California Environmental Protection Agency
Department of Pesticide Regulation

Pest Management and Licensing Branch

County Information Technology Resources

Permit/Use Mapping Development

Developers Group

The ArcView 3.2a Projection Utility versus Projector! and NADCON Extensions

I. Using data with different projections

DPR, and a number of other state agencies, use a specific projection called the Teale Albers Equal Area projection. The parameters for this projection are:

- 1st Standard Parallel: 34 00 00
- 2nd Standard Parallel: 40 30 00
- Central Meridian: -120 00 00
- Latitude of origin: 00 00 00
- False easting (meters): 0 Datum: **NAD27**
- Spheroid: Clarke 1866
- Units: meters

Most of California's counties use the State Plane coordinate system (**NAD83**) which is based on a Lambert Conformal Conic projection (units: feet).

Depending on whether the county is using NAD 83 or NAD27, the State Plane coordinate system divides the state into 6 (or 7) zones. Because each zone is separate, spatial data from counties in different zones are not within the same geographical space, and so cannot be overlaid.

Spatial data in the Teale Albers projection needs to be re-

State Plane Zones in California

NAD 83 Zones
1
2
3
4
5
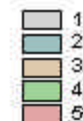
projected if it is to overlay data in the State Plane
Coordinate system.

What are NAD 27 and NAD 83?

According to the National Geodetic Survey the North American Datum of 1927 (NAD 27) is defined as "The *horizontal control datum* for the United States that (was) defined by (a) location and azimuth on the Clarke spheroid of 1866, with origin at (the survey station) Meades Ranch." ...The geoidal height at Meades Ranch (was) assumed to be zero."

Geodetic positions on the North American Datum of 1927 were derived from the (coordinates of and an azimuth at Meades Ranch) through a readjustment of the triangulation of the entire network in which Laplace azimuths were introduced, and the Bowie method was used." (Geodetic Glossary, pp. 57)

The North American Datum of 1983 (NAD 83) is "The *horizontal control datum* for the United States, Canada, Mexico, and Central America, based on a geocentric origin and the *Geodetic Reference System 1980.*

"This datum, designated as NAD 83, is the new geodetic reference system...NAD 83 is based on the adjustment of 250,000 points including 600 satellite Doppler stations which constrain the system to a geocentric origin." (Geodetic Glossary, pp 57)

Why did NGS change from NAD 27 to NAD 83?

NAD 83 was computed by the geodetic agencies of Canada (Federal and Provincial) and the National Geodetic Survey for several reasons. The horizontal control networks had expanded piecemeal since 1933 to cover much more of the countries and it was very difficult to add new surveys to the network without altering large areas of the previous network. Field observations had added thousands of accurate Electronic Distance Measuring Instrument (EDMI) base lines, hundreds of additional points with astronomic coordinates and azimuths, and hundreds of Doppler satellite determined positions. It was also recognized that the Clarke Ellipsoid of 1866 no longer served the needs of a modern geodetic network. For an in-depth explanation see NOAA Professional Paper NOS 2 "The North American Datum of 1983", Charles R. Schwarz, Editor, National Geodetic Survey, Rockville, MD 20852, December 1989.

How do the horizontal datums differ?

The NAD 27 was based on the Clarke Ellipsoid of 1866 and the NAD 83 is based on the Geodetic Reference System of 1980. The NAD 27 was computed with a single survey point, MEADES RANCH in Kansas, as the datum point, while the NAD 83 was computed as a geocentric reference system with no datum point. NAD 83 has been officially adopted as the legal horizontal datum for the United States by the Federal government, and has been recognized as such in legislation in 44 of the 50 states. The computation of the NAD 83 removed significant local distortions from the network which had accumulated over the years, using the original observations, and made the NAD 83 much more compatible with modern survey techniques.

SUMMARY NOTES:

- ○ Currently, the Teale Data Center, which has provided much of the statewide GIS data to date, and many state agencies including DPR use NAD 27.
- ○ To transform data from the Teale Albers projection to any other projection, one needs to consider not only the projection/coordinate system, but also the datum.
- ○ Using ArcViewGIS 3.2 there are two ways to re-project data. Users can either use the Projection Utility or a combination of unsupported ArcView extensions, Projector! and NADCON.

II. Using the ArcView Projection Utility shipped with ArcView 3.2

NOTE: There is an ArcView 3.2a Projection Utility patch available from ESRI at:
http://www.esri.com/software/arcview/avsoftware.html#av32apatch

The first point to note is that the Teale Albers Projection is not among the standard projections included in the projection utility library. Therefore a "custom" .prj file must be created for any shapefile requiring re-projection. The .prj file can be built from within the utility, however, rather than investing valuable time figuring out how to do this, Melita Kennedy at ESRI provided a .prj file with the correct specifications which can be found on DPR's GIS and Permit/Use Mapping Development web site http://www.cdpr.ca.gov/docs/county/pumpdvlp/pumpmenu.htm or as follows:

```
PROJCS["Teale_Albers",GEOGCS["GCS_North_American_1927",DATUM
["D_North_American_1927",SPHEROID["Clarke_1866",6378206.4,
294.9786982]],PRIMEM["Greenwich",0],UNIT["Degree",
0.017453292519943295]],PROJECTION["Albers"],PARAMETER
["False_Easting",0],PARAMETER["False_Northing",-4000000],
PARAMETER["Central_Meridian",-120],PARAMETER
["Standard_Parallel_1",34.0],PARAMETER["Standard_Parallel_2",40.5],
PARAMETER["Latitude_Of_Origin",0],UNIT["Meter",1]]
```

This information needs to be placed in a text file named the same name as that of the shapefile with a .prj filetype extension (i.e. plsnet.shp will have a corresponding projection file plsnet.prj) and placed in the same location as the shapefile. The .prj file now becomes an important shapefile component, and must be carried along with the .shp, .shx and .dbf files.

A. Running the ArcView Projector Utility

Loading:

- ▪ The utility, which is wizard based, is very slow to load.
- ▪ If there are directories in the folder tree with spaces (such as d:/projection demo/shape1.shp), an error message will indicate that this shapefile cannot be opened as it is the wrong file type. The utility will continue to load, and the user will have the opportunity to go back

and find the necessary shapefiles.

Step 1: Selecting the Shapefiles
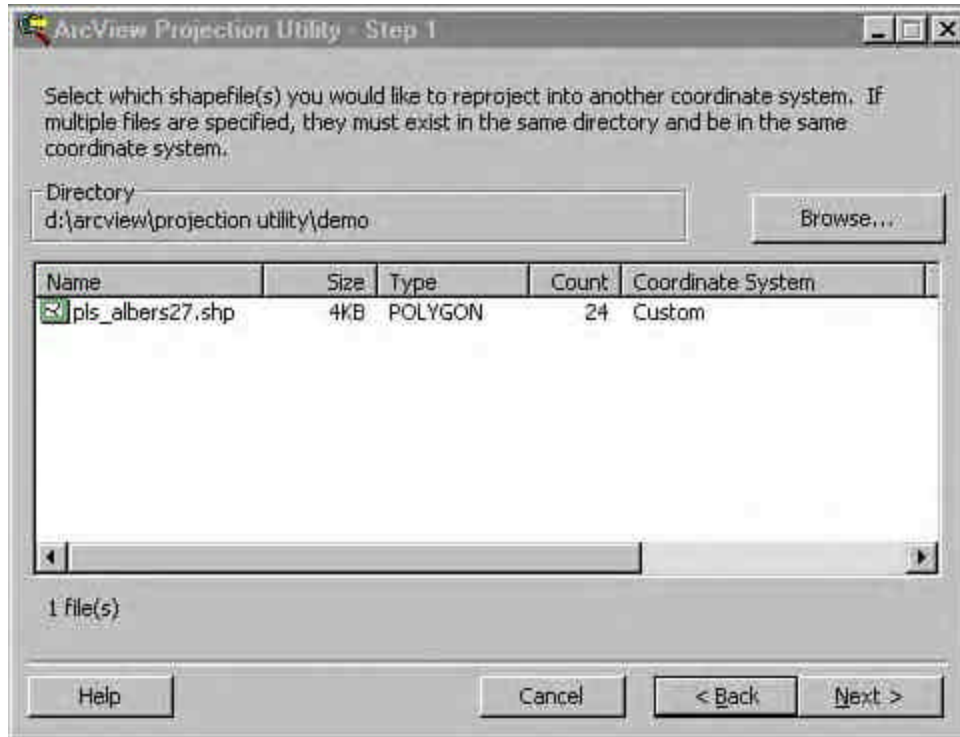
- The dialog box allows users to select shapefiles for re-projection. One or more can be selected provided the same transformation is performed on each one. In addition, the shapefiles do not have to be in the currently opened project.
- Select the shapefile(s) using the *Browse* button, using the shift key to select more than one shapefile.
- If the shapefile has no .prj associated with it, the coordinate system type will be set to "unknown".
- If the shapefile has a .prj file associated with it, the Projection Utility will check its substantial library looking for that projection. The Teale Albers projection is not a standard in the Projection Utility library, and so, after checking the entire library, it will assign a "custom" coordinate system type. Although the .prj file actually has a name other than custom (in this case "Teale_Albers"), the Projection Utility (PU) doesn't seem to recognize this.
- Select one (or more) of the shapefiles, and click *Next*.
- If the coordinate systems of the shapefiles in the dialog box do not match, non-matching shapefiles will need to be removed before the PU will move to step 2.

Step 2: Setting up the Input Projection
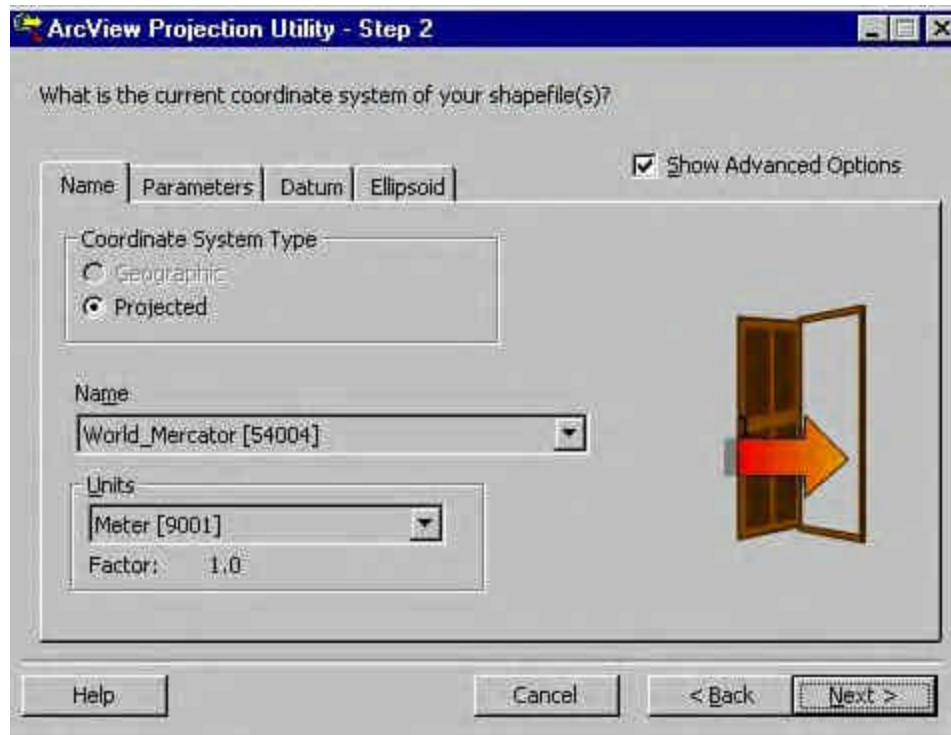
- Progression to Step 2 will be slow if the shapefiles have a custom projection, because the PU must search the entire library looking for a match.
- The dialog box in Step 2, allows users to enter the parameters of the shapefile if no associated .prj file exists.
- If the shapefile has a .prj file the users ability to change the name/projection/datum/ellipsoid are disabled. It should be noted, however, that even though the associated .prj file contains information for the Teale Albers projection, the name of the projection appears as World_Mercator [54004], and all the corresponding settings in the Parameters, Datum and Ellipsoid windows reflected the World_Mercator projection, and not the parameters included in the TealeAlbers.prj file. This is very confusing to the user, but is actually false information and should be overlooked.
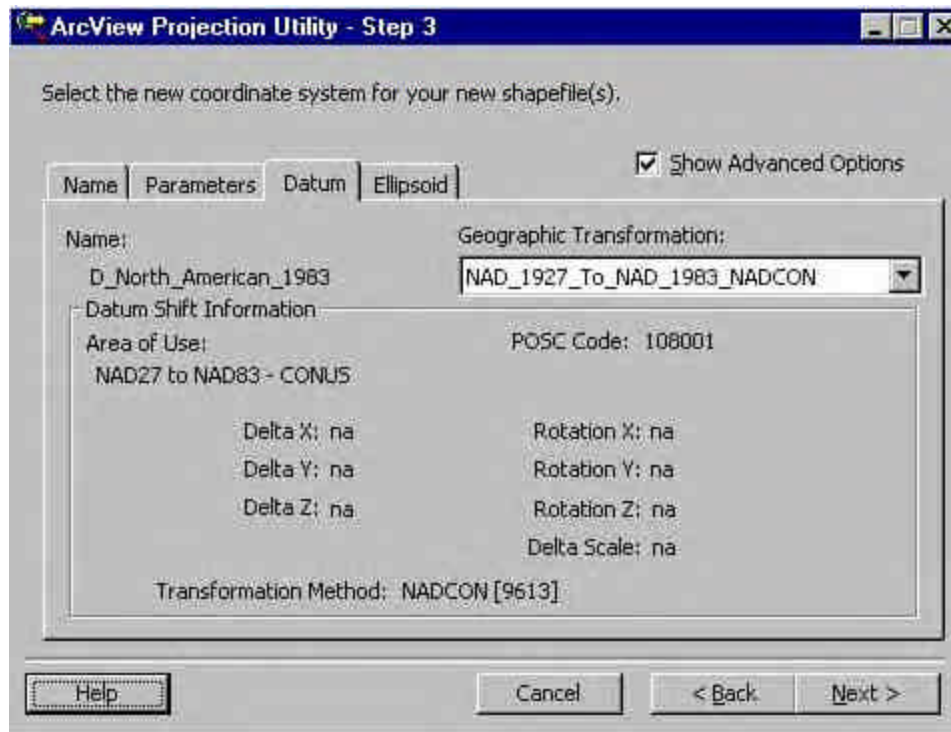- Click *Next* to move to Step 3.

Step 3: Setting up the Output Projection
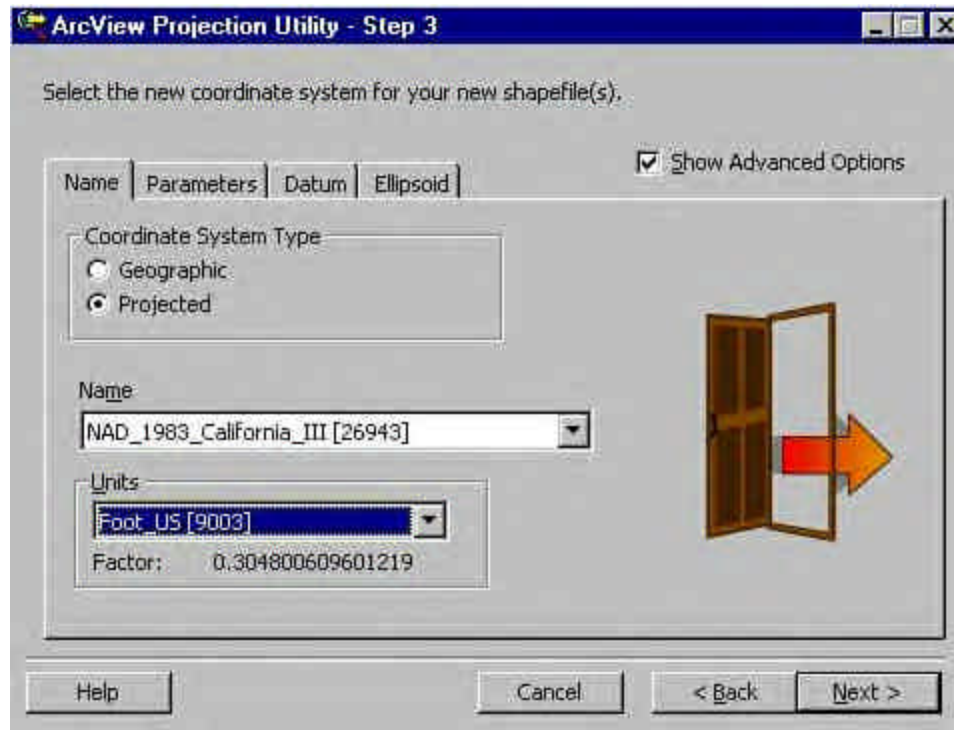
- Name Tab **Coordinate System type**: Projected--This is selected if the shapefile is top be re-projected to another projection. If the shapefile is to be re-projected to Lat/Long coordinates select Geographic.
  Name: NAD_1983_California_III--The drop down list contains most of the standard projections.
  Units: Foot_US--NAD83 with feet, which is used by many CA counties, is not a PU library standard. As a result the PU will create a "Custom" projection. In the PU library standard State Plane projections use meters.

- Parameters Tab The fields are automatically populated using the parameters of the chosen projection. The PU allows the user to modify some of the parameters, but this is not usually necessary.

- Ellipsoid Tab--No user input is generally required.

- Datum Tab

  The Teale Albers projection uses the NAD27 datum. Any transformation between NAD27 and NAD 83 or WGS84, will require the use of the PU's NADCON (NAD conversion) transformation located under the Datum tab. Use of this tab is complicated because the PU is

showing the user the parameters for the World Mercator projection which uses the WGS84 datum, so the user must manually select the appropriate transformation and not rely on the PU prompt.

To transform the data from NAD27 to NAD83, the user should select NAD_1927_To_NAD_1983_NADCON.

- After selecting the appropriate settings, click *Next* to move to Step 4.

Step 4: Saving Shapefiles

- Use the browse button to locate the directory to where the newly projected shapefiles will be written.
- Click *Next* to move to Step 5.

Step 5: Summary

- Step 5 provides a summary of the projection transformation. As before the PU refers to the World Mercator projection as the input

projection. In spite of all appearances to the contrary, however, the final transformation will use the TealeAlbers.prj and the correct re-projection will take place.

- Click *Finish*, and the wizard will vanish (as all good wizards should!). After several seconds a dialog box which monitors the projection process will appears in the upper left-hand corner of the screen. The projection may take several minutes, particularly large or complex shapefiles.
- Finally, a clickable box will inform the user that the processing is complete. Click *OK*.
- The subsequent dialog box will ask the user if the data should be added to the project.

    Comments:
    - The PU is cumbersome and slow.
    - ESRI has experienced problems adding new projections (such as Teale Albers) to the PU Library.
    - ESRI is developing a predefined coordsys for NAD83 SPCS using feet, but it has yet to be included in the PU.

B. Using the Projector! and NADCON Extensions

The Projector! extension (prjctr.avx) is an unsupported extension that is shipped with ArcView as a sample Extension. It can be found in the ...\arcview\samples\ext directory, and should be moved to the ..\arcview\ext32 directory for use.

The Projector! Extension can be used to re-project data from one projection coordinate system to another **provided the to- and from-projection systems have the same datum**. However, if the data is to be re-projected to a system using a different NAD, say from Teale Albers NAD 27 to State Plane, Zone3, NAD83, a second extension, the NADCON extension, must be used.

The NADCON extension is an Avenue implementation of NOAA's NADCON program; it transforms lat/long shapefiles from NAD27 to NAD83 and vice versa, and can either be downloaded from the ESRI ArcScripts site (http://gis.esri.com/arcscripts/scripts.cfm) or from DPR's GIS and Permit/Use Mapping Development web site (http://www.cdpr.ca.gov/docs/county/pumpdvlp/arcvwitm/extentls.htm).

Important Points:
- It is extremely important for ArcView users to understand that ArcView's projection engine does **not** inherently support datum transformation. The following is from the online help under "datums", "working with datums": "When a projection associated with a certain spheroid is used, ArcView **assumes** that the decimal degrees data being projected was collected in a datum based on that spheroid."
- Thus, for example, if your data in Decimal Degrees (DD) were collected in NAD27 and you're attempting to project your view to a projection using NAD83, you will not get correct coordinates.
- Similarly, if you were to attempt to use ArcView's Projector! extension to convert between two projections based on different datums, you will not get correct results.
- The Datum Converter extension (located in ArcView's "samples\ext" directory) is a port of the Molodensky 3-parameter transformation.

This extension is appropriate for conversion between most standard datums **except** between NAD27 and NAD83.
- The NADCON Extension is a port of NOAA's NADCON program for converting coordinates within the United States between NAD27 and NAD83.

Step 1: Adding the Teale Albers Projection to ArcView's default projection library.

The Projector! extension has a problem in the form menu. The default spheroid is listed as *Clarke 1866*, which is correct for the Teale Albers projection, however unless you pull this menu down and redundantly select *Clarke 1866*, the menu passes *Sphere* to the projection engine, and the resulting projection is incorrect.

A script available on DPR's GIS and Permit/Use Mapping Development web site http://www.cdpr.ca.gov/docs/county/pumpdvlp/pumpmenu.htm) will either append the Teale Albers Projection to the system-wide default.prj ($AVHOME/etc/default.prj) or create or append to a user default.prj ($HOME/default.prj) file. This makes the Teale Albers one of the selectable standard projections.

To add the Teale Albers projection to the default.prj:
   a. in a project, open a blank script window
   b. cut and paste the script into the blank window
   c. compile the script by clicking the compile button
   d. run the script and follow the prompts to save the file
   e. close and do not save the project

Step 2: Converting the Teale Albers NAD27 data to Decimal Degrees Using the Projector! Extension

   1. Make sure the Projector! Extension has been loaded into the project.
      The Projector! Extension will place a button at the right hand end of the buttonbar.

   2. In the Table of contents activate the theme that is to be re-projected.
   3. Make sure the *View Properties/ Map Units* are set correctly, in this case to *meters*.
   4. Click the Projector! button.
   5. Dialog box--Click OK.
   6. Projection Properties

- Select the Teale Albers Projection from the Category dropdown list. Click OK.

7. Pick Output Units

- Choose decimal degrees. Click OK.

8. Dialog Box: Recalculate area, perimeter, and length fields (if present) using decimal degrees? Optional.
9. Dialog Box: Add Projected shapefile(s) as theme(s) to a view? Click Yes.
10. Select <New View> or a view where data in decimal degrees currently reside. Click OK.
11. Choose a name for the shapefile that reflects it's current projection and datum status (e.g. theme_dd27.shp).

Step 3: Transforming the Datum Using the NADCON Extension

12. Make sure the NADCON extension has been loaded into the project. The NADCON Extension will place an additional menu choice at the bottom of the *Theme* menu.
13. With the decimal degree view open and the interim theme selected, select the *Theme/NADCON* menu choice.
14. Locate the Lat/Long Grid file (conus.dbf)
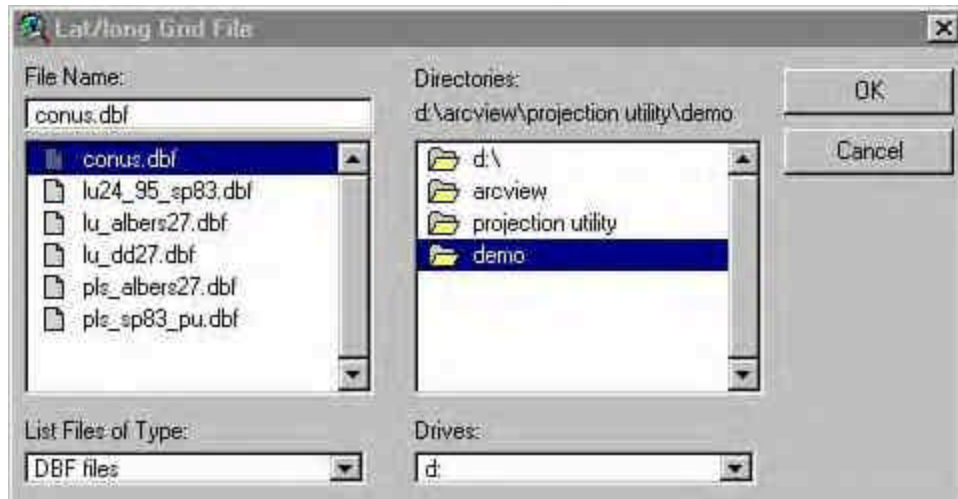
- The files, conus.dbf and conus.prm, can be located together in any directory. If multiple transformations are going to be performed, locate these files in a convenient location to minimize searching directories. Click OK.

15. Select Transformation Option

- Choose NAD27 to NAD83

16. Dialog Box: Add Transformed shapefile(s) as theme(s) to a view? Click Yes.

17. Select the view where the data in decimal degrees currently resides. Click OK.
18. Choose a name for the shapefile that reflects it's current projection and datum status (e.g. theme_dd**83**.shp).
19. The status bar will note the progress of the data transformation. **IMPORTANT NOTE:** Large shapefiles, such as county-wide parcels, will take a very long time to transform (several hours).
20. The new shapefile is placed in the same view as the NAD27 shapefile, enabling the user to see the differences between the layers.
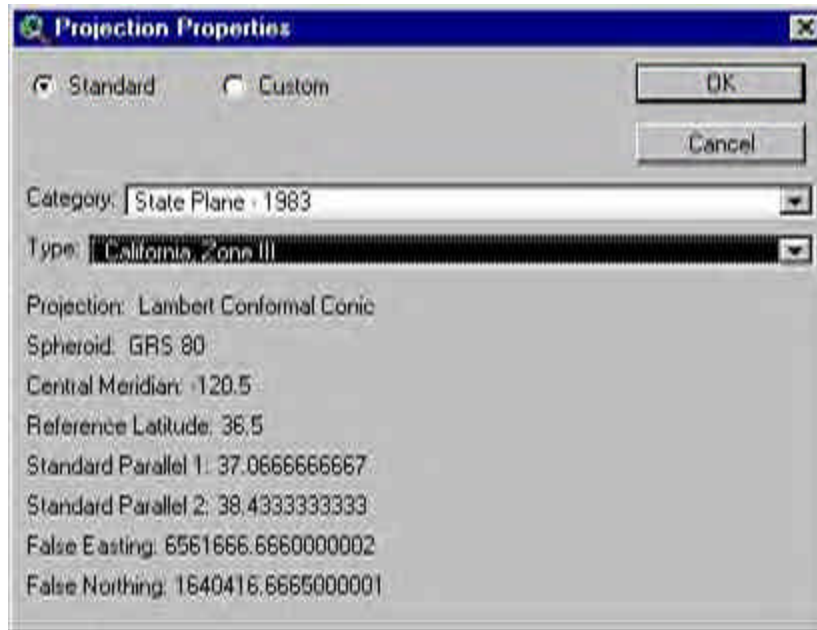
Step 4: Converting the Decimal Degree data to State Plane, Zone III, NAD83 using the Projector! Extension

21. With the new shapefile (e.g. theme_dd83.shp) in the decimal degree view active, click the Projector! button.
22. Output Units

- Select Feet

23. Projection Properties

- Select "State Plane--1983" from the *Category* dropdown list, and California, Zone III from the *Type* dropdown list.

24. Dialog Box: Recalculate area, perimeter, and length fields (if present) using decimal degrees? Optional.
25. Dialog Box: Add Projected shapefile(s) as theme(s) to a view? Click Yes.
26. Select <New View> or a view where data in State Plane Zone III, NAD83 currently reside. Click OK.
27. Choose a name for the shapefile that reflects it's current projection and datum status (e.g. theme_sp83.shp).