SOFTWARE VALIDATION TEST PLAN AND REPORT FOR ArcInfo® 9

Prepared for

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Date

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1 SCOPE

According to ESRI® (2004a), "ArcGIS® 9 is an integrated collection of Geographic Information Systems (GIS) software products for building a complete GIS." One of these products is ArcGIS Desktop. ESRI (2004a) states "ArcGIS Desktop is an integrated suite of advanced GIS applications" (e.g., ArcMap®) and "is available at three functional levels—ArcView®, ArcEditor™, and ArcInfo®." ArcInfo Desktop contains the same applications and capabilities as ArcInfo for Unix. Therefore, the validation of ArcInfo 9 Desktop is a continuation of the ArcGIS Desktop 9.0 [previously validated under Technical Operating Procedure (TOP)–018] and should basically mirror the software validation of ArcInfo 7.0.2 for Unix and ArcInfo 8.0.2 for Unix.

The functions of ArcGIS 9 to be validated in this report are limited to

- Spatial editing (reprojecting)
- Georeferencing
- Data conversion using the Grid geoprocessing system

2 REFERENCES

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Environmental Systems Research Institute, Inc. "Getting to Know ArcGIS Desktop." Redlands, California. 2004b.

Environmental Systems Research Institute, Inc. "Arc/Info® User's Guide—Cell-Based Modeling with GRID™ 6.0." Redlands, California. 1992.

Environmental Systems Research Institute, Inc. "ArcGIS: The Complete Enterprise GIS." Redlands, California. <http://www.esri.com/software/arcgis/about/desktop_gis.htm> (July 2, 2007).

Environmental Systems Research Institute, Inc. "ArcInfo—Complete Desktop GIS for the GIS Professional." <http://www.esri.com/software/arcgis/arcinfo/index.html> (July 2, 2007).

Environmental Systems Research Institute, Inc. "ArcInfo Desktop 9.0 on PC-Intel Windows XP Professional Edition, Home Edition." <http://support.esri.com/index.cfm?fa=knowledgebase.systemRequirements.list&PN=ArcInfo+Desktop&pName=ArcInfo+Desktop&PVName=&PID=43&count=1&pvid=177&VID=621> (July 3, 2007).

University of Nevada, Reno. "W.M. Keck Earth Sciences & Mining Research Information Center." 1999. <http://keck.library.unr.edu/> (July 9, 2007 and July 10, 2007).

3 ENVIRONMENT

3.1 Software

ArcInfo 9 is a product of ArcGIS Desktop, which is one of four parts of ArcGIS 9 software, a commercially developed “integrated suite of professional Geographic Information Systems (GIS)” (ESRI, 2004a) and mapping software applications by Environmental Systems Research Institute® (ESRI®). The ArcInfo Grid™ module will be used as part of the validation testing. Grid is a geoprocessing system “based on a combined raster-based (grid-cell) spatial model and a relational attribute model” (ESRI, 1992). There is an “SP2” suffix on the ArcGIS 9 program name; this refers to the certified with limitations service pack, which was installed to correct a license manager conflict between ArcGIS 9 and Windows XP. Other operating systems may require other service packs or patches to correct conflicts with the software. Service packs or patches are available for free download at the ESRI web site.

Operating System: Microsoft® Windows XP® Professional, Service Pack 2.

3.2 Hardware

CPU speed of 1.0 GHz or higher recommended
Pentium or higher processor
512 MB or higher recommended for memory/RAM
300 MB minimum of swap space

Minimum installation of Microsoft® Internet Explorer® Version 6.0 is required for some features of ArcInfo 9 Desktop.

4 PREREQUISITES

Running ArcInfo Desktop 9 requires installation of ArcGIS Desktop 9, a commercially available software, per the developers’ User’s Manual.

5 ASSUMPTIONS AND CONSTRAINTS

The user of ArcInfo 9 Desktop is assumed to be familiar with GIS and geospatial data sets. The user is also assumed to be familiar with ESRI GIS software product Arc/Info 7.0.2 or 8.0.2 for Unix. ArcMap™ 9, part of ArcGIS Desktop 9, will be used to open, visualize, and confirm that the processes performed using ArcInfo 9 are valid. The commands to be entered appear with the prompt and command in bold print herein, and it is assumed the user will follow the command with a hard return. Words in small capital letters refer to areas of interest in the current window. The names of directories, folders, and/or files are italicized.

Data supplied for this software validation are available for download from the University of Nevada, Reno, Keck Library web site. Metadata for each set of data are contained in the individual data file folders on the attached CD of downloaded data for this validation test. All data compressed in ZIP or TAR has been uncompressed for ease of use for this software validation. The files downloaded from the Nevada Atlas were Digital Raster Graphic, Landsat image, and the 30′ Quad 11-06 map.

The downloaded georeferenced atlas map of Quad 11-06 used in this software validation was opened in Adobe® Photoshop® and saved using a new name (*beatty.tif*) so that the *atlas1106.tif* header, including georeferencing information, would not be associated with the new file.

The files containing projection information (*.*prj*) are supplied with the test data files.

6 TEST CASES

6.1 Spatial Transformation of Datum and Raster Conversions

ArcInfo 9 will read the internal information of the selected DRG raster image and will return the information regarding cell size, projection, units, and minimum and maximum xy coordinates. This raster will be converted into three separate grids, containing the cell information for red, green, and blue band colors. Each grid will have the datum transformed using a project file (*.prj) to convert the North American Datum 1927 (NAD27) to NAD83, creating new color grids from the original grids. A comparison of the internal information of an original grid with a new datum shifted grid will show that all information is the same except the coordinates, indicating a datum shift. The three new grids will be reassembled into DRG raster format. A comparison of the two DRG raster images will be made using traces of linear features and with a third raster image of a known coordinate system using ArcMap 9.

6.1.1 Test Input

(1) DRG, big_dune.jpg
(2) Project file, u11_27_u11_n83.prj
(3) Landsat GeoTIFF image, 40-3435_050414geotif.tif

6.1.2 Test Procedure

(1) ArcInfo opens through the MS Windows Start Menu > Programs > ESRI > ArcGIS SP2 > ArcInfo Workstation > Arc. The Arc Window opens with the Arc prompt. The default workspace is determined by the location entered in the START IN line of the ARC PROPERTIES Shortcut window opened by right clicking on the ARC MENU button in the START MENU. Other features (i.e., color schemes and size of the display window) may also be set in the ARC PROPERTIES window.

(2) Quit ArcInfo: **Arc:q**. Copy the *ArcInfo9Data* folder, supplied on CD, to the hard drive. Map the path to *nv_data\DRG* within the *ArcInfo9Data* folder in the START IN line of the ArcInfo Properties Shortcut window (Figure 1a). Open ArcInfo.

(3) To confirm the workspace location, enter **w** at the Arc prompt. Arc will display the path to the current workspace (Figure 1b). If the dialogue responds that the current location is not a workspace, create a workspace: **Arc:cw .** (space with period is part of the command).

(4) List images in the *DRG* directory: **Arc:li**. The available image *big_dune.jpg* is listed. Get the header information of this image by entering **Arc:describe *big_dune.jpg***. Note that the image type is listed as MULTIBAND or RGB. The world file (*jgw*) accompanying the jpeg file sets the image in the correct position spatially (see BOUNDARY coordinates), but does not name the coordinate system. The source web site for the DRG lists the projection as UTM, Zone 11, NAD27 datum (see file *bigdune62.5k_info.rtf*).

(5) Convert multiband DRG to grids: **Arc:imagegrid big_dune.jpg grid27**. List grids: **Arc:lg**. Three grids have been created—one for each color band. Grid appended as C1 is the red band grid, C2 is the green band grid, and C3 is the blue band grid. Describe one of the grids: **Arc:describe *grid27c1***. BOUNDARY, ROW, COLUMN remain the same. PIXEL SIZE is now the CELL SIZE and IMAGE DEPTH is the ATTRIBUTE DATA (bytes). The STATISTICs represent the range of data numbers (DN) in that grid.

(6) Assign the current projection to each grid by defining the projection. Enter **Arc:Projectdefine grid *grid27c1***. At the PROJECT prompt, enter **projection UTM**. At the next prompt, enter **units meters;** next prompt **Zone 11;** next prompt **datum NAD27**; next entry **para** (abbreviation for parameters). ARC prompt returns. Repeat for the other two grids. Repeat **describe** as in No. 5 above. Note that all information is the same and that the COORDINATE SYSTEM DESCRIPTION was added and contains the projection and the default SPHEROID for the NAD27 datum.

(7) Convert the datum from NAD27 to NAD83 using the project file *u11_27_u11_83.prj*. The PROJECT file uses the NADCON conversion and changes the SPHEROID from CLARKE1866 to GRS1980 (default spheroid for NAD83). Enter **Arc:Project grid grid27c1 grid83c1 u11_27_u11_83.prj**. Repeat for the other two grids. Describe a grid to insure the only changes are the BOUNDARY coordinates and the DATUM and SPHEROID. All other information is identical.

(8) Reassemble new grids and convert to TIFF raster format. To reassemble the new grids, a stack file must be created using the ArcInfo GRID module. At the ARC prompt, enter **grid**. There is now a GRID prompt. The GRID GRAPHICS DISPLAY window allows the visualization of grids and images. Open the graphics display window by entering **Grid:display 9999** at the GRID prompt. Enter **Grid:mapext grid83c1**. Enter **Grid:image grid83c1**. The image is a grayscale of the red band data (Figure 2a). A preview of the final image can be viewed with the gridcomposite command. Enter **Grid:gridcomposite rgb grid83c1 grid83c2 grid83c3**. A preview of the new image is now displayed (Figure 2b). Make a grid stack of new grids in RGB order. Enter **Grid:makestack 83stk list grid83c1 grid83c2 grid83c3.** The conversion of a grid to an image will be done in ARC. Enter **Grid:q** to quit GRID. At the ARC prompt, enter **Arc:gridimage 83stk none bigdune83.tif tiff** to create a tiff format RGB raster image with corresponding world file (*tfw*). List images to verify the new image: **Arc:li**. Quit Arc Info: **Arc:q**.

(9) Use the drawing tool in ArcMap 9 to trace the road from *bigdune83.tif* (U.S. Highway 95) and the California/Nevada state line to verify that the two DRG images are not spatially identical. The graphic highway line will also be used with the Landsat Geotiff, downloaded from the source already in the desired projection, to overlay and confirm that the road in the image aligns with the graphic line. Open ESRI ArcGIS 9 ArcMap. Add *bigdune83.tif*. Build pyramid layers. Do not set the VIEW projection. Zoom in to the

area of U.S. Highway 95 that cuts across the upper right-hand corner. Select the line drawing tool and trace U.S. Highway 95. Change zoom area to that of the state line and trace that line. Make the lines 3 points thick and yellow. Set the zoom to include both lines to enable comparison (Figure 3a). Uncheck *bigdune83.tif* and add *big_dune.jpg* to the view. The lines created from *bigdune83.tif* DRG should not align with the lines on the *big_dune.jpg* DRG (Figure 3b). Uncheck *big_dune.jpg*. Open the multispectral Landsat image *40-3435_050414geotif.tif (geotif.tif)* from the *nv_data\landsat* directory. The Symbology should be set at RGB composite, Red = Band 1, Green = Band 2, and Blue = Band 3, and Standard Deviations as stretch type. Move *Geotif.tif* to the bottom of the Layers list in the TABLE OF CONTENTS and once again check *bigdune83.tif* to make it visible. In the DISPLAY window of the LAYER PROPERTIES menu for *bigdune83.tif*, set the TRANSPARENCY to 30 percent. Verify the red highway line of the DRG aligns with the road line of the Landsat image by opening and closing *bigdune83.tif* (Figure 3c). Close ArcMap.

6.1.3 Expected Test Results

(1) Three grids representing the three RGB color bands of a JPEG image will be created.
(2) The original datum projection (NAD27) will be transformed to datum (NAD83), creating three new grids representing the RGB color bands.
(3) The grids will be assembled and converted to a raster image format that is visibly, but not spatially, identical to the original image.
(4) The reprojected spatial location will be confirmed using comparison of graphics and a third, different image in the new datum between the original and new DRG image using ArcGIS 9 ArcMap.

6.1.4 Test Results

ArcInfo 9 converted a multiband R (red) G (green)B (blue) raster image into three separate grids (Figure 2a), one for each color band of the image; retaining the spatial information of the raster image while converting pixels to cells and image depth to attribute data (bytes). The projection of the world file (.jgw) of the raster image was assigned by defining the projection to each grid. The datum of the original projection of each grid was converted from NAD27 to NAD83. The reprojected grids were reassembled in RGB order and converted to TIFF raster format. Figure 2b shows a preview composite of the grids prior to converting to a TIFF. The grids were then combined to recreate the raster image in the same projection, but now having a datum shift from NAD27 to NAD83.

The datum shift was verified using ArcMap to compare the location of feature lines traced from the new raster image (Figure3a). These lines remained spatially static in the ArcMap view screen, so when the image in NAD27 is added to the view, the datum shift is observable. Figure 3b shows that the digitized feature lines from the NAD83 image do not overlay the same features on the original NAD27 image. If the datum shift did not occur, the lines would overlay.

The second test of the datum shift to NAD83 was made by overlaying the NAD83 raster on a landsat image with metadata stating it was in the projected datum from its source. Using the transparency tool on the NAD83 raster created in this test, the red Highway 95 line overlays the highway on the Landsat image (Figure 3c).

Test results verify procedure results.

Results Verified By: ___________________________________Date: _____________

6.2 Defining a Projection for an Unregistered Raster Image (Georeferencing)

ArcInfo 9 will create a lattice grid based on points of known world coordinates that correspond to points from an unregistered raster image. The lattice grid will then be projected to the desired different coordinate system. A minimum of three points will be used to link corresponding points located in the raster image and the lattice grid. When the registration is saved, ArcInfo will create a world file to accompany the image. The world file contains the six parameters used to determine the transformation. “Rectify” is the process of applying the transformation to the image. The rectified image, the lattice registration, and system being defined for the unregistered raster image will be opened in ArcMap 9. Alignment of features from the three files input to ArcMap will verify the unregistered image is now rectified to the desired coordinate system.

6.2.1 Test Input

(1) 30′ Quad 11-06, *Beatty.tif.* This image is a copy of the downloaded GeoTIFF with the projection information removed.
(2) Landsat GeoTIFF image, *40-3435_050414geotif.tif*
(3) *NET* will be created using the ArcCommand, Generate

6.2.2 Test Procedure

(1) Open ArcInfo 9. Change the workspace to **arcinfo9data\nv_data\map_atlas**. You should receive a warning that the location is not a workspace. Convert the directory to a workspace using **Arc:cw .** (space and period are part of the command). Check the workspace location and enter **Arc:w**. List images: **Arc:li**. One image is listed: *beatty.tif*. Describe *beatty.tif*: **Arc:describe beatty.tif**. You can see that the image is a single band, 8-byte gray scale with no assigned coordinate system.

(2) Use **GENERATE** to create a lattice grid. Refer to the hard copy of *Beatty.tif* attached to this document for grid coordinates. Enter **Arc:generate net_ll**. At the GENERATE prompt, enter **fishnet**. The origin coordinate will be the longitude and latitude of the lower left corner of the image in decimal degrees. Enter **−117.0000,36.5000**. Y-axis coordinates are the coordinates of the upper left corner and will be **−117.0000,37.0000**. Cell dimensions are 10′ by 10′; convert to decimal degrees by dividing 10′ by 60′ and enter **0.1667,0.1667**. ArcInfo will calculate the number of rows and columns, so enter **0,0**. Opposite corner is the upper right corner—enter **−116.5000,37.0000**. Enter **q** at the GENERATE prompt to end the program.

(3) **Arc:Describe net_ll**. The coverage has FEATURES, but it needs to create ATTRIBUTES using the build command. **Arc:build net_ll points**, then **Arc:build net_ll arcs**, and **Arc:Describe net_ll**. The coverage lists the x and y coordinates entered as the xy maximum and minimum, but has no projection listed. The PROJECTDEFINE command is used to define a coordinate system. Enter **projectdefine cover net_ll**, then **projection geographic**, then **units dd**, then **datum nad27**, then **para**. **Arc:Describe net_ll**. The display window should now look like Figure 4a.

(4) Open ArcMap and add the coverage *net_ll* to the view. The net should have three columns and three rows as shown in Figure 4b. This can be confirmed by checking the attached copy of the *Beatty.tif* map image coordinates.

(5) Reproject *net_ll* from geographic coordinates: NAD27 datum to UTM zone 11, NAD27 datum using project file *geo2utm11n27.prj*. Enter **Arc:project cover net_ll netu11 geo2utm11n27.prj**. **Arc:Describe netu11**. The coordinate system is now UTM, zone 11, NAD27, and the coverage boundary is in meters. Add *netu11* to ArcMap. Open the VIEW properties and clear the projection if one is listed. Zoom to *netu11* (Figure 4c). There are still three rows and three columns, but the grid has changed in appearance due to the UTM projection. (Confirm that no projection is assigned to the VIEW.)

(6) Change the datum of *netu11* from NAD27 to NAD83 using project file *u11_27_u11_83.prj*. Enter **Arc:project cover netu11 netu1183 u11_27_u11_83.prj**. Two PROJECTS are used—the first from geographic to UTM and the second from NAD27 to NAD83—because ArcInfo cannot do both calculations at the same time. **Arc:Describe netu1183**. Note the COVERAGE BOUNDARY has changed as well as the DATUM and SPHEROID in the COORDINATE SYSTEM DESCRIPTION.

(7) Use the REGISTER arc (Figure 5a) command with *netu1183* to associate a coordinate system to *beatty*.tif by creating parameters for an affine transformation. Enter **Arc:register beatty.tif netu1183 2** (the trailing **2** assigns red color to the net). Three interactive resizable windows open within the REGISTER window. The OVERLAY window will show the combined selected areas from the IMAGE and COVERAGE windows, the IMAGE window shows *beatty.tif* image with a selection box, and the COVERAGE window shows a red *netu1183* also with a selection box. REGISTER applies an affine transformation to calculate the amount of scaling, rotating, and translating required to align the image to map coordinates. In the REGISTER pull-down menu, select VIEW and click on LINK ACTIONS. The LINK ACTIONS window contains the command buttons required to complete the registration (Figure 5a).

(8) Links entered in the OVERLAY window between the vector coverage and the raster image are used to establish the coordinate system (Figures 5b–5e). Each link is assigned an ID number, and a minimum of three links are required (Figures 5b–5d). The real-world coordinates obtained from the vector coverage can be selected using the mouse or may be entered in the XY FOR LINK space in the LINK ACTIONS window. Use the selection boxes to zoom to link sites and REDRAW OVERLAY to show area in OVERLAY window. In the OVERLAY window, using the left mouse button, first select the link point of the raster and then the corresponding link of the vector coverage (Figure 5b). A line now connects the two selected points (Figures 5c and 5d). Care should be taken to ensure that the link has the correct corresponding points and that the selected points are precisely positioned on the raster image and vector coverage. Links distributed around the image will result in a more correct/controlled coordinate registration. Use the above process to select two more points for the second link (Figure 5c). Repeat the process one more time (Figure 5d) for the third link.

(9) After three links, the results can be visualized by checking the LOCK IMAGE box in THE LINK ACTIONS window (Figure 5e). The use of one of the selection/view boxes will allow panning and zooming in the OVERLAY window for a visual alignment comparison between the image and the coverage. Selection of the REGISTER button on the LINK ACTIONS window results in the REGISTRATION window opening. This window displays the

SCALE and ROTATION and the OFFSET DISTANCE for each link (Figure 5e). A comparison of the CALCULATED and TRUE x-y values can be used to evaluate the registration. When input is composed of only three links, the distance between the CALCULATED and TRUE points will be "0" (Figure 5e). Click the DONE button in the REGISTRATION window to close the window. Select additional links followed by the register button in the link actions window until the information in the registration window is acceptable for the intended use. If results are acceptable, use the SAVE TRANSFORMATION button. ArcInfo will confirm the TRANSFORMATION SAVE. Select QUIT in the LINK ACTIONS window to close the REGISTER windows. The world file (*.tfw) created for the *beatty.tif* image will be located in the directory.

(10) The rectify command will be used to create a new rotated, scaled, and transformed image based on the information in the world file. This allows the alignment with coverages without having to warp the image. Enter **Arc:rectify beatty.tif beatty_r.tif**. Check the registration using ArcMap. Open *beatty_r.tif* in the view. When asked to BUILD PYRAMIDS, select **yes**. In the VIEW properties window, clear the coordinate system if one is selected. Open the coverage *netu1183*. Zoom in and check the alignment (Figure 6a) of *netu1183* and *beatty_r.tif*. Open the Landsat image used in Test 6.1, which was downloaded from the State of Nevada GIS website in UTM zone 11, NAD83 datum coordinate system. Move *beatty_r.tif* above the location of the Landsat in the TABLE OF CONTENTS. In the DISPLAY page of LAYER PROPERTIES window for *beatty_r.tif*, enter **45** for percent TRANSPARENCY. Comparing surface features [e.g., drainage paths, roads, and cone locations (Figure 6b)] indicated on both images results in determining the images are in alignment and the image *beatty.tif* has been successfully georeferenced to UTM, zone 11, NAD83 datum. Quit ArcInfo: **Arc:q**.

6.2.3 Expected Test Results

(1) A lattice grid will be created and coordinate system defined based on coordinates indicated on an unregistered raster image.
(2) The lattice grid will be reprojected using a project file to the coordinate system desired for the raster image.
(3) Coordinates will be assigned to the raster image by links to the lattice grid.
(4) An associated file will be created containing the parameters for the affine transformation used to define the image coordinate system.
(5) A new, final registered image will be created when the affine transformation was applied to the first image.
(6) ArcMap will be used to display the final image, the lattice grid, and an obtained image having the desired coordinate system.
(7) The alignment of coordinate tics and surface features will verify that a desired coordinate system is assigned to an unregistered raster image by georeferencing an unregistered image to a coverage with a coordinate system using ArcInfo 9.

6.2.4 Test Results

ArcInfo 9 created a lattice grid to be used for georeferencing a unprojected raster image. The lattice grid was reprojected from geographic coordinates (Figure 4b) to UTM projection desired for the image (Figure 4c). The UTM lattice grid was used to link corresponding points on the raster image, assigning coordinates to those points (Figures 5b,c,d).

The georeferencing of the raster image was performed using ArcMap 9. The image and the lattice grid (UTM grid used in the registration) were opened with the lattice grid as the top layer. The image was viewed at various locations and the lattice grid overlayed the printed coordinate grid of the raster image (Figure 6a). A second test was performed using a Landsat image known to be in the correct projection (UTM, NAD83). The georeferenced image and Landsat image were opened in ArcMap with the georeferenced image as the top layer. The georeferenced image was made partially transparent to verify that geographical features of the Landsat image were overlain correctly and logically by features in the georeferenced image (Figure 6b). If the images were not in the same projection and datum, features such as drainage, roads, and volcanoes would not be aligned.

Test results verify procedure results.

Results Verified By: ___________________________________Date: _____________

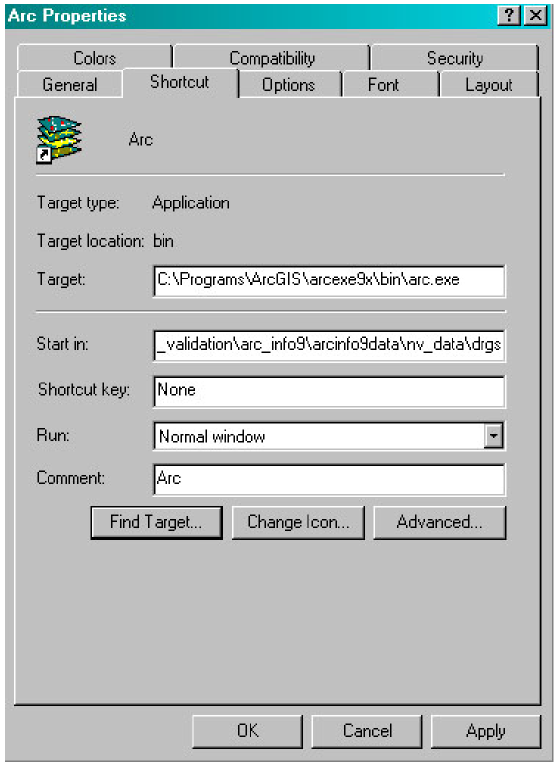

Figure 1a. Set Default Workspace

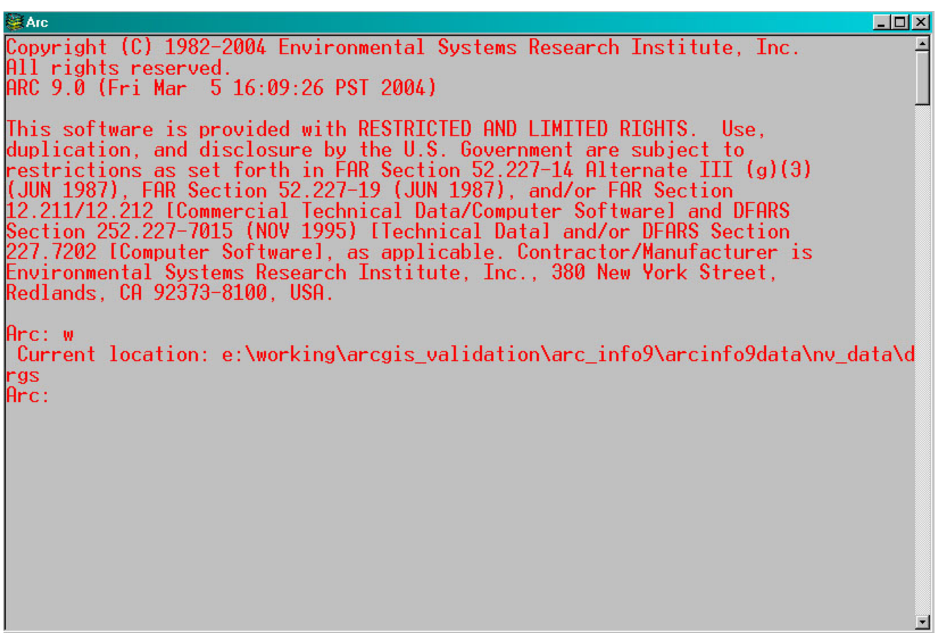

Figure 1b. Confirm Workspace

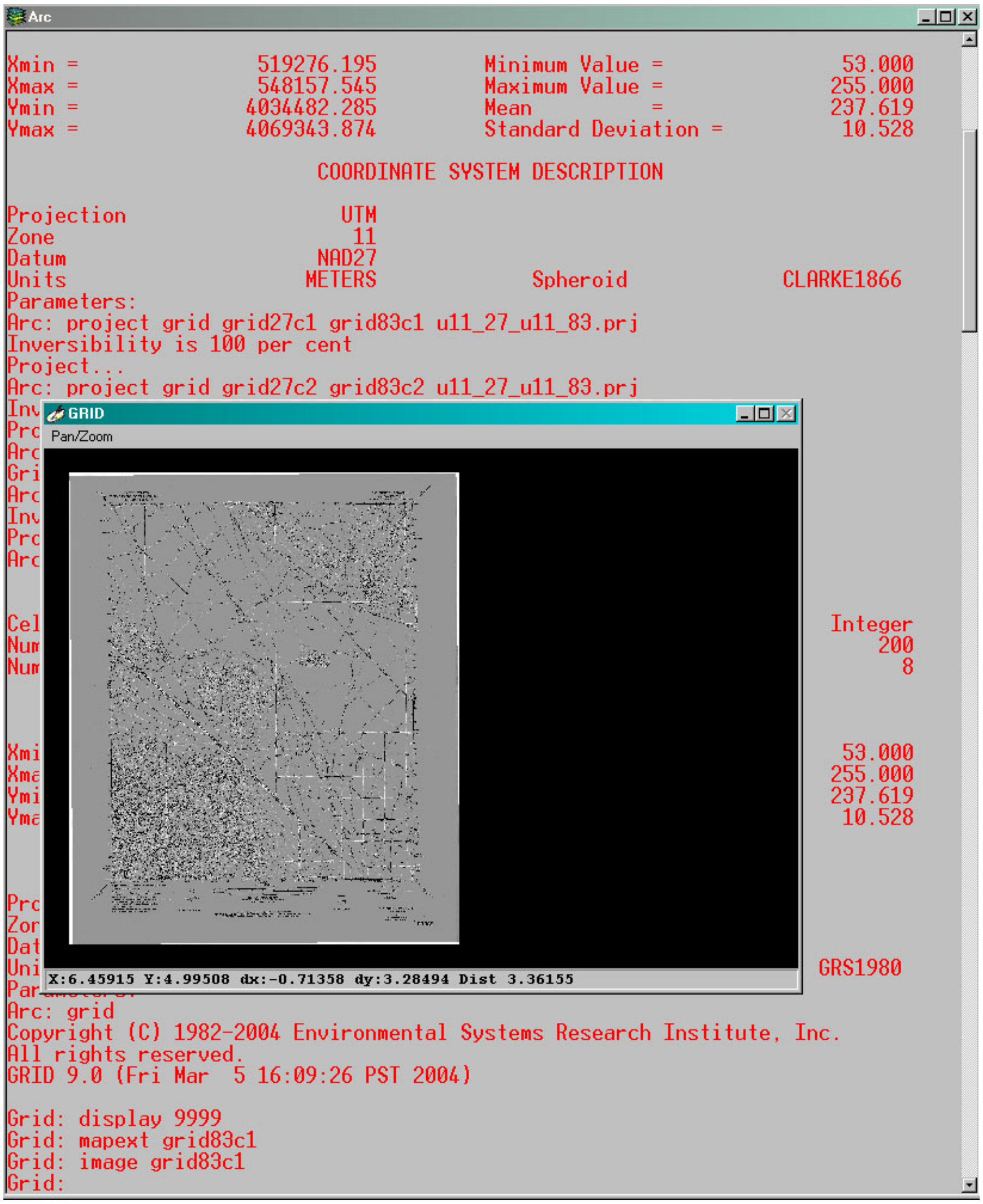

Figure 2a. Display a Grid Using Grid Graphic Display Window

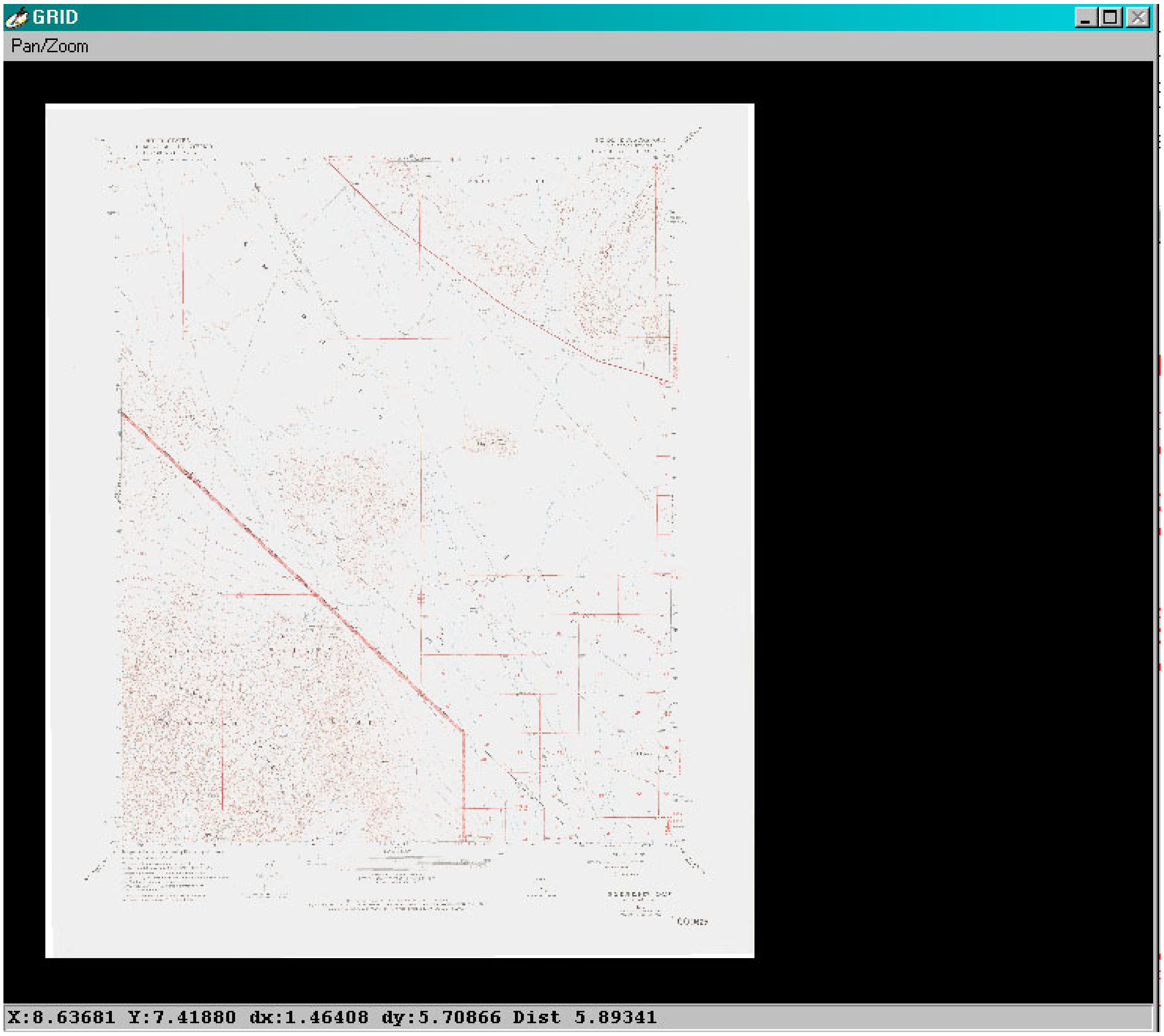

Figure 2b. Preview Final Image Using GRIDCOMPOSITE

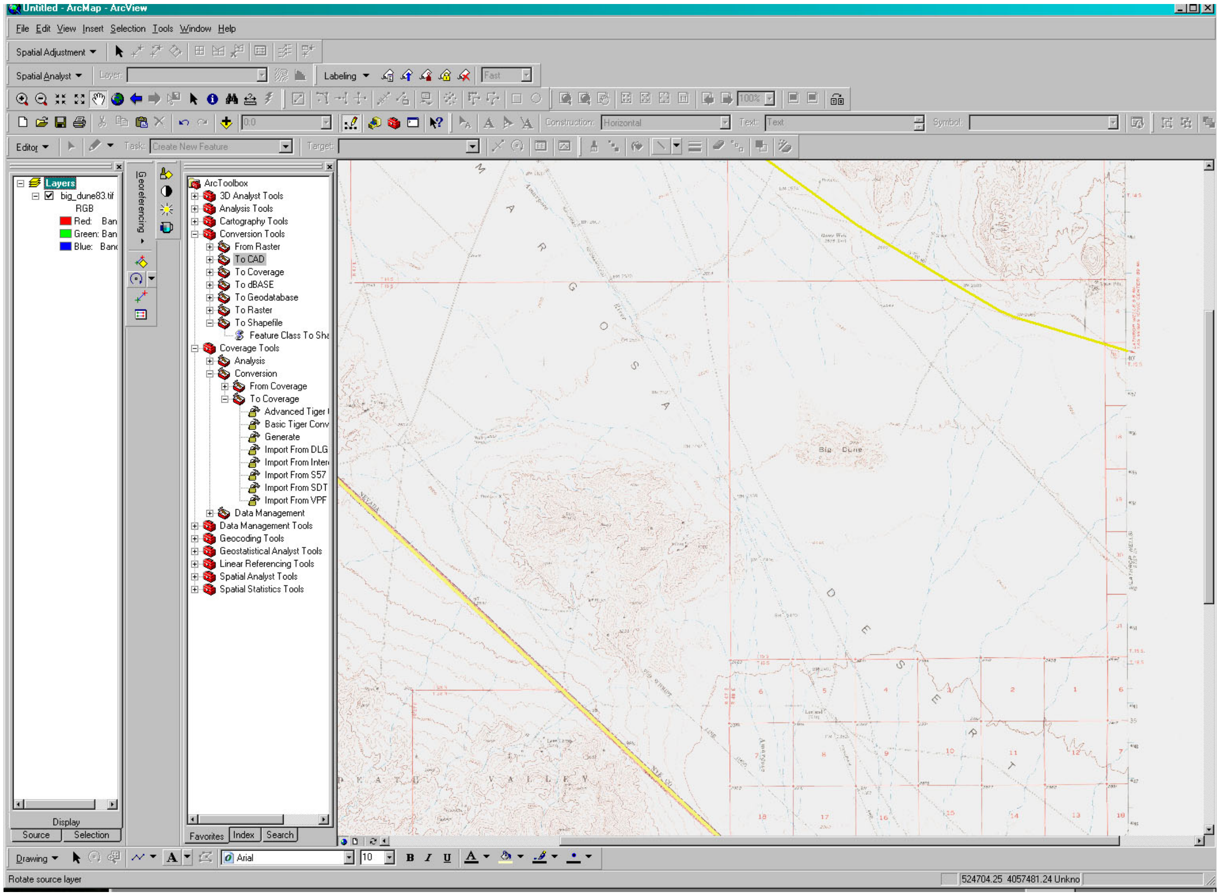

Figure 3a. Created Graphic Lines (Yellow) of Linear Features Made in ArcMap

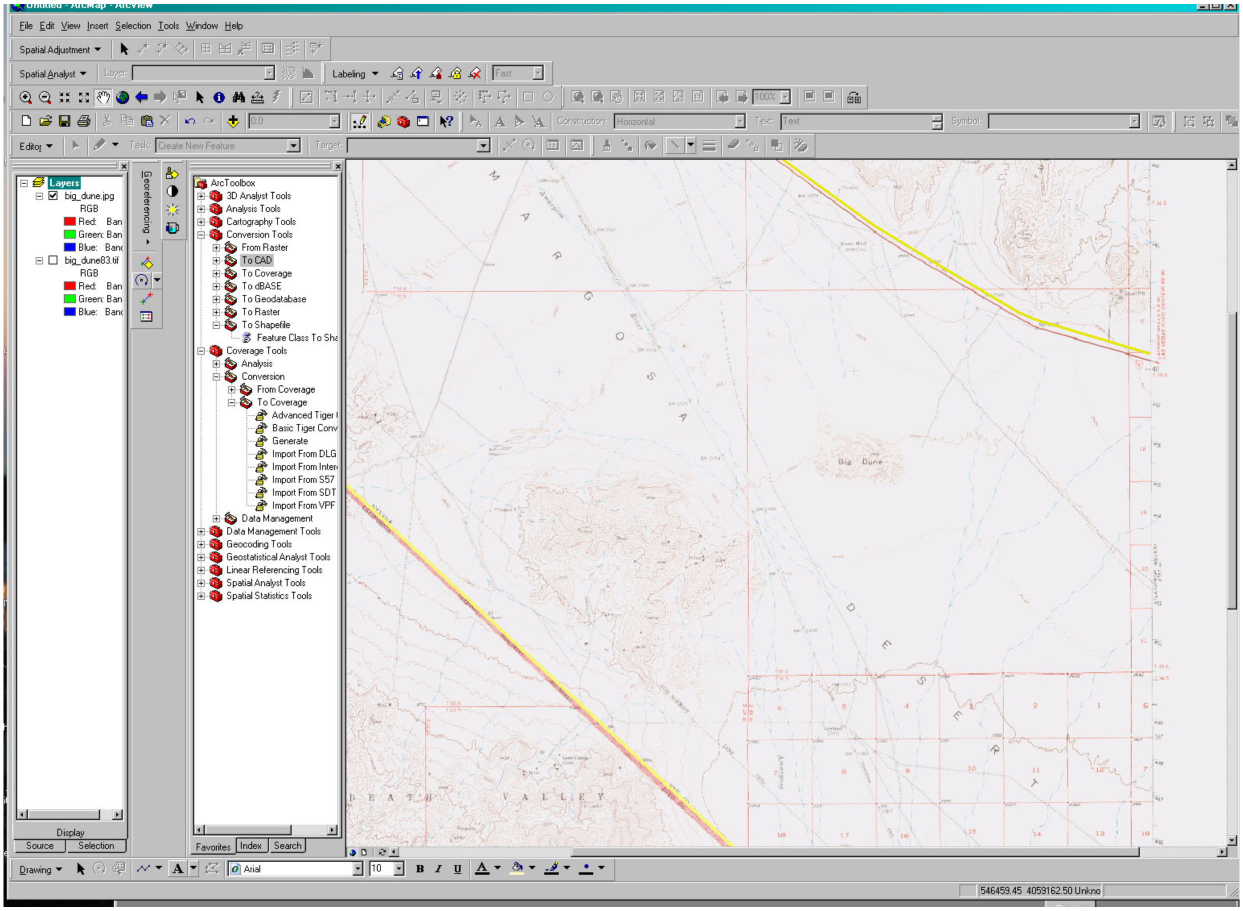

Figure 3b. Comparison of Yellow Graphic Lines Traced From NAD83 Image (*bigdune83.tif*) to NAD27 Image (*bigdune.jpg*). Note That the NAD27 Image Has a Datum Shift to the Southwest.

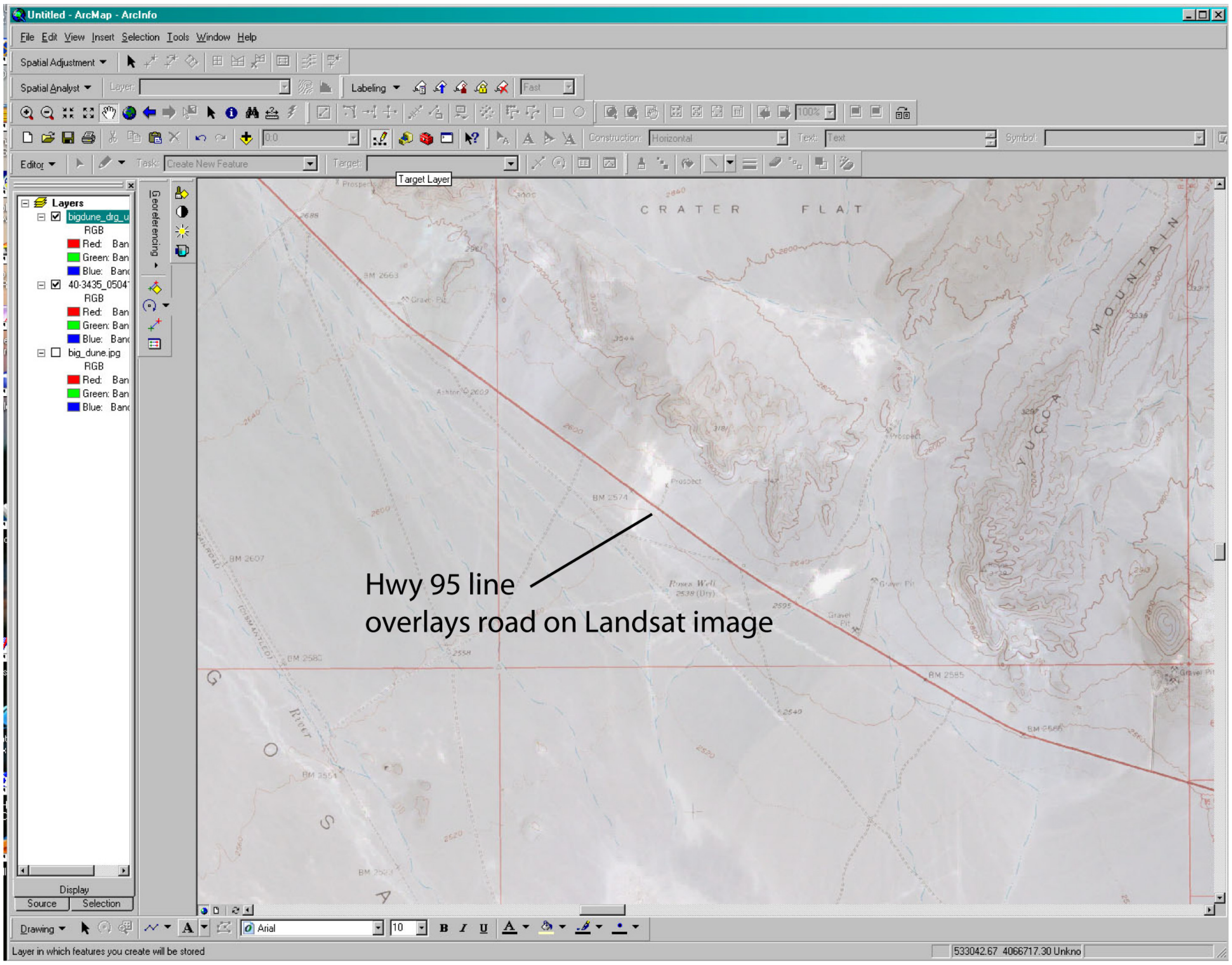

Figure 3c. Comparison of *bigdun83.tif* at 30 Percent Transparency Overlain on Landsat Image *geotif.tif*

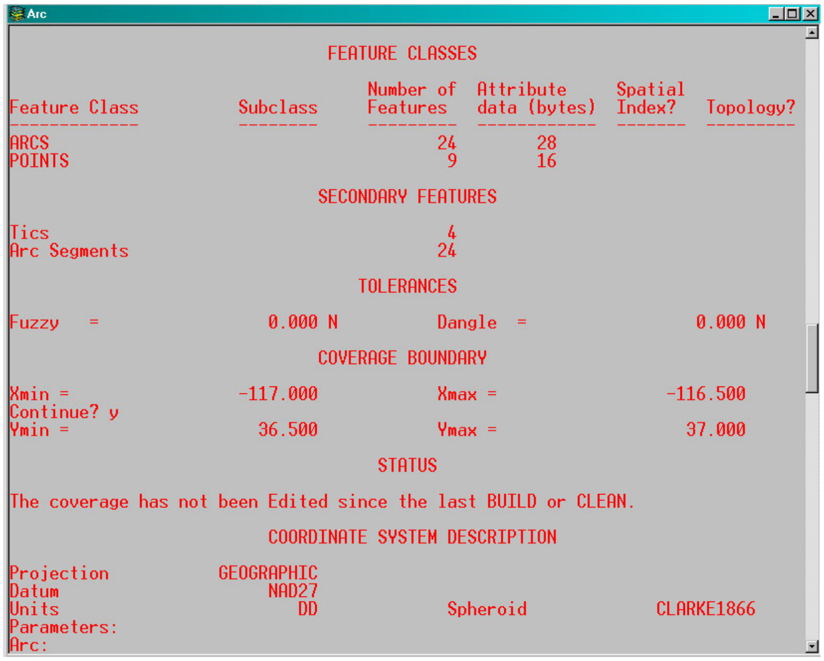

Figure 4a. Results From Command Applied to Describe Completed Generated Geographic Lattice Grid

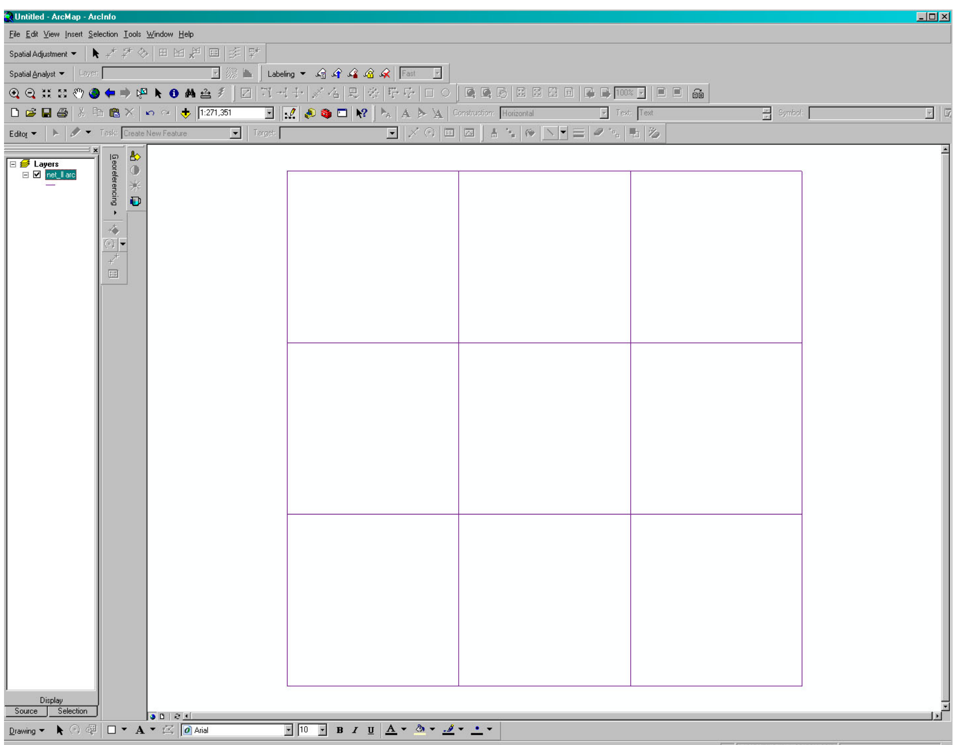

Figure 4b. View of Generated Geographic Lattice Grid, Net_II

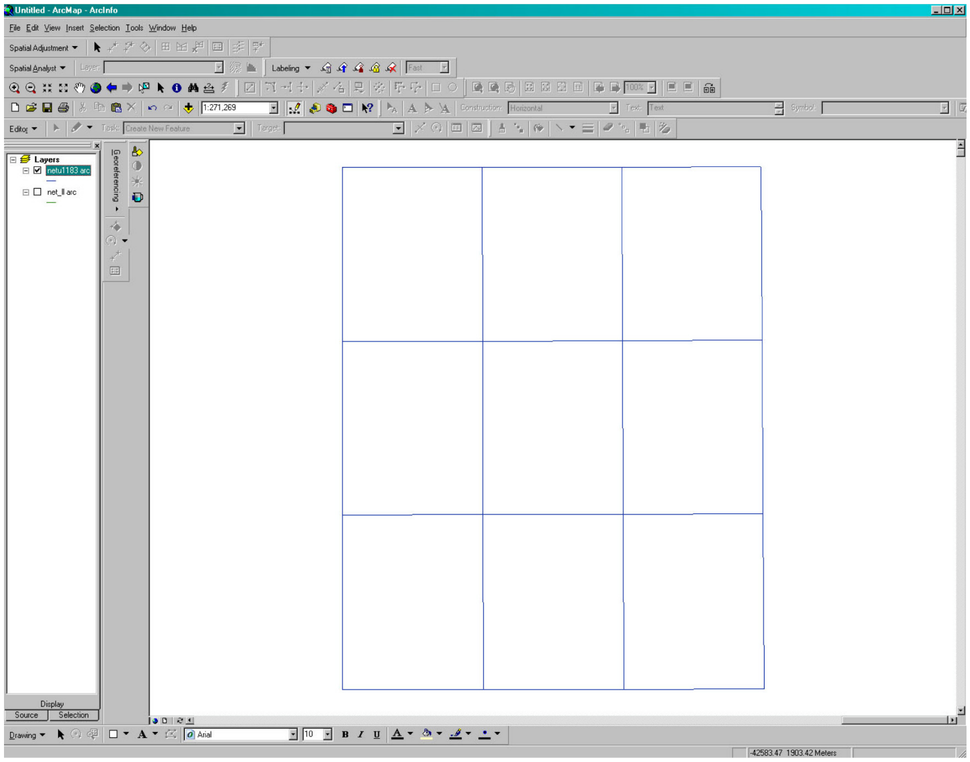

Figure 4c. View of Projected Netu11

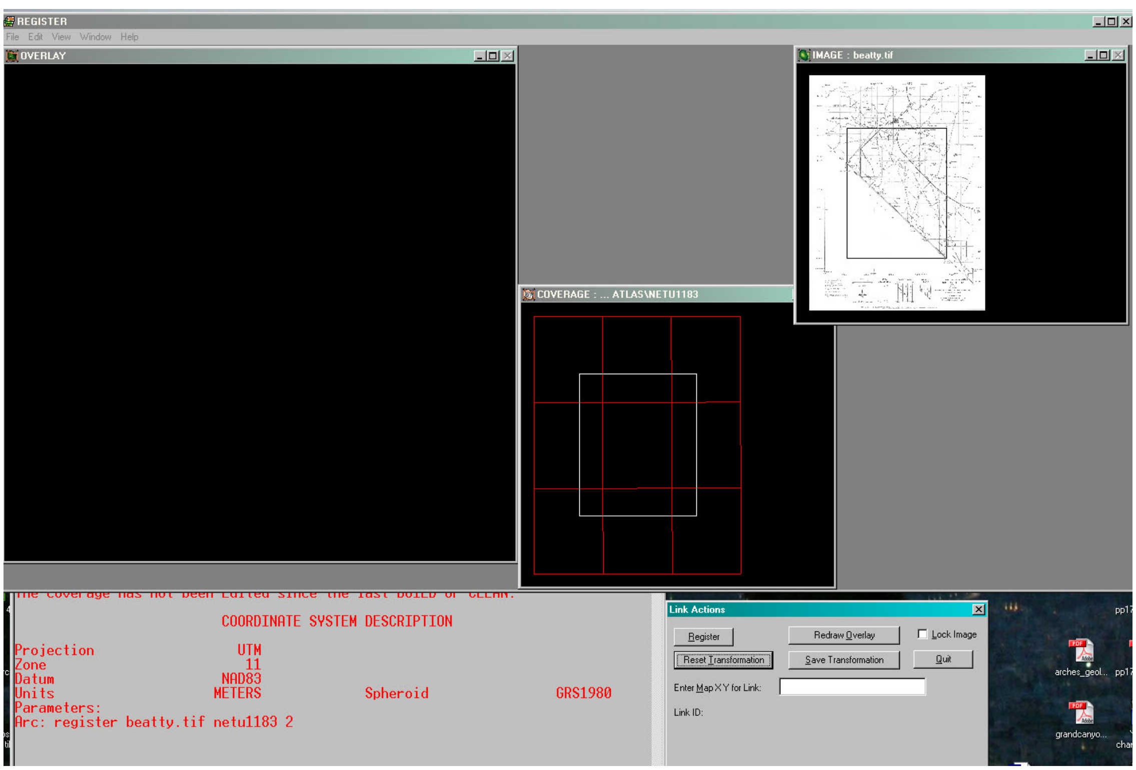

Figure 5a. REGISTER Interactive Windows and LINK ACTIONS Dialogue Window

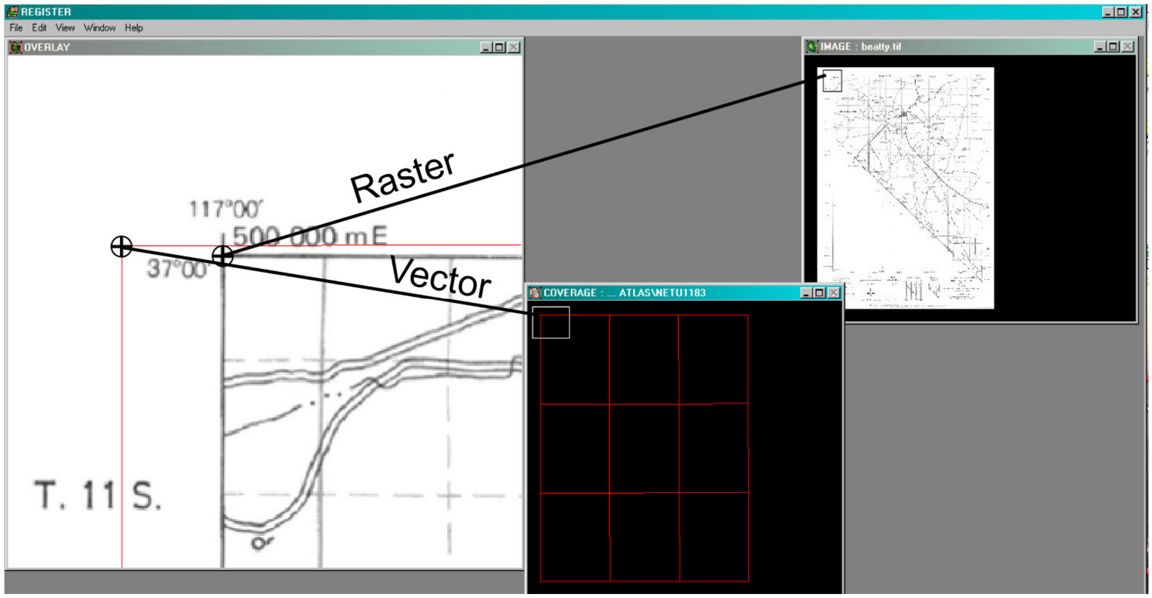

Figure 5b. Selected Areas and Overview of Selection Showing Corresponding Link Points Between Raster and Vector Themes for First Link

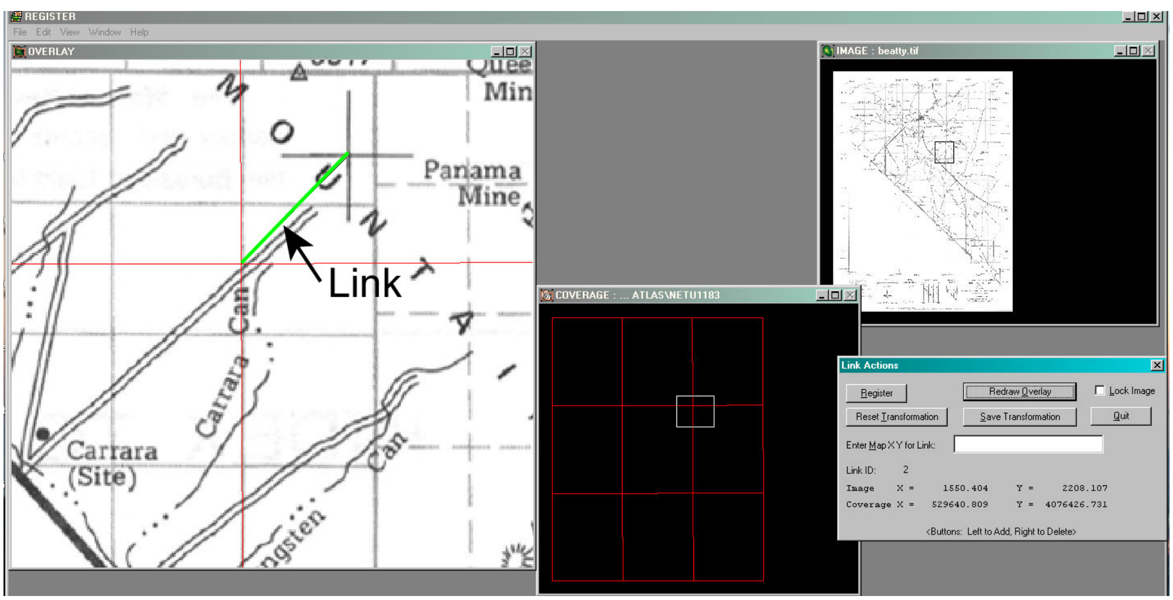

Figure 5c. Second Register Link

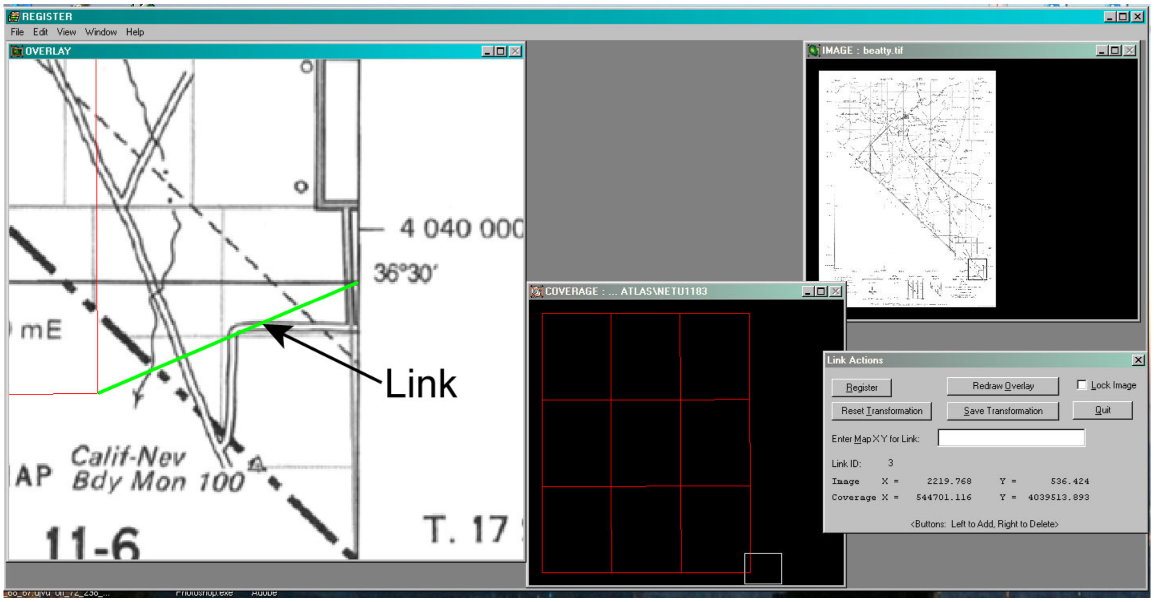

Figure 5d. Third Register Link

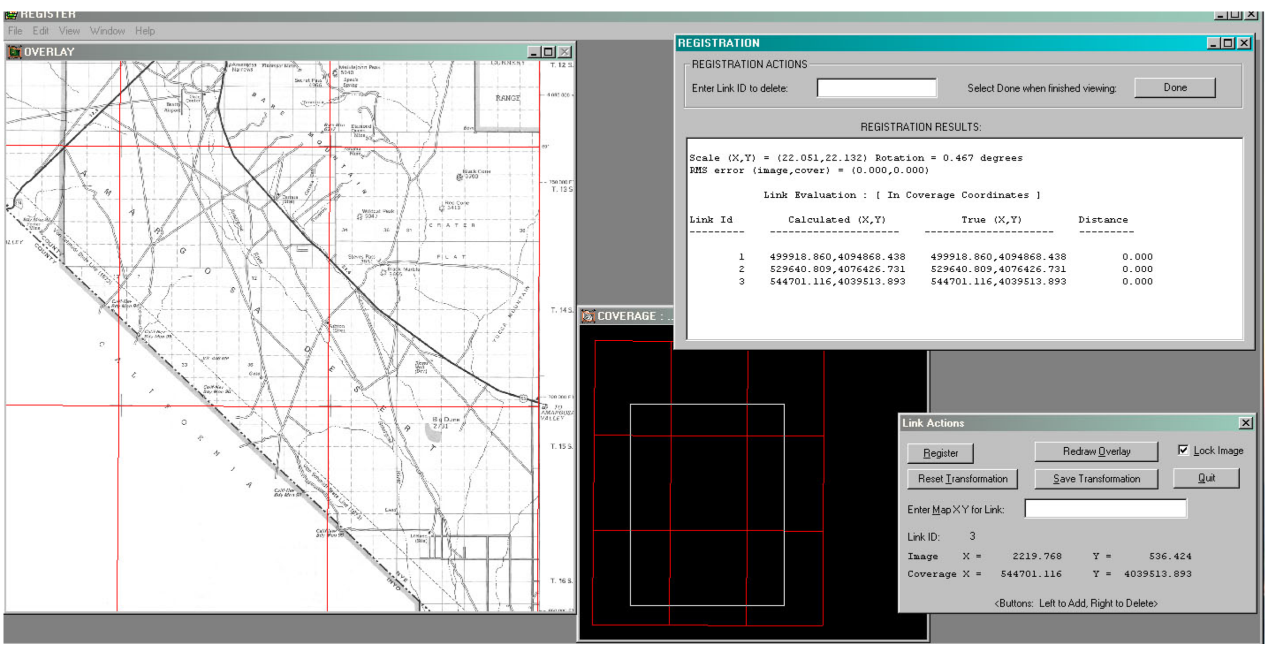

Figure 5e. Coverage and Image Locked and Registered After Three Links

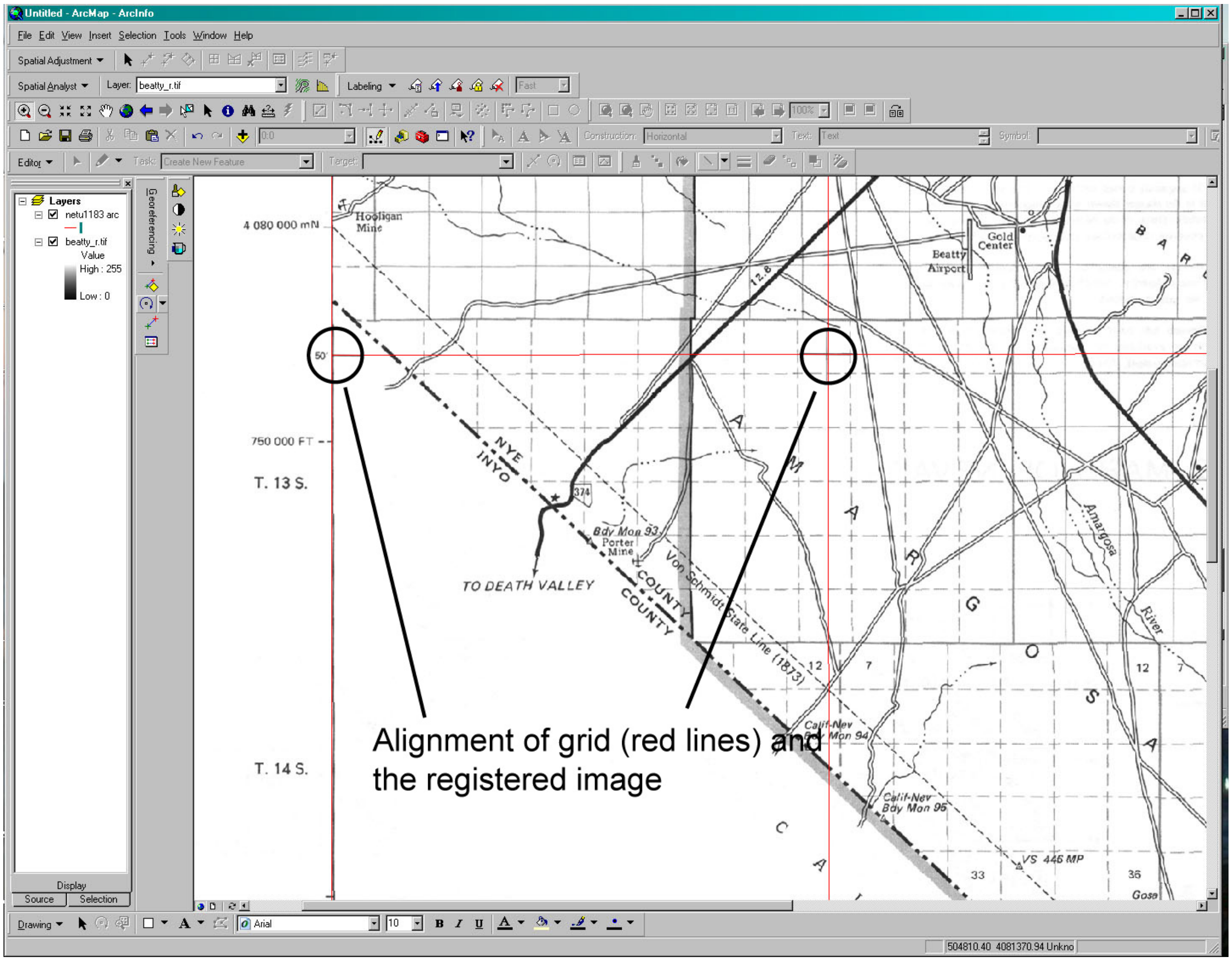

Figure 6a. Comparison Using ArcMap of the Georeferenced Image and the Created Lattice Grid

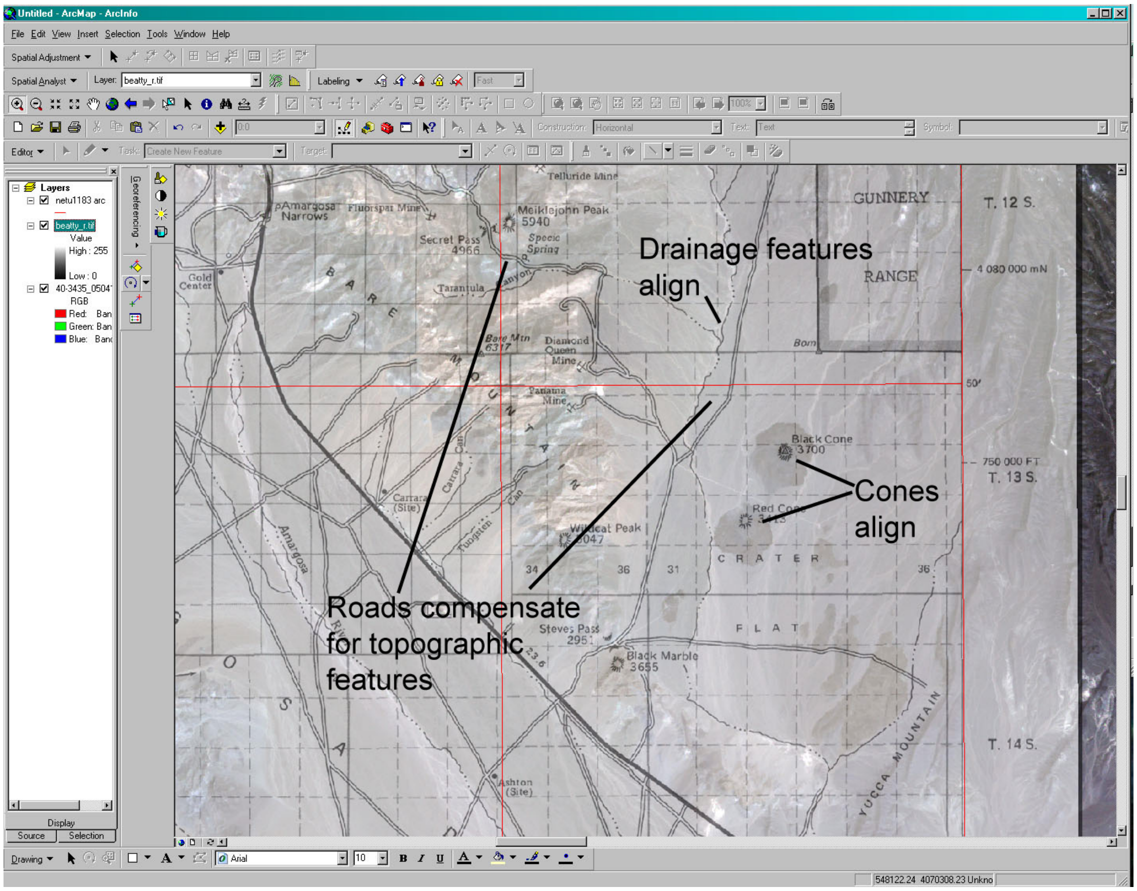

Figure 6b. Surface Features of Underlying Landsat Image Confirm Successful Georeferencing of *beatty.tif* Image