

# 15 Earthwork

Now that we have final cross sections, we can calculate earthwork for this roadway. In the first part of this exercise, we will go through the procedures to calculate cut & fill quantities where only earth is involved. In part 2, we have a set of cross sections pre-defined on which rock lines have been plotted and some deep cut benching has been developed for the roadway. We will use this data set to process some earthwork where multiple soil types are involved.

## NOTE:

Several special non-roadway typical sections are available for plotting rock lines, topsoil lines, existing pavement or un-suitable material onto cross sections using the proposed cross section tool. In the typical list their names all start with P\_ (for plot).

## I.) Earth Only

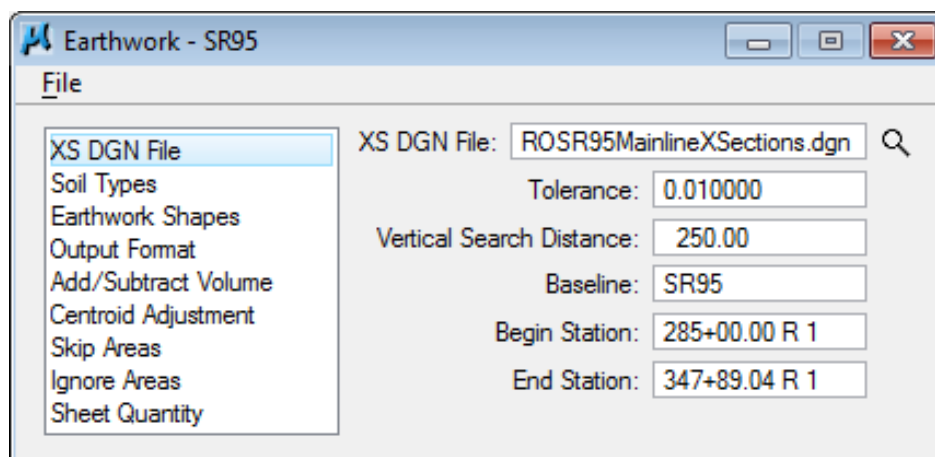
- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\ROSR95MainlineXSections.dgn

Access Project Manager.

- 2) Choose Earthwork from the Project Manager dialog and create a new run named SR95.

- 3) Populate the XS DGN File section of the dialog as shown below (most settings should fill in automatically from our working alignment definition):



NOTE:

The Vertical Search Distance should never be set at a value greater than 1/2 the distance between cross sections. In our cross sections, that offset distance is 500 feet so we use 250 feet.

If set greater than that, it is possible graphics for one section will be read by the one before or after it. If your graphics go past this half way point, then cross sections will need to be re-generated at a larger distance apart so that the vertical search distance can be set at a higher value.

- 4) In the Soil Types section of the dialog, create the following classifications and soil types utilizing the parameters detailed in the table below.

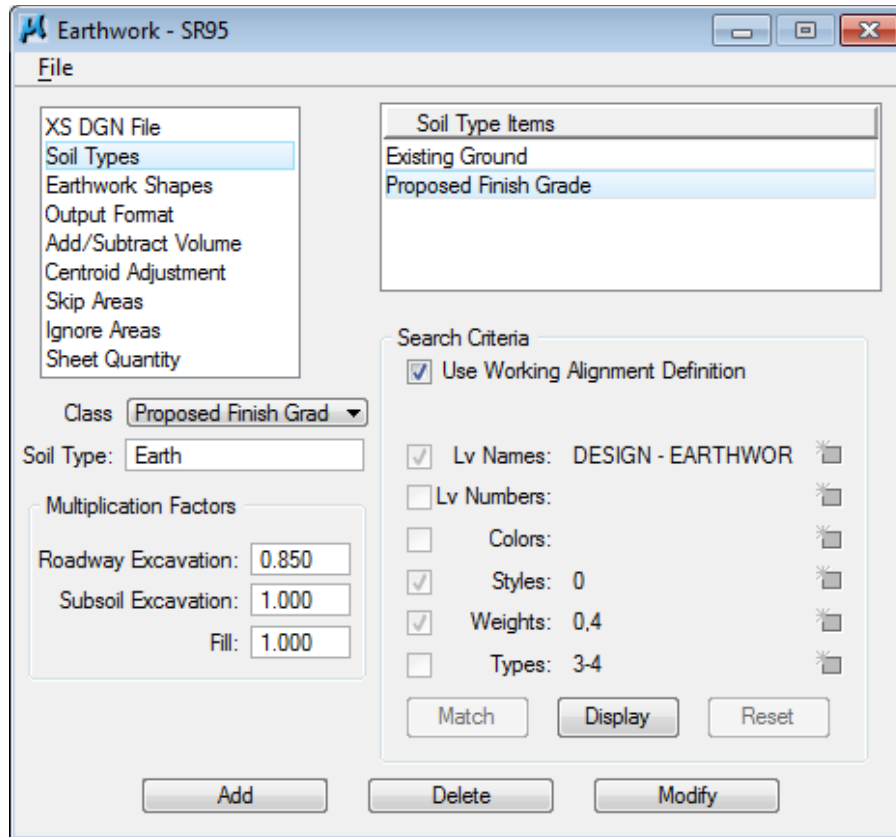
| Class                 | Soil Type | Search Criteria                  |
|-----------------------|-----------|----------------------------------|
| Existing Ground       | Earth     | Use Working Alignment Definition |
| Proposed Finish Grade | Earth     | Use Working Alignment Definition |

Shrink and Swell factors are set under the Multiplication Factors section. Factors are based on 1 so for a shrinkage of 15% you would set the value 0.85. Set the Multiplication Factor for Roadway Excavation with a value of 0.85. Once a definition is set click the Add button.

NOTE:

If topsoil stripping is desired under fills then you must define Excavation Limit lines in this section. It is the only class that is not an actual soil type. Excavation limit lines are placed by default at slope tie-ins on T.D.O.T. cross sections. The topsoil line itself should be defined as an unsuitable material so that it would not be used as fill material.

## Exercise 15



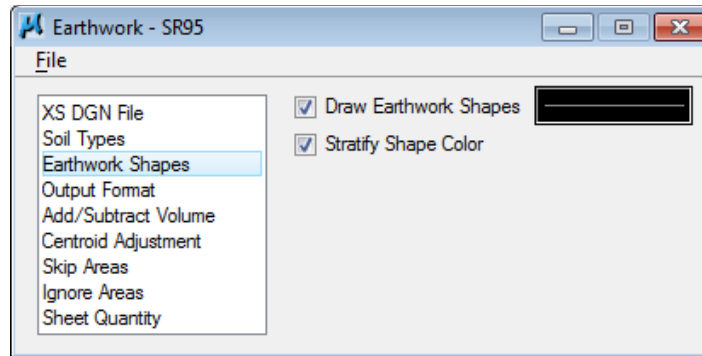
In our case, we are using the Working Alignment Definition to define the symbologies of our materials. If we were not using the Working Alignment Definition, we could manually define the symbologies using the settings in the Search Criteria portion of the dialog. When using these settings, there are also three additional buttons to help you.

**Match**      Prompts you to identify an element. Once you do, it will fill in the symbology settings with the symbology of the identified element.

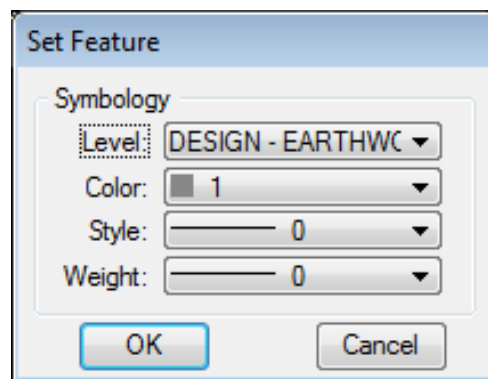
**Display**      Highlights all elements in the design file matching the set symbology.

**Reset**      Clears all symbology settings.

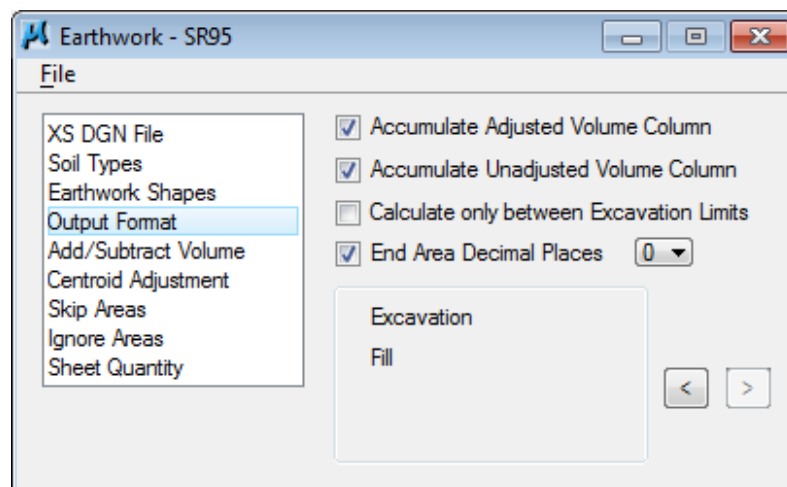
- 5) In the Earthwork Shapes section of the dialog, Toggle on Draw Earthwork Shapes and Stratify Shape Color. Double click on the symbology review area to open the Set Feature dialog.



Populate the dialog with the parameters as shown below. The level name is DESIGN - EARTHWORK - Shapes



- 6) Set the Output Format as shown below.



Use the arrow buttons (< or >) to change the format to Excavation and Fill.

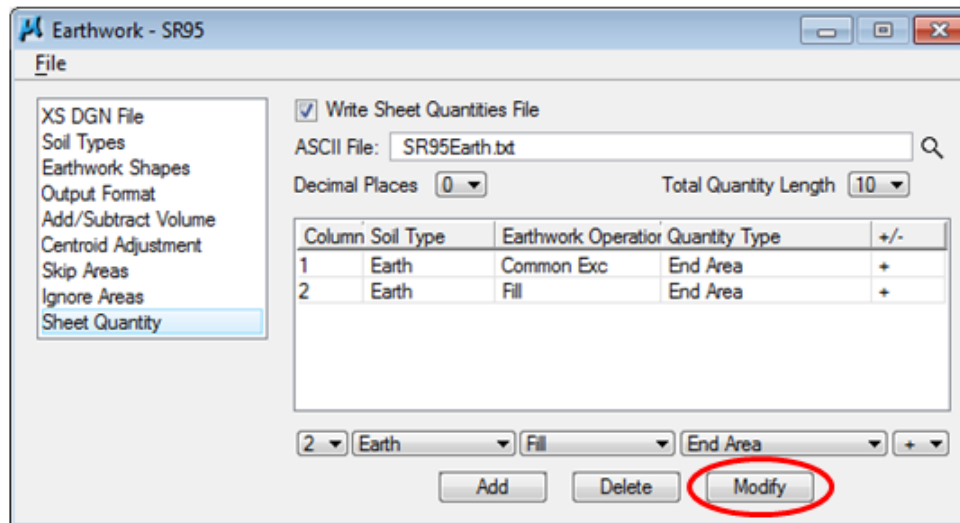
- 7) Skip down to the Sheet Quantity section and toggle on the Write Sheet Quantities File.

Name the file SR95Earth.txt. Add the following columns to the file with Decimal Places = 0 and Total Quantity Length = 10.

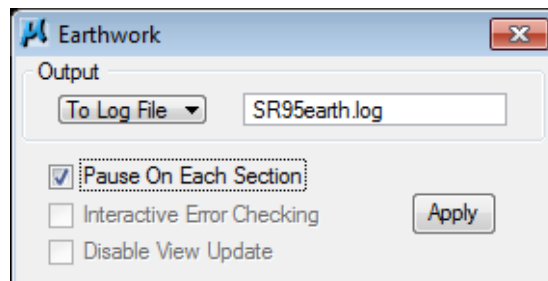
## Exercise 15

After setting values at the bottom, click Add to set them up in the list box.

| Col. | Soil Type | EW Operation | Quantity Type | +/- |
|------|-----------|--------------|---------------|-----|
| 1    | Earth     | Common Exc   | End Area      | +   |
| 2    | Earth     | Fill         | End Area      | +   |

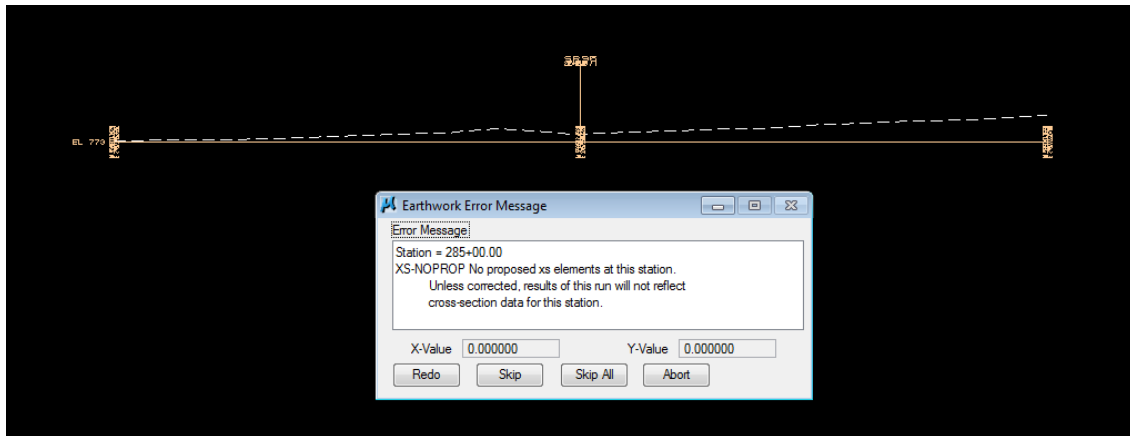


- 8) Using the Files > Run drop down option, run the earthwork for the proposed cross sections. Place your output into a log file as shown in the dialog below and Pause on Each Section. Click Apply to start processing.



If the Pause on Each Section is off the Disable View Update option can be used to eliminate view updates which will reduce the required processing time. This can be an excellent time saver on larger projects.

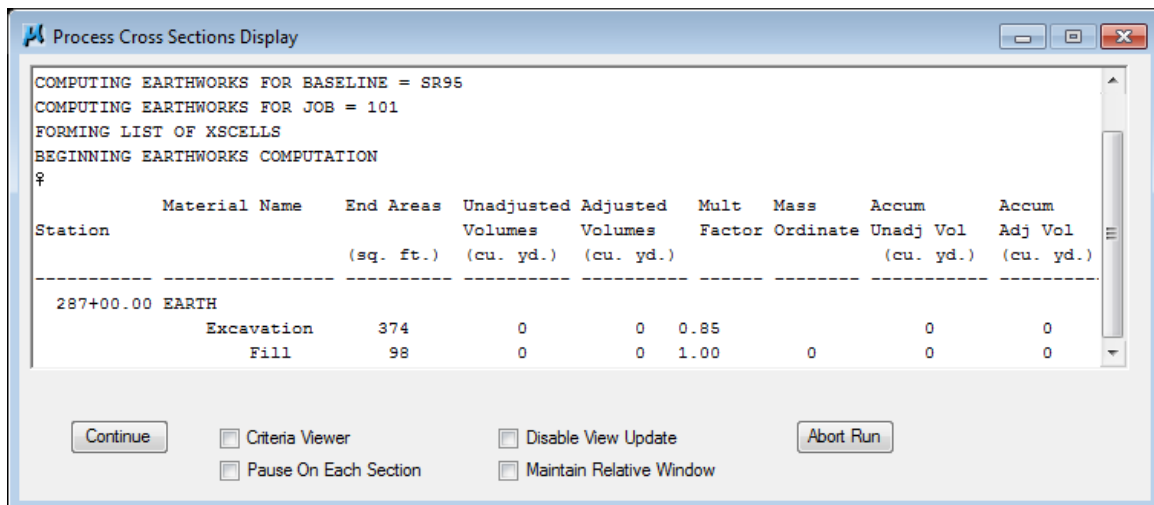
- 9) You will have to skip the first few sections and the last section where there are no proposed cross sections.



If you ever encounter a spot where it says the proposed does not tie with the existing, use MicroStation's Zoom In and click the DP button provided on the earthwork warning box. You will zoom in on the problem spot. If it is between 2 proposed cross section elements, check their symbology to make sure they are correct. If it is at the ground tie in, check to make sure they do in fact intersect.

You should never use the Skip button shown above in bridge or other areas where you do not want earthwork. Instead use Skip Areas & Ignore Areas as described later in this chapter.

- 10) After reviewing the first section at 287+00, turn off the Pause On Each Section option and click Continue.



- 11) When processing is complete, exit the Earthwork dialog and save your run.
- 12) Review the file SR95earth.log using the GEOPAK Text editor. Grand totals and Balance points are listed at the end of the report.

## Exercise 15

Process Cross Sections Display

Input File: ewkprj.inp  
Output File: SR9Searth.log  
COMPUTING EARTHWORKS FOR BASELINE = SR9S  
COMPUTING EARTHWORKS FOR JOB = 101  
FORMING LIST OF XSCCELLS  
BEGINNING EARTHWORKS COMPUTATION  
?

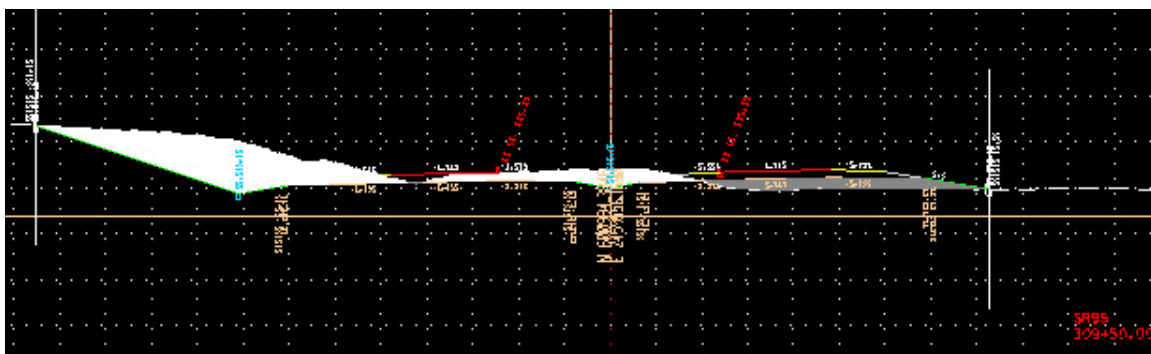
| Station   | Material Name | End Areas<br>(sq. ft.) | Unadjusted<br>Volumes<br>(cu. yd.) | Adjusted<br>Volumes<br>(cu. yd.) | Mult<br>Factor | Mass<br>Ordinate | Accum<br>Unadj Vol<br>(cu. yd.) | Accum<br>Adj Vol<br>(cu. yd.) |
|-----------|---------------|------------------------|------------------------------------|----------------------------------|----------------|------------------|---------------------------------|-------------------------------|
| 287+00.00 | EARTH         |                        |                                    |                                  |                |                  |                                 |                               |
|           | Excavation    | 374                    | 0                                  | 0                                | 0.85           |                  | 0                               | 0                             |
|           | Fill          | 98                     | 0                                  | 0                                | 1.00           | 0                | 0                               | 0                             |
| 287+50.00 | EARTH         |                        |                                    |                                  |                |                  |                                 |                               |
|           | Excavation    | 306                    | 630                                | 535                              | 0.85           |                  | 630                             | 535                           |
|           | Fill          | 56                     | 143                                | 143                              | 1.00           | 392              | 143                             | 143                           |
| 288+00.00 | EARTH         |                        |                                    |                                  |                |                  |                                 |                               |
|           | Excavation    | 168                    | 439                                | 373                              | 0.85           |                  | 1069                            | 908                           |
|           | Fill          | 100                    | 144                                | 144                              | 1.00           | 621              | 287                             | 287                           |
| 288+50.00 | EARTH         |                        |                                    |                                  |                |                  |                                 |                               |
|           | Excavation    | 79                     | 229                                | 194                              | 0.85           |                  | 1298                            | 1102                          |
|           | Fill          | 257                    | 331                                | 331                              | 1.00           | 484              | 618                             | 618                           |
| 289+00.00 | EARTH         |                        |                                    |                                  |                |                  |                                 |                               |
|           | Excavation    | 53                     | 122                                | 104                              | 0.85           |                  | 1420                            | 1206                          |
|           | Fill          | 372                    | 582                                | 582                              | 1.00           | 6                | 1200                            | 1200                          |
| 289+50.00 | EARTH         |                        |                                    |                                  |                |                  |                                 |                               |
|           | Excavation    | 45                     | 91                                 | 77                               | 0.85           |                  | 1511                            | 1283                          |
|           | Fill          | 603                    | 903                                | 903                              | 1.00           | -820             | 2103                            | 2103                          |

Next Run Exit

### NOTE:

The log file is the earthwork documentation to be submitted with plans when turning a job in for construction. This file can be printed on letter size paper from NOTEPAD in landscape mode.

- 13) Review your cross sections using XS Navigator. Notice that GEOPAK has placed shapes onto your cross sections representative of the calculated earthwork areas. These shape areas can be measured to verify earthwork areas if desired. Turn fill on to see where cuts and fills are.



## II.) Earth with Rock

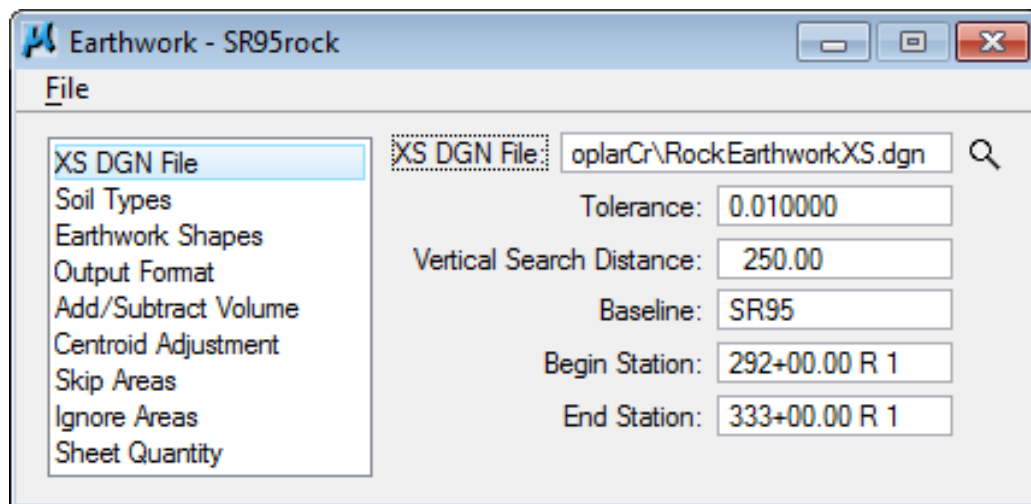
In the second part of this exercise, we'll compute earthwork for a dataset containing rock. To save time going through this exercise, we have already plotted rock lines in on the cross sections.

- 1) Open the MicroStation file

C:\Projects\Roane\SR95PoplarCr\RockEarthworkXS.dgn

Access Project Manager.

- 2) Choose Earthwork from the Project Manager dialog and create a new run named SR95rock.
- 3) Populate the XS DGN File section of the dialog as shown below:

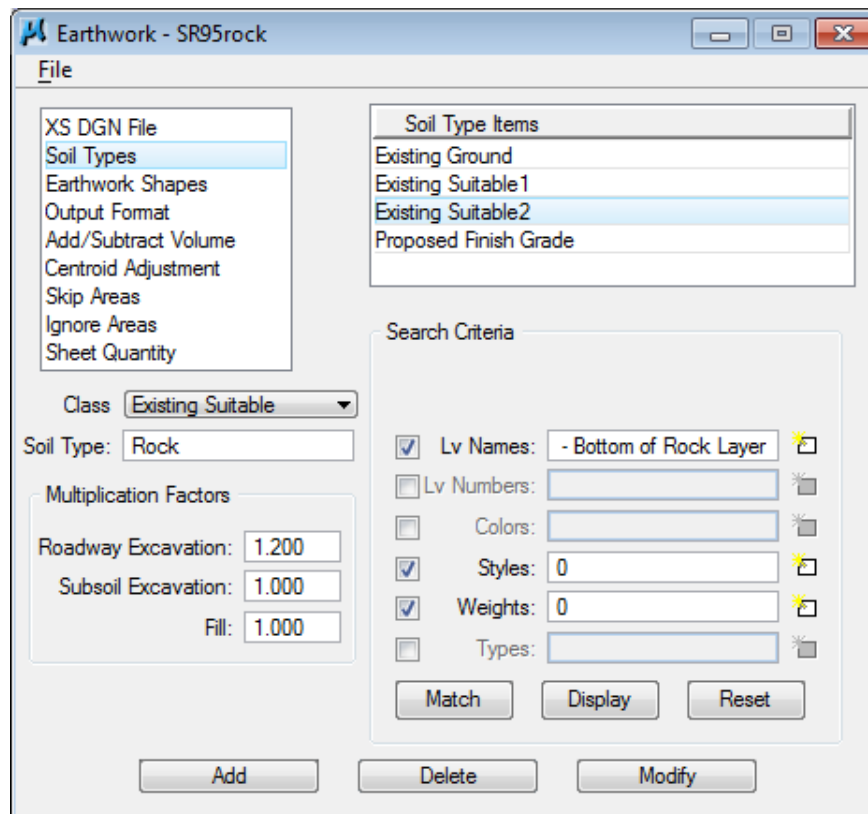




## Exercise 15

- 4) In the Soil Types section of the dialog, create the following classifications and soil types utilizing the parameters detailed in the table below.

| Class                 | Soil Type | Roadway Excavation<br>Multiplication Factor | Search Criteria                  |
|-----------------------|-----------|---|----------------------------------|
| Existing Ground       | Earth     | .85   | Use Working Alignment Definition |
| Proposed Finish Grade | Earth     | .85   | Use Working Alignment Definition |
| Existing Suitable 1   | Earth     | .85   | Toggle on Level, Style & Weight  |
| Existing Suitable 2   | Rock      | 1.2   | Toggle on Level, Style & Weight  |



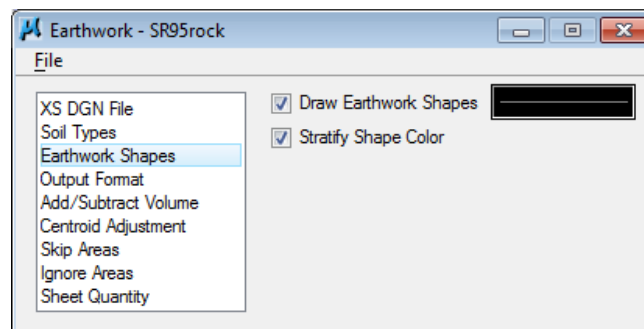
For Existing Suitable 1, click reset, then click match. Then click on the Top of Rock line. Do the same for Existing Suitable 2 except match it with the Bottom of Rock line.

NOTE:

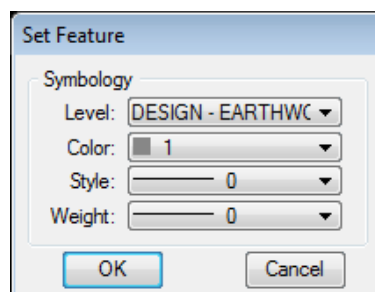
The most important concept to pick up as you set these Soil Types is that any lines found beneath the top of existing ground define the limits of the soil type above them.

In the example we are working, the top of the rock is specified as soil type Earth which is the soil type above that line.

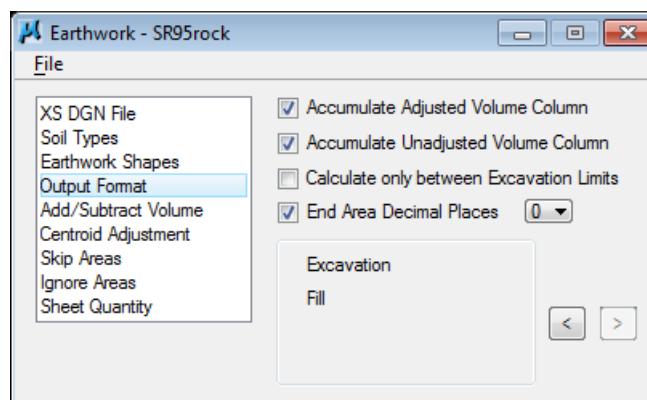
- 5) In the Earthwork Shapes section of the dialog, Toggle on Draw Earthwork Shapes and Stratify Shape Color. Double click on the symbology review area to open the Set Feature dialog.



Populate the dialog with the parameters as shown below. The level name is DESIGN - EARTHWORK - Shapes



- 6) Change the Output Format as shown below.

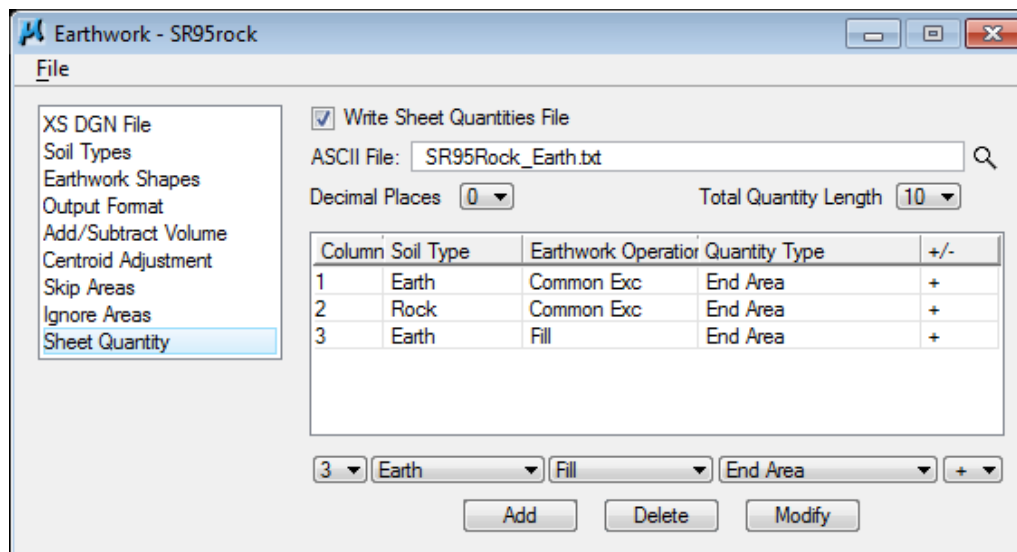


## Exercise 15

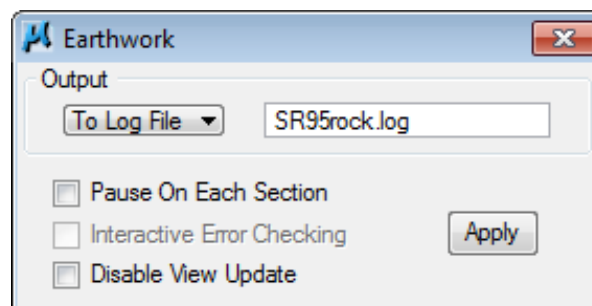
- 7) Skip down to the Sheet Quantity section and toggle on the Write Sheet Quantities File.

Name the file SR95Rock\_Earth.txt. Add the following columns to the file with Decimal Places = 0 and Total Quantity Length = 10.

| Col. | Soil Type | EW Operation | Quantity Type | +/- |
|------|-----------|--------------|---------------|-----|
| 1    | Earth     | Common Exc   | End Area      | +   |
| 2    | Rock      | Common Exc   | End Area      | +   |
| 3    | Earth     | Fill         | End Area      | +   |



- 8) Using the Files → Run drop down, run the earthwork for the proposed cross sections. Place your output into a log file as shown in the dialog below and click Apply to start processing.



- 9) Exit the Earthwork dialog and save your run.

- 10) Review the file SR95rock.log using the GEOPAK Text editor.

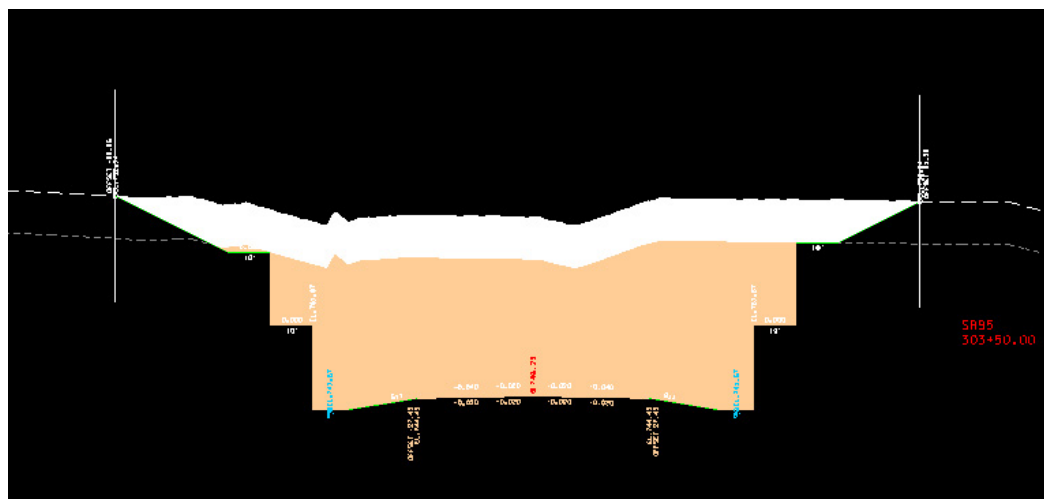
Process Cross Sections Display

COMPUTING EARTHWORKS FOR BASELINE = SR95  
 COMPUTING EARTHWORKS FOR JOB = 101  
 FORMING LIST OF XSCCELLS  
 BEGINNING EARTHWORKS COMPUTATION

| Station   | Material Name | End Areas<br>(sq. ft.) | Unadjusted<br>Volumes<br>(cu. yd.) | Adjusted<br>Volumes<br>(cu. yd.) | Mult<br>Factor | Mass<br>Ordinate | Accum<br>Unadj Vol<br>(cu. yd.) | Accum<br>Adj Vol<br>(cu. yd.) |
|-----------|---------------|------------------------|------------------------------------|----------------------------------|----------------|------------------|---------------------------------|-------------------------------|
| 292+00.00 | EARTH         |                        |                                    |                                  |                |                  |                                 |                               |
|           | Excavation    | 1379                   | 0                                  | 0                                | 0.85           |                  | 0                               | 0                             |
|           | Fill          | 0                      | 0                                  | 0                                | 1.00           | 0                | 0                               | 0                             |
|           | ROCK          |                        |                                    |                                  |                |                  |                                 |                               |
|           | Excavation    | 795                    | 0                                  | 0                                | 1.20           |                  | 0                               | 0                             |
|           | Fill          | 0                      | 0                                  | 0                                | 1.00           | 0                | 0                               | 0                             |
| 292+50.00 | EARTH         |                        |                                    |                                  |                |                  |                                 |                               |
|           | Excavation    | 1396                   | 2569                               | 2184                             | 0.85           |                  | 2569                            | 2184                          |
|           | Fill          | 0                      | 0                                  | 0                                | 1.00           | 2184             | 0                               | 0                             |
|           | ROCK          |                        |                                    |                                  |                |                  |                                 |                               |
|           | Excavation    | 894                    | 1564                               | 1877                             | 1.20           |                  | 1564                            | 1877                          |
|           | Fill          | 0                      | 0                                  | 0                                | 1.00           | 4061             | 0                               | 0                             |
| 293+00.00 | EARTH         |                        |                                    |                                  |                |                  |                                 |                               |
|           | Excavation    | 1376                   | 2567                               | 2182                             | 0.85           |                  | 5136                            | 4366                          |
|           | Fill          | 0                      | 0                                  | 0                                | 1.00           | 6243             | 0                               | 0                             |
|           | ROCK          |                        |                                    |                                  |                |                  |                                 |                               |
|           | Excavation    | 979                    | 1734                               | 2081                             | 1.20           |                  | 3298                            | 3958                          |
|           | Fill          | 0                      | 0                                  | 0                                | 1.00           | 8324             | 0                               | 0                             |
| 293+50.00 | EARTH         |                        |                                    |                                  |                |                  |                                 |                               |
|           | Excavation    | 1364                   | 2537                               | 2156                             | 0.85           |                  | 7673                            | 6522                          |
|           | Fill          | 0                      | 0                                  | 0                                | 1.00           | 10480            | 0                               | 0                             |
|           | ROCK          |                        |                                    |                                  |                |                  |                                 |                               |
|           | Excavation    | 1109                   | 1933                               | 2320                             | 1.20           |                  | 5231                            | 6278                          |
|           | Fill          | 0                      | 0                                  | 0                                | 1.00           | 12800            | 0                               | 0                             |

Next Run Exit

- 11) Review your cross sections using XS Navigator. You should see that rock cuts are figured separately from earth cuts.

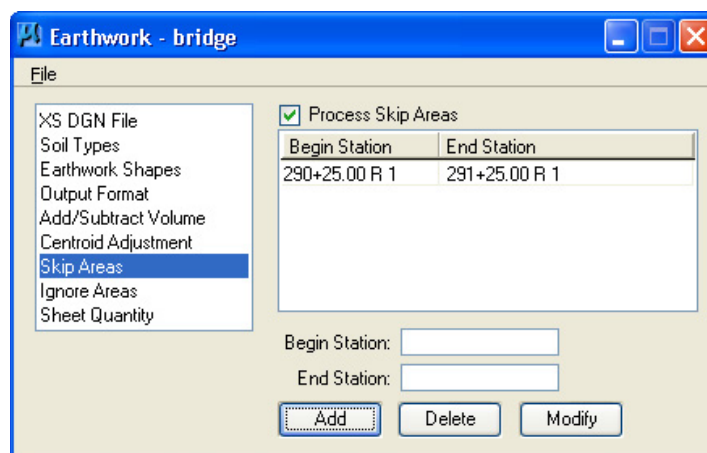


### III.) Skip Areas & Ignore Areas

The most common use of Skip Areas and Ignore Areas is to stop earthwork end areas & volumes from being calculated in bridge areas. You cannot use the on the fly Skip option to accomplish this. If you click Skip at any station that earthwork processing stops, then the station is skipped but earthwork will still be calculated across the station which was skipped.

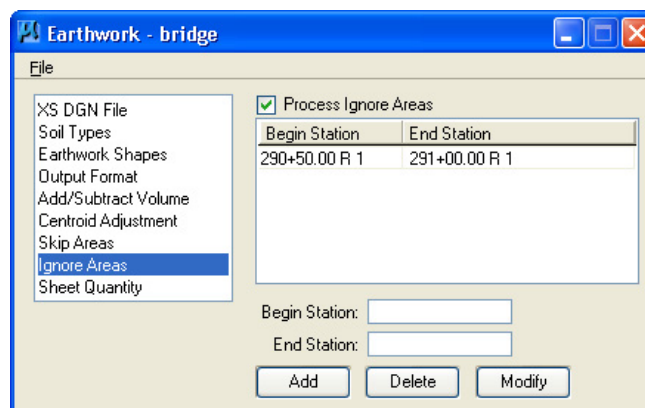
This information is provided for review and reference only.

In the Skip Areas dialog, set up the begin and end stations of the bridge as a skip area to control the limits of earthwork volume calculations. Cross Sections at these stations must be cut with the proposed roadway placed on them in the cross section DGN file in order for Geopak to correctly calculate the earthwork.



To get GEOPAK to completely ignore the proposed bridge cross section stations, we must set up both Skip Areas and Ignore Areas.

We do not need end areas calculated at proposed bridge cross sections so we also need to set up the Ignore Areas section of Earthwork. The station range should be set to the first station beyond the beginning of the bridge and the last station before the end of the bridge.



In proposed cross section runs, the station limits for the proposed bridge deck should be set to be greater than the begin bridge station and less than the end bridge station. The cross sections at the begin bridge station and at the end bridge station should show the proposed roadway with slopes not the bridge deck. The begin and end stations are used for volume calculations with the cross sections before and after the skipped area.

LT where sta > 290+25.00 R 1 and sta < 291+25.00 R 1  
 RT where sta > 290+25.00 R 1 and sta < 291+25.00 R 1

Define Modify Delete Up Down

Criteria Files

| Name         | Description       |
|--------------|-------------------|
| VarBridge.x  | Bridge Variables. |
| BridgeDeck.x | Bridge Deck.      |

Add Delete Up Down

When set up and processed correctly, the Skip Area station range is shown in the earthwork log file but the earthwork volume totals shown at the begin and end station of the bridge are the same. Due to the settings made in Ignore Areas, no end area data is given for the stations between the begin & end.

Process Cross Sections Display

|   |            |       |     |     |      |      |      |      |
|---|------------|-------|-----|-----|------|------|------|------|
| 289+50.00                                   | EARTH      |       |     |     |      |      |      |      |
|   | Excavation | 308.5 | 639 | 543 | 0.85 |      | 7792 | 6622 |
|   | Fill       | 39.6  | 37  | 37  | 1.00 | 6585 | 37   | 37   |
| 290+00.00                                   | EARTH      |       |     |     |      |      |      |      |
|   | Excavation | 286.1 | 551 | 468 | 0.85 |      | 8343 | 7090 |
|   | Fill       | 85.6  | 116 | 116 | 1.00 | 6937 | 153  | 153  |
| SKIP STATION RANGE = 290+25.00 to 291+25.00 |            |       |     |     |      |      |      |      |
| 290+25.00                                   | EARTH      |       |     |     |      |      |      |      |
|   | Excavation | 278.0 | 261 | 222 | 0.85 |      | 8604 | 7312 |
|   | Fill       | 110.9 | 91  | 91  | 1.00 | 7068 | 244  | 244  |
| 291+25.00                                   | EARTH      |       |     |     |      |      |      |      |
|   | Excavation | 369.5 | 0   | 0   | 0.85 |      | 8604 | 7312 |
|   | Fill       | 12.6  | 0   | 0   | 1.00 | 7068 | 244  | 244  |
| 291+50.00                                   | EARTH      |       |     |     |      |      |      |      |
|   | Excavation | 410.5 | 361 | 307 | 0.85 |      | 8965 | 7619 |
|   | Fill       | 0.0   | 6   | 6   | 1.00 | 7369 | 250  | 250  |
| 292+00.00                                   | EARTH      |       |     |     |      |      |      |      |
|   | Excavation | 555.6 | 895 | 760 | 0.85 |      | 9860 | 8379 |
|   | Fill       | 0.0   | 0   | 0   | 1.00 | 8129 | 250  | 250  |

Next Run Exit