Jubilee Trail", ff, 1261418254, 0.025201, 30  
47.09162700, -122.76358830, "Jubilee Trail", ff, 1261418284, 0.026288, 30  
47.09160688, -122.76304901, "Jubilee Trail", ff, 1261418314, 0.025407, 30  
47.09161593, -122.76248860, "Jubilee Trail", ff, 1261418344, 0.026370, 30  
47.09160797, -122.76190480, "Jubilee Trail", ff, 1261418374, 0.027469, 30  
47.09190603, -122.76166658, "Jubilee Trail", ff, 1261418404, 0.023446, 30  
47.09222806, -122.76143617, "Jubilee Trail", ff, 1261418434, 0.024751, 30  
47.09245856, -122.76120139, "Jubilee Trail", ff, 1261418463, 0.019381, 29

## Appendix B – Jubilee Trail Markers (TNP MXF Format)

47.09489912, -122.77051913, "T19N-R1W 35 01 A1", "T19NR1", "21-DEC-09 9:45:58AM.  
Start of trail segment.", ff0000, 3, 1261431186  
47.09222421, -122.76961632, "T19N-R1W 35 02 A5", "T19NR1", "21-DEC-09 9:49:42AM.  
Trail desoyed by aliens.", ff0000, 3, 1261431186  
47.09050910, -122.76872800, "T19N-R1W 35 03 A2", "T19NR1", "21-DEC-09 9:52:09AM.  
Two track overlays trail.", ff0000, 3, 1261431186  
47.09043475, -122.76486051, "T19N-R1W 35 04 A3", "T19NR1", "21-DEC-09 9:55:35AM.  
Further alien damage.", ff0000, 3, 1261431186  
47.09146430, -122.76479790, "T19N-R1W 35 05 A1", "T19NR1", "21-DEC-09 9:56:52AM.  
Class 1 segment.", ff0000, 3, 1261431186  
47.09160772, -122.76188150, "T19N-R1W 35 06 A3", "T19NR1", "21-DEC-09 9:59:35AM",  
ff0000, 3, 1261431186  
47.09243803, -122.76123073, "T19N-R1W 35 07 A2", "T19NR1", "21-DEC-09 10:00:55AM.  
Some improvement due to logging operations.", ff0000, 3, 1261431186

Appendix C – Jubilee Trail Labels (TNP LXF Format)

47.09482327, -122.77057556, "Begin Class 1 segment of the Jubilee Trail", 3,  
ff0000, fffffff, 88, -81, 138, 82  
47.09115975, -122.76916521, "Meeker diary notes large boulder on left of  
trail", 3, ff0000, fffffff, -108, 141, 168, 76  
47.09339849, -122.77001951, "Rust marks on rocks", 3, ff0000, fffffff, -124,  
46, 128, 60  
47.09041496, -122.76479559, "Trail veers north to avoid rock outcrop", 3,  
ff0000, fffffff, 15, 110, 162, 64

## Appendix D – Jubilee Trail Track (GPX Format)

```

<?xml version="1.0" encoding="ISO-8859-1" standalone="yes"?>
<gpx
  xmlns="http://www.topografix.com/GPX/1/1"
  creator="Maptech Terrain Professional"
  version="1.1" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.topografix.com/GPX/1/1
http://www.topografix.com/GPX/1/1/gpx.xsd">

  <metadata>
    <name><![CDATA[C:\Users\Dave\Documents\OCTA MMC\MET Manual\Revision\Jubille
Trail DJW 01.GPX]]></name>
    <author>
      <name>Terrain Professional</name>
      <link href="http://www.mytopo.com">
        <text>MyTopo</text>
      </link>
    </author>
    <time>2010-03-03T21:58:56Z</time>
    <bounds minlat="47.090433" minlon="-122.770670" maxlat="47.094898" maxlon="-
122.761201"/>
  </metadata>

  <trk>
    <name>Jubilee Trail</name>
    <cmt>This is a test case for the mapping manual.</cmt>
    <desc>JblTrl</desc>
    <number>1</number>
    <trkseg>
      <trkpt lat="47.094815" lon="-122.770670">
        <time>2009-12-21T17:45:30Z</time>
      </trkpt>
      <trkpt lat="47.094898" lon="-122.770514">
        <time>2009-12-21T17:46:04Z</time>
      </trkpt>
      <trkpt lat="47.094445" lon="-122.770568">
        <time>2009-12-21T17:46:34Z</time>
      </trkpt>
      <trkpt lat="47.094083" lon="-122.770408">
        <time>2009-12-21T17:47:04Z</time>
      </trkpt>
      <trkpt lat="47.093735" lon="-122.770157">
        <time>2009-12-21T17:47:34Z</time>
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      <trkpt lat="47.093393" lon="-122.769907">

```

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</trkpt>  
<trkpt lat="47.092675" lon="-122.769532">  
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</trkpt>  
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<time>2009-12-21T17:50:34Z</time>  
</trkpt>  
<trkpt lat="47.091351" lon="-122.769141">  
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<trkpt lat="47.090961" lon="-122.768855">  
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</trkpt>  
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```
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</trkpt>
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  <time>2009-12-21T17:58:34Z</time>
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  <time>2009-12-21T17:59:04Z</time>
</trkpt>
<trkpt lat="47.091608" lon="-122.761905">
  <time>2009-12-21T17:59:34Z</time>
</trkpt>
<trkpt lat="47.091906" lon="-122.761667">
  <time>2009-12-21T18:00:04Z</time>
</trkpt>
<trkpt lat="47.092228" lon="-122.761436">
  <time>2009-12-21T18:00:34Z</time>
</trkpt>
<trkpt lat="47.092459" lon="-122.761201">
  <time>2009-12-21T18:01:03Z</time>
</trkpt>
</trkseg>
</trk>
</gpx>
```

## Appendix E – Jubilee Trail Markers (GPX Format)

```

<?xml version="1.0" encoding="ISO-8859-1" standalone="yes"?>
<gpx
  xmlns="http://www.topografix.com/GPX/1/1"
  creator="Maptech Terrain Professional"
  version="1.1" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.topografix.com/GPX/1/1
  http://www.topografix.com/GPX/1/1/gpx.xsd">

  <metadata>
    <name><![CDATA[C:\Users\Dave\Documents\OCTA MMC\MET Manual\Revision\Jubilee
  Trail DJW 01M.GPX]]></name>
    <author>
      <name>Terrain Professional</name>
      <link href="http://www.mytopo.com">
        <text>MyTopo</text>
      </link>
    </author>
    <time>2010-03-03T22:03:53Z</time>
    <bounds minlat="47.090434" minlon="-122.770520" maxlat="47.094900" maxlon="-
  122.761230"/>
  </metadata>

  <wpt lat="47.094899" lon="-122.770519">
    <time>2009-12-21T21:33:06Z</time>
    <name>T19N-R1W 35 01 A1</name>
    <cmt>21-DEC-09 9:45:58AM. Start of trail segment.</cmt>
    <sym>3</sym>
    <type>Marker</type>
  </wpt>
  <wpt lat="47.092224" lon="-122.769616">
    <time>2009-12-21T21:33:06Z</time>
    <name>T19N-R1W 35 02 A5</name>
    <cmt>21-DEC-09 9:49:42AM. Trail desoyed by aliens.</cmt>
    <sym>3</sym>
    <type>Marker</type>
  </wpt>
  <wpt lat="47.090509" lon="-122.768728">
    <time>2009-12-21T21:33:06Z</time>
    <name>T19N-R1W 35 03 A2</name>
    <cmt>21-DEC-09 9:52:09AM. Two track overlays trail.</cmt>
    <sym>3</sym>
    <type>Marker</type>
  </wpt>

```

```
<wpt lat="47.090435" lon="-122.764861">
  <time>2009-12-21T21:33:06Z</time>
  <name>T19N-R1W 35 04 A3</name>
  <cmt>21-DEC-09 9:55:35AM. Further alien damage.</cmt>
  <sym>3</sym>
  <type>Marker</type>
</wpt>
<wpt lat="47.091464" lon="-122.764798">
  <time>2009-12-21T21:33:06Z</time>
  <name>T19N-R1W 35 05 A1</name>
  <cmt>21-DEC-09 9:56:52AM. Class 1 segment.</cmt>
  <sym>3</sym>
  <type>Marker</type>
</wpt>
<wpt lat="47.091608" lon="-122.761881">
  <time>2009-12-21T21:33:06Z</time>
  <name>T19N-R1W 35 06 A3</name>
  <cmt>21-DEC-09 9:59:35AM</cmt>
  <sym>3</sym>
  <type>Marker</type>
</wpt>
<wpt lat="47.092438" lon="-122.761231">
  <time>2009-12-21T21:33:06Z</time>
  <name>T19N-R1W 35 07 A2</name>
  <cmt>21-DEC-09 10:00:55AM. Some improvement due to logging operations.</cmt>
  <sym>3</sym>
  <type>Marker</type>
</wpt>
</gpx>
```