Engineering Applications employing GIS Technology

How ArcGIS can be tailored for Engineering and Surveying Applications

Presenter:
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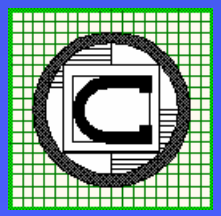
Kadrmas, Lee & Jackson



Constantine Tonias, P.E.

Fields Utilizing GIS

Business, Telecommunications, Defense,

Health, Homeland Security, Education

Oil & Gas, and many more…

Engineers and Surveyors

Even Civil Engineers and Surveyors are using GIS,

But not to its full extent.

Municipal Clients

Civil Engineers and Surveyors working with municipal clients are finding themselves having to supply their clients with data that can be incorporated into the clients' GIS database

CAD to GIS

A CAD file (.dxf, .dwg) has typically been used as the mechanism to transfer the engineer or surveyor's work to the municipal client

CAD to GIS

The CAD file (.dxf, .dwg) provides:

- **Exchange of geometric graphics**
- **But not a good mechanism for exchanging attribute data**
- **Attribute data is becoming more and more important for municipal clients**

A New Approach

Avoid the CAD to GIS transfer by performing the design within the GIS, that is, design with ArcMap !

Design within ArcGIS

By creating custom commands and tools, we can utilize ArcGIS as the graphics engine for performing Civil Engineering and Surveying applications

Start to End Approach

By creating custom commands and tools, we can utilize ArcGIS to design and draft in a GIS environment

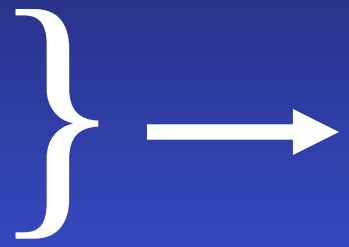
"drafting as a by-product of the design process"

Custom Commands/Tools

Visual Basic 6

ArcObjects

Avenue Wraps



Active X DLL's

Toolbars which can be added to ArcMap,

and

Design Processes

which can be performed within ArcGIS

- Survey – Field Work
- Digital Terrain Model
- Horizontal Alignments
- Cross-Sections/Profiles
- Vertical Alignments
- Roadway Templates
- Roadway Surface
- Earthwork Quantities
- Subdivision Design
- P&P Drawings

To name a few

Topographic Mapping

Create a digital model of the project site

comprised of

contours and existing features utilizing:

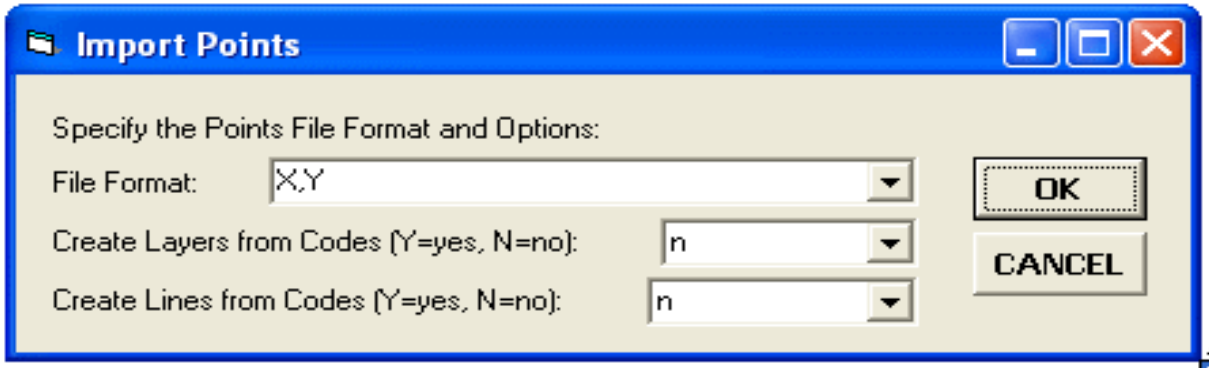
Aerial photography, and/or

Conventional Field Survey Data, better yet

Current GIS Database

Field Survey Data

Create a custom command for the mass importing of field survey data in a variety of formats, and with the ability to generate line and curve features from point codes



With the indicated choice list data fields, the user may Control the import of features as indicated below:

TOP — Select the format under which the subject Features are to be imported.

MIDDLE — Using the code associated with the subject features, the user may assign features of a certain code to an individual layer.

BOTTOM — Using the code associated with points being imported, the user may cause points of the same code to be connected with a line.

Import Conventional Field Survey Data

LIST OF POINT, LINE AND POLYGON IMPORT FORMATS

- X,Y
- Y,X
- X,Y,Z
- Y,X,Z
- ID,X,Y
- ID,Y,X
- ID,X,Y,Z
- ID,Y,X,Z
- ID,X,Y,Z,Code
- ID,Y,X,Z,Code
- ID,X,Y,Z,Desc
- ID,Y,X,Z,Desc
- ID,X,Y,Z,Code,Desc
- ID,Y,X,Z,Code,Desc
- ITOPO Points File
- EPANET Map File
- LINK05 Survey File
- Line Connectivity File
- Line Coordinate File - 1
- Line Coordinate File - 2
- Line Coordinate File - 3
- Polygon 1 (lat,long in Quad 1)
- Polygon 2 (lat,long in Quad 2)
- Polygon 3 (lat,long in Quad 3)
- Polygon 4 (lat,long in Quad 4)
- Polygon 5 (lat,long in all Quads)
- Polygon 6 (x,y w/ Bearing & TieLine)
- Polygon 7 (x,y w/ Bearing)
- Polygon 8 (x,y w/ Azimuth)
- Polygon 9 (x,y w/ Cartesian)
- Polygon 10 (y,x w/ Bearing)
- Polygon 11 (y,x w/ Azimuth)
- Polygon 12 (y,x w/ Cartesian)

Contouring

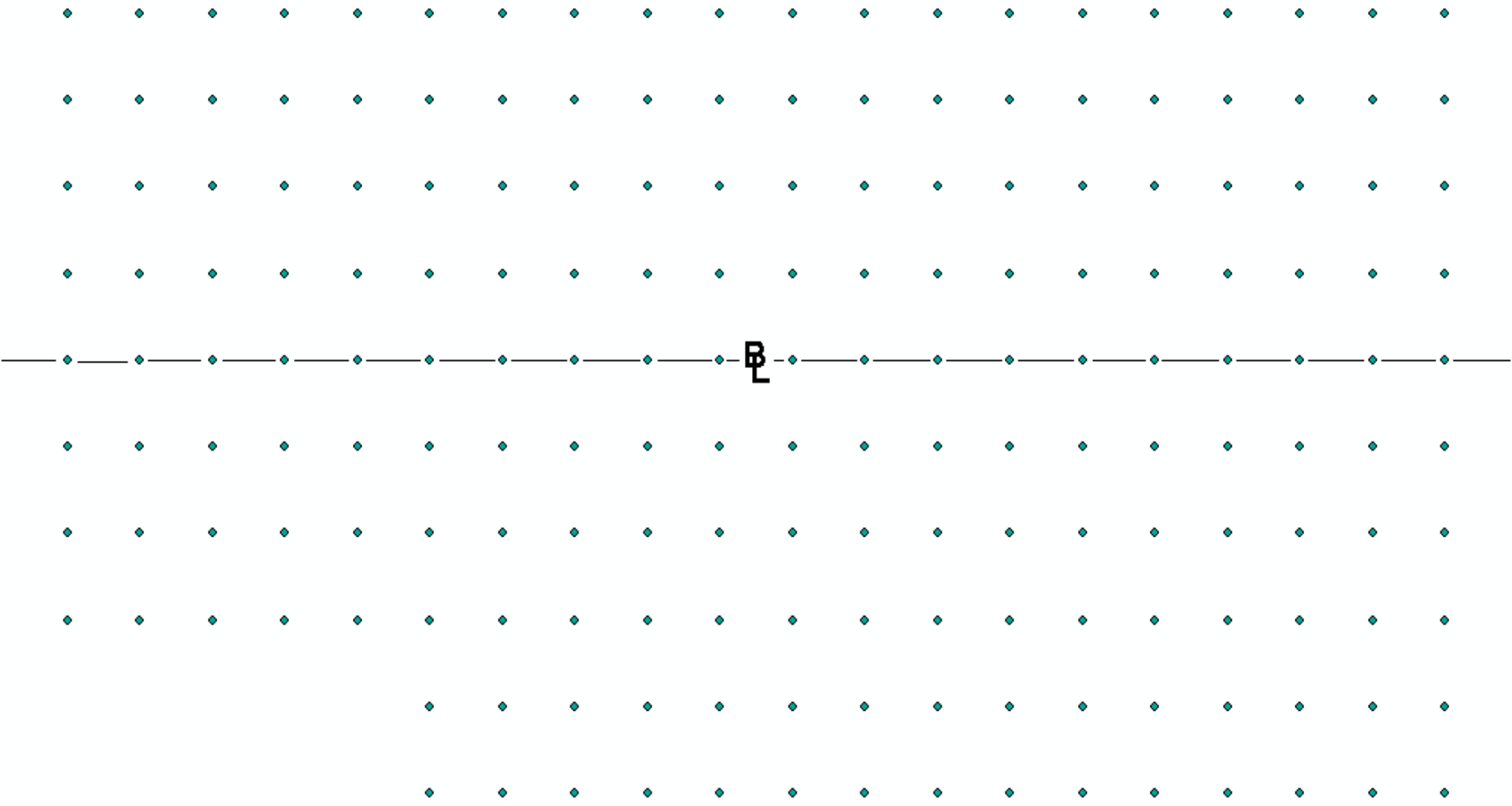
Create a custom command for creating contours from:

Radial survey, and

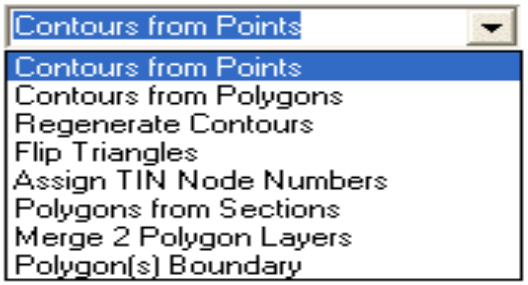
Cross-sectional survey

Radial Survey Data

Cross-Sectional Survey Data

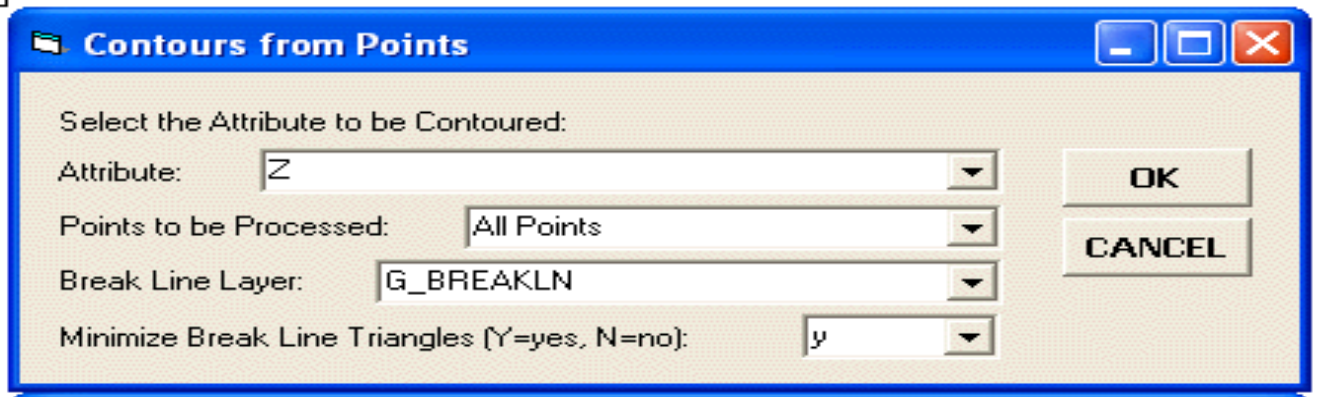


Requires special contouring algorithm

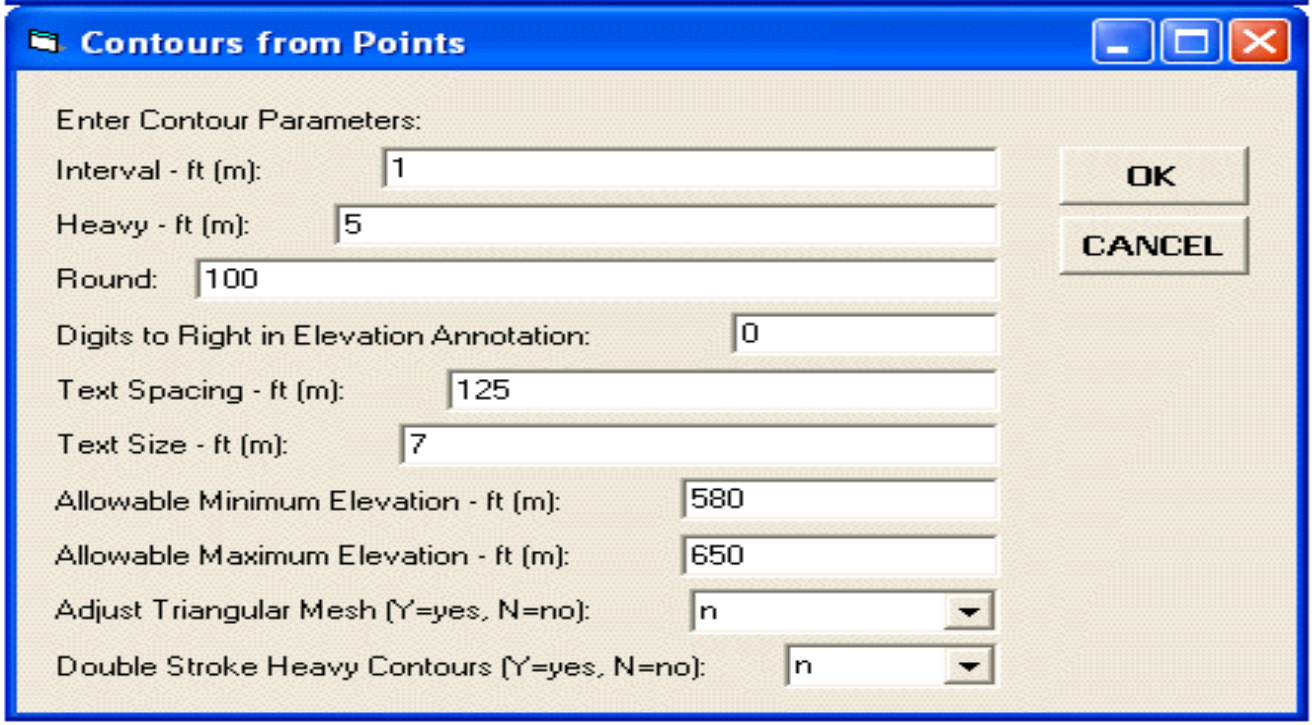


Menu combo box for generating and manipulating TINs and contours.

Dialog box for selecting the point attribute bearing the elevation, and controlling the break lines (lines that cannot be crossed by a TIN triangle).



Dialog box for specifying the various contouring parameters.



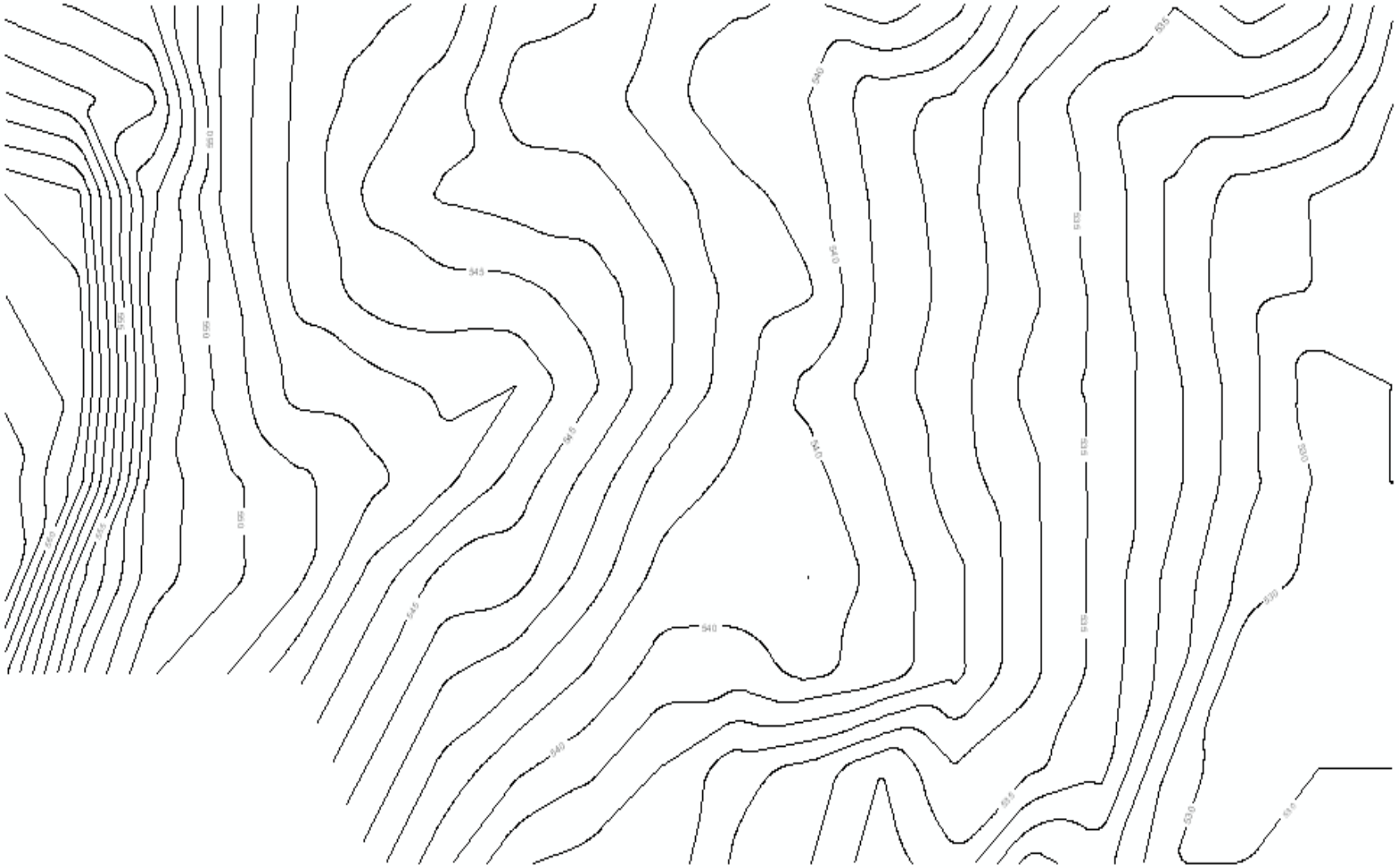
Contouring Parameters

GeoDatabase

Stored in a geodatabase are the:

- **Contour strings (polyline features with the elevation stored as an attribute)**
- **Elevation annotation**
- **Polygons comprising the TIN (3D polygon features)**

Contours from Cross-Sectional Survey Data

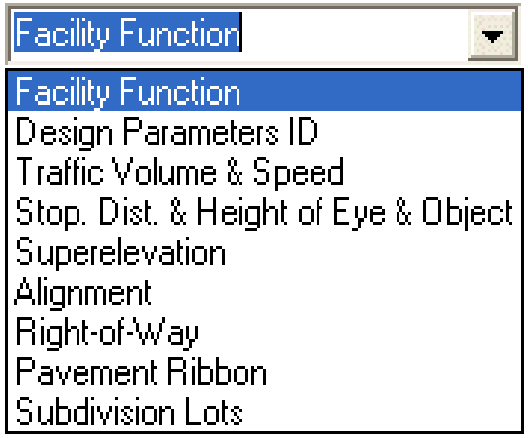


Roadway Design

Requires Geometry and Design Data

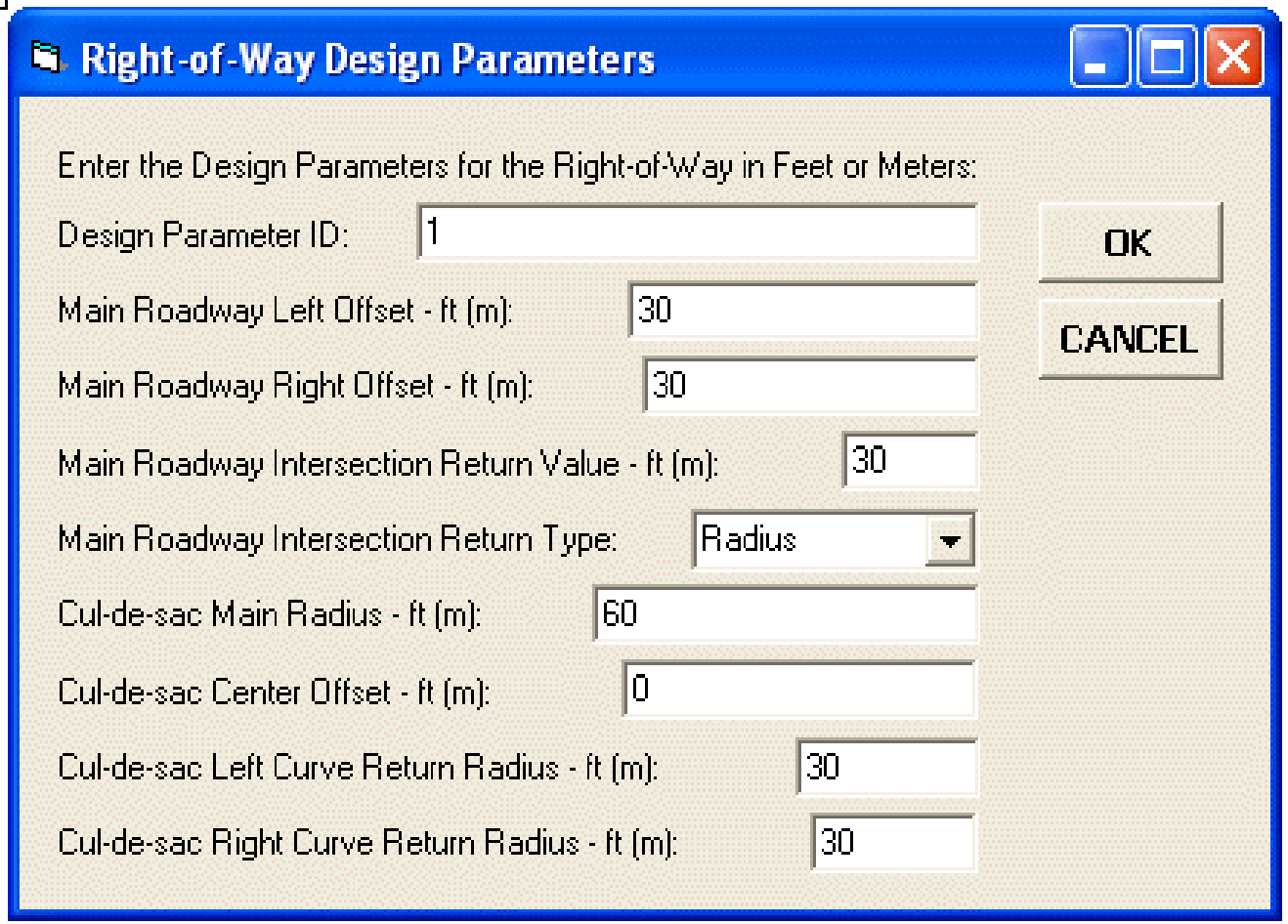
- Design Data is assigned an Identifier
- Custom Commands reference the Design Data Identifier

Specification of Design Data



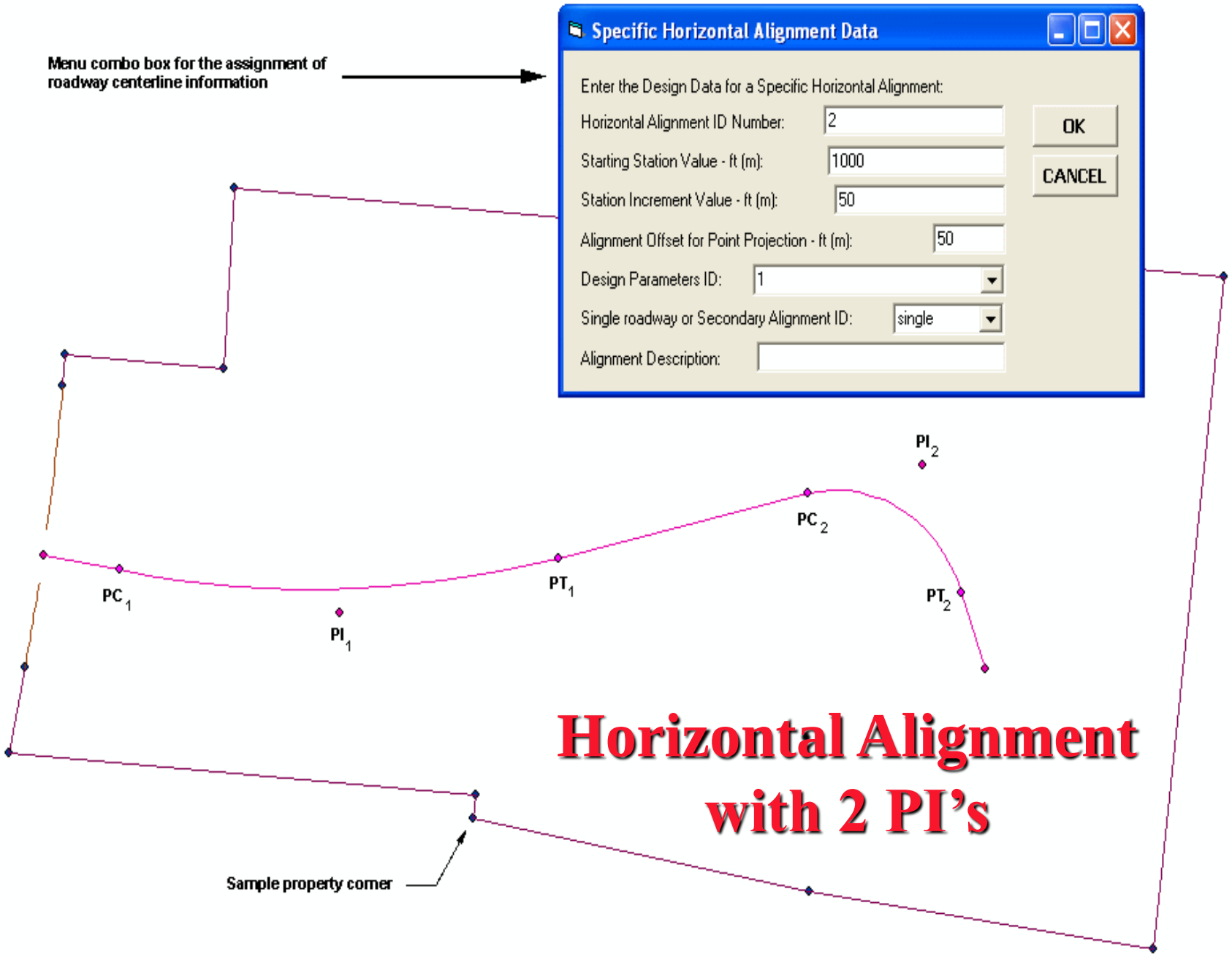
Menu combo box for the assignment of roadway design information

Sample dialog box for the specification of design information regarding ROW lines and cul-de-sac design



Horizontal Alignments

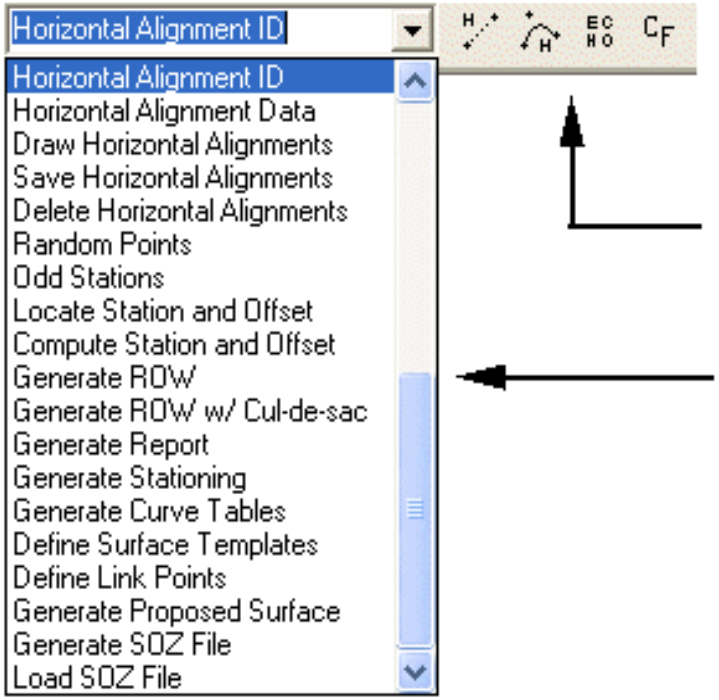
An interactive design feature to introduce one or many PI's with curves and spirals, and dynamically display alignment changes as each PI is dragged across the monitor screen


Menu combo box for the assignment of roadway centerline information
Specific Horizontal Alignment Data
Enter the Design Data for a Specific Horizontal Alignment:
Horizontal Alignment ID Number: 2
Starting Station Value - ft (m): 1000
Station Increment Value - ft (m): 50
Alignment Offset for Point Projection - ft (m): 50
Design Parameters ID: 1
Single roadway or Secondary Alignment ID: single
Alignment Description:
OK
CANCEL
PI2
PC2
PC1
PT1
PT2
PI1
Sample property corner
Horizontal Alignment with 2 PI's

Horizontal Alignment Editing

Specialized commands were developed to facilitate the editing, or modification of the horizontal alignments

Horizontal Alignment Commands and Tools



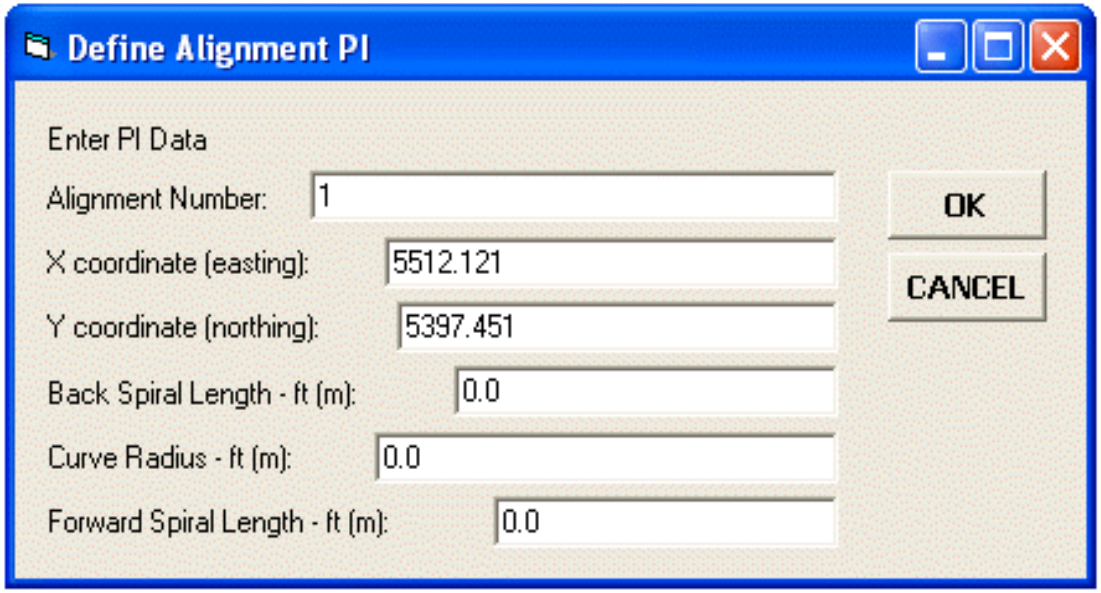
Tool bar for the dynamic design of horizontal alignments

Menu combo box for the definition and manipulation of roadway alignments

Some of the menu commands include the automatic station annotation, application of typical roadway sections (templates), display of curve data, generation of alignment reports, etc.

Sample dialog box for the specification of base curve data

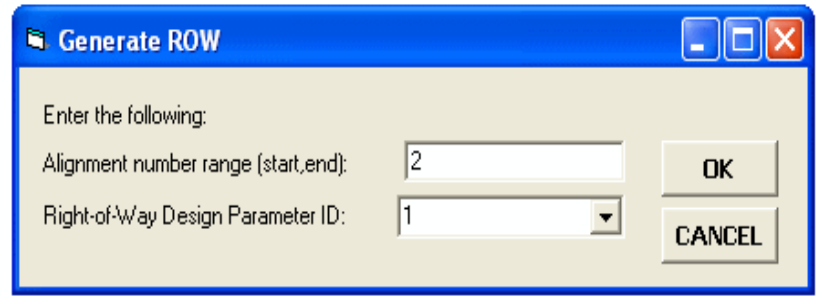
The displayed coordinates is echo information which may be overwritten

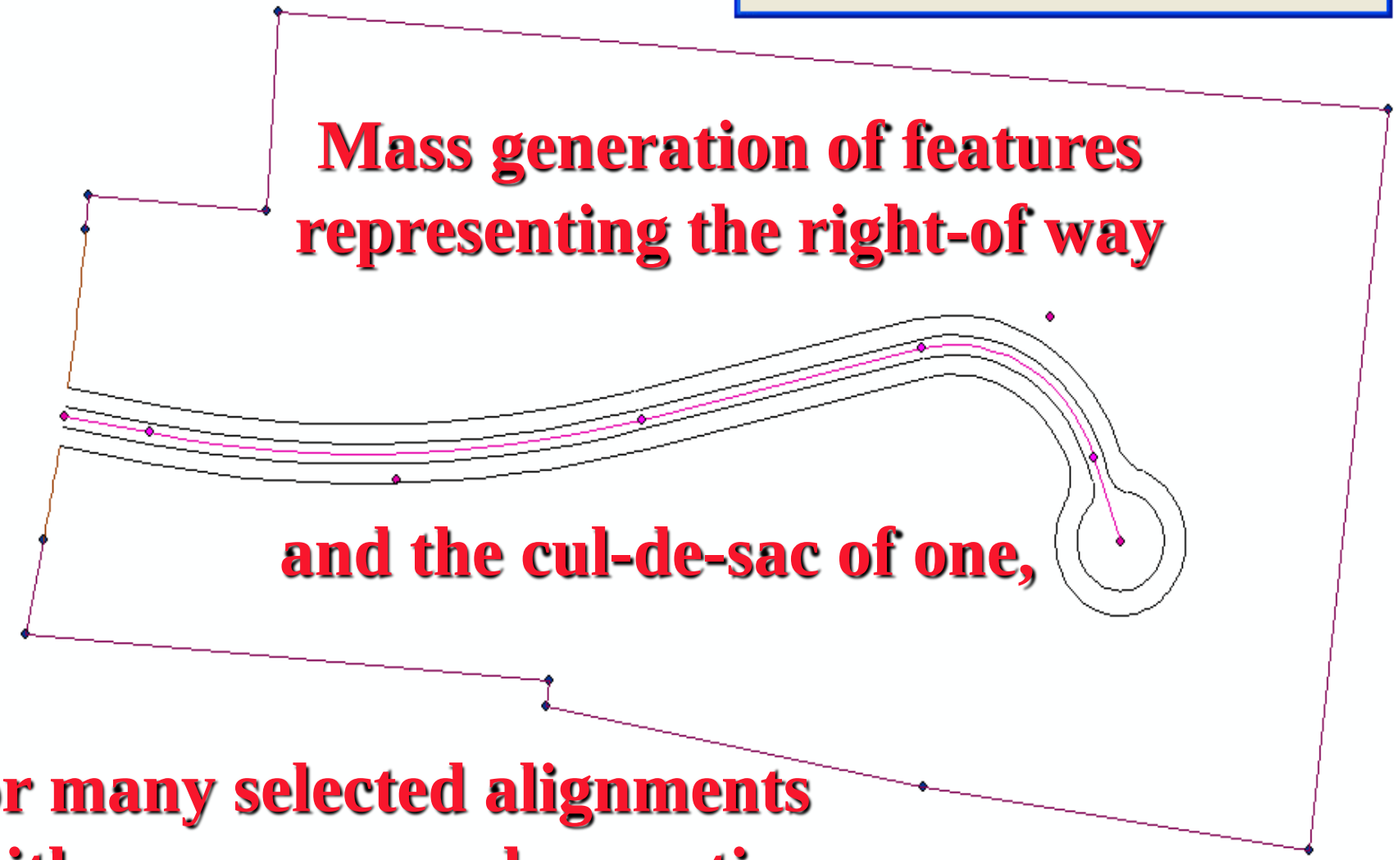


Post-Processing

Specialized commands were developed to post-process the horizontal alignments so as to facilitate the drafting process (automated generation of lines, curves and annotation features from design data)

Dialog box, in response to the [Generate ROW w/ Cul-de-sac] command (see the menu combo box of Figure 8), for the mass generation of ROW lines, with or without cul-de-sacs. The same command can be used to mass generate pavement ribbons, gutter or curb lines, and the like.





Mass generation of features representing the right-of way

and the cul-de-sac of one,

or many selected alignments with one command execution

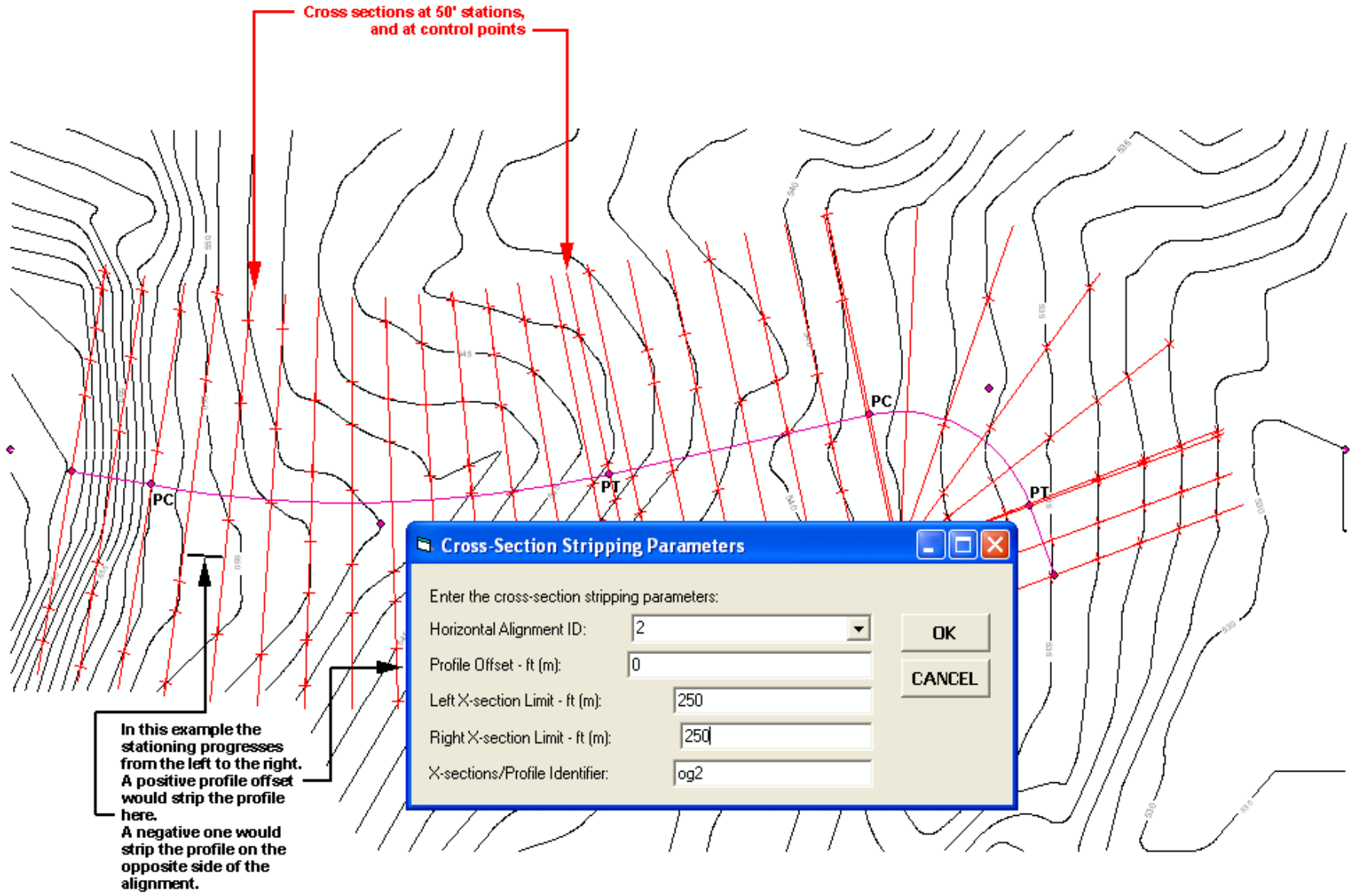
Cross-Section/Profiles

Using the horizontal alignment

existing ground

cross-sections and profiles can be

extracted from the digital terrain model



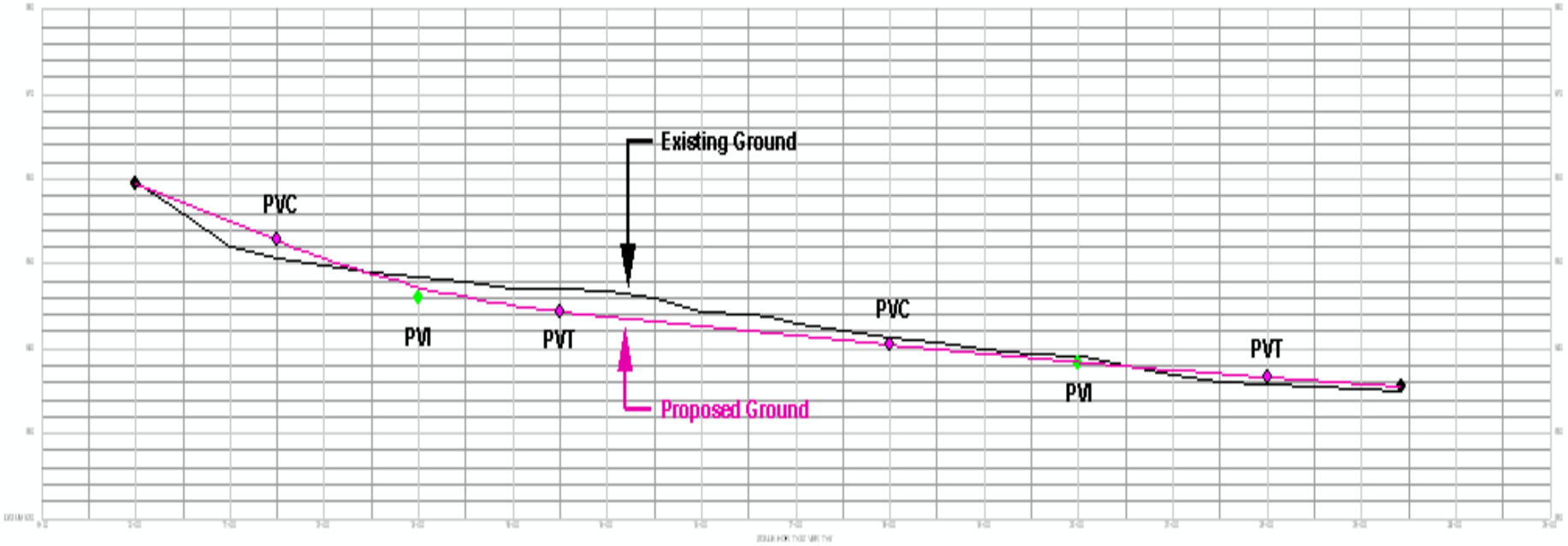
Cross-Section/Profile Extraction

Vertical Alignments

An interactive design feature to introduce one or many PVI's with parabolic curves, and dynamically display alignment changes as each PVI is dragged across the monitor screen.

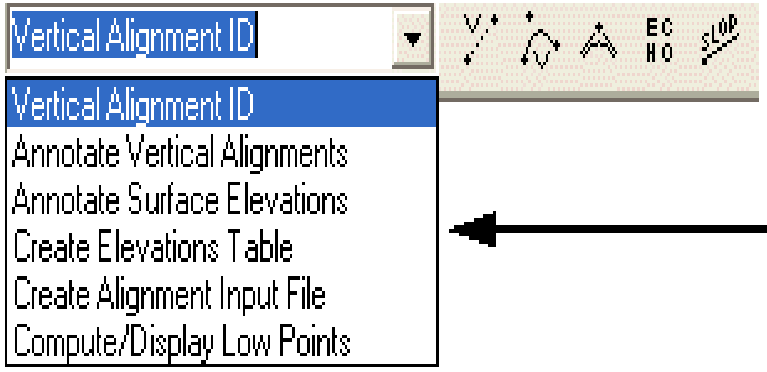
Vertical Alignment Design

This area is reserved for the plan view



Vertical Alignment Editing

Specialized commands were developed to facilitate the editing or modification of the vertical alignments

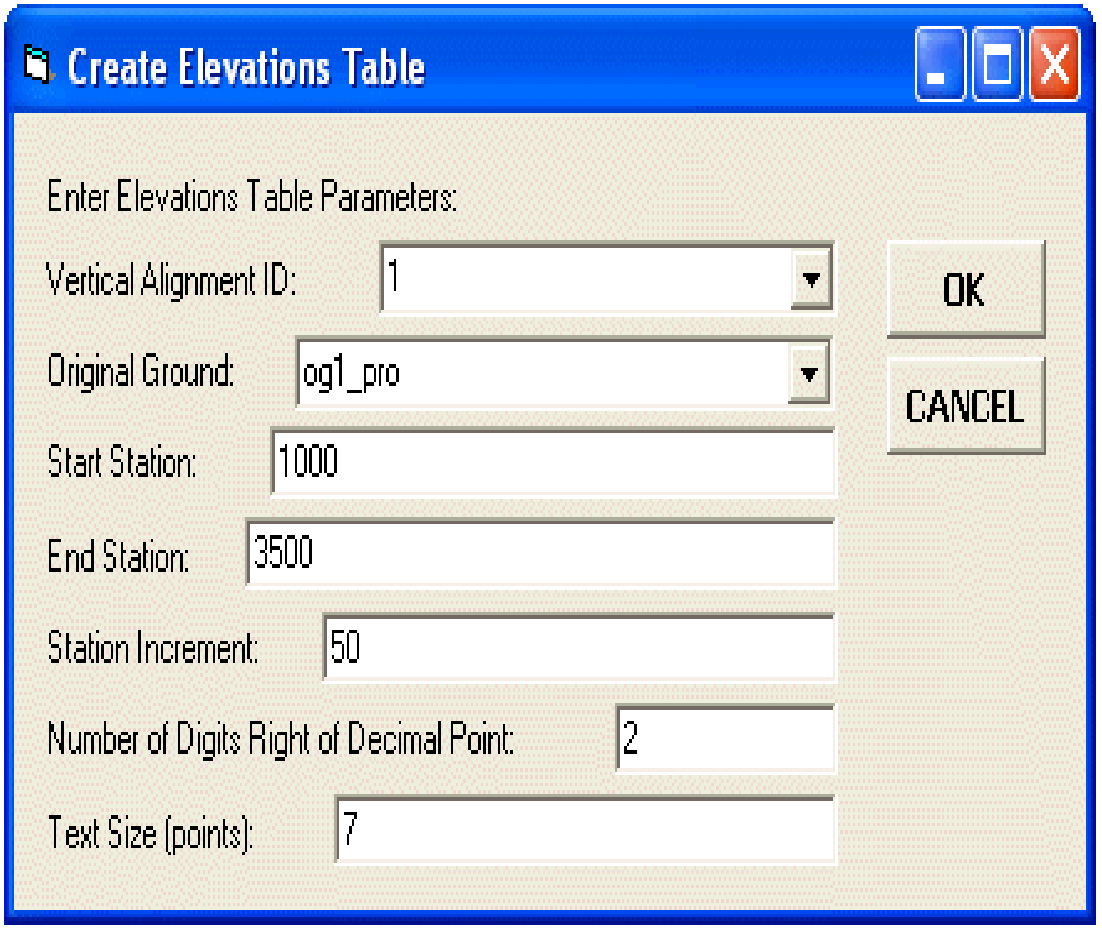


Tool bar for the dynamic design of vertical alignments

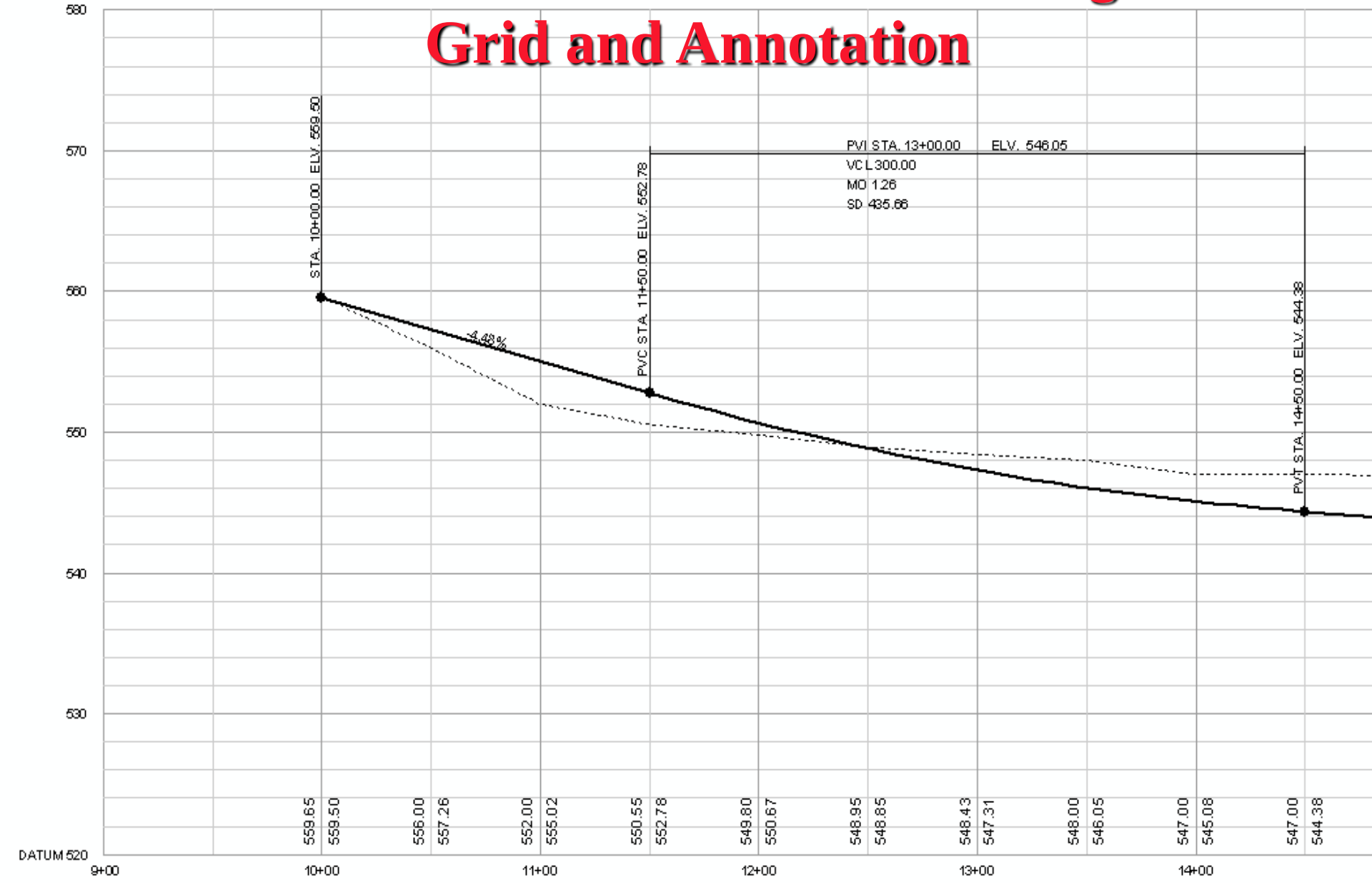
Menu combo box for the definition and manipulation of vertical alignments Some of the menu commands include the automatic annotation, display of curve data, and generation of alignment reports.

Sample dialog box for the specification of vertical curve data

Vertical Alignment Commands and Tools



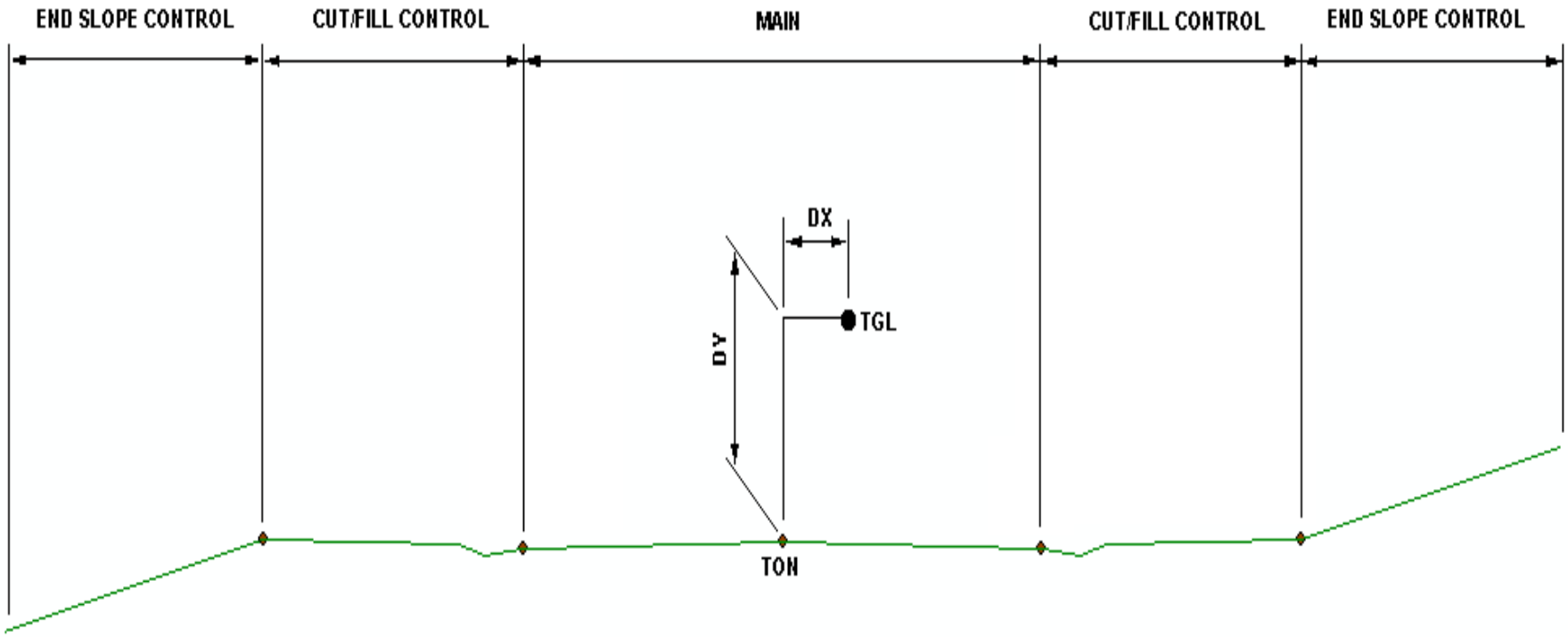
Automated Generation of Vertical Alignment Grid and Annotation



Proposed Ground Templates

Proposed ground templates (typical sections) are drafted using a custom tool for handling offset distances as well as slope and distance values

Typical Proposed Ground Template And its Components

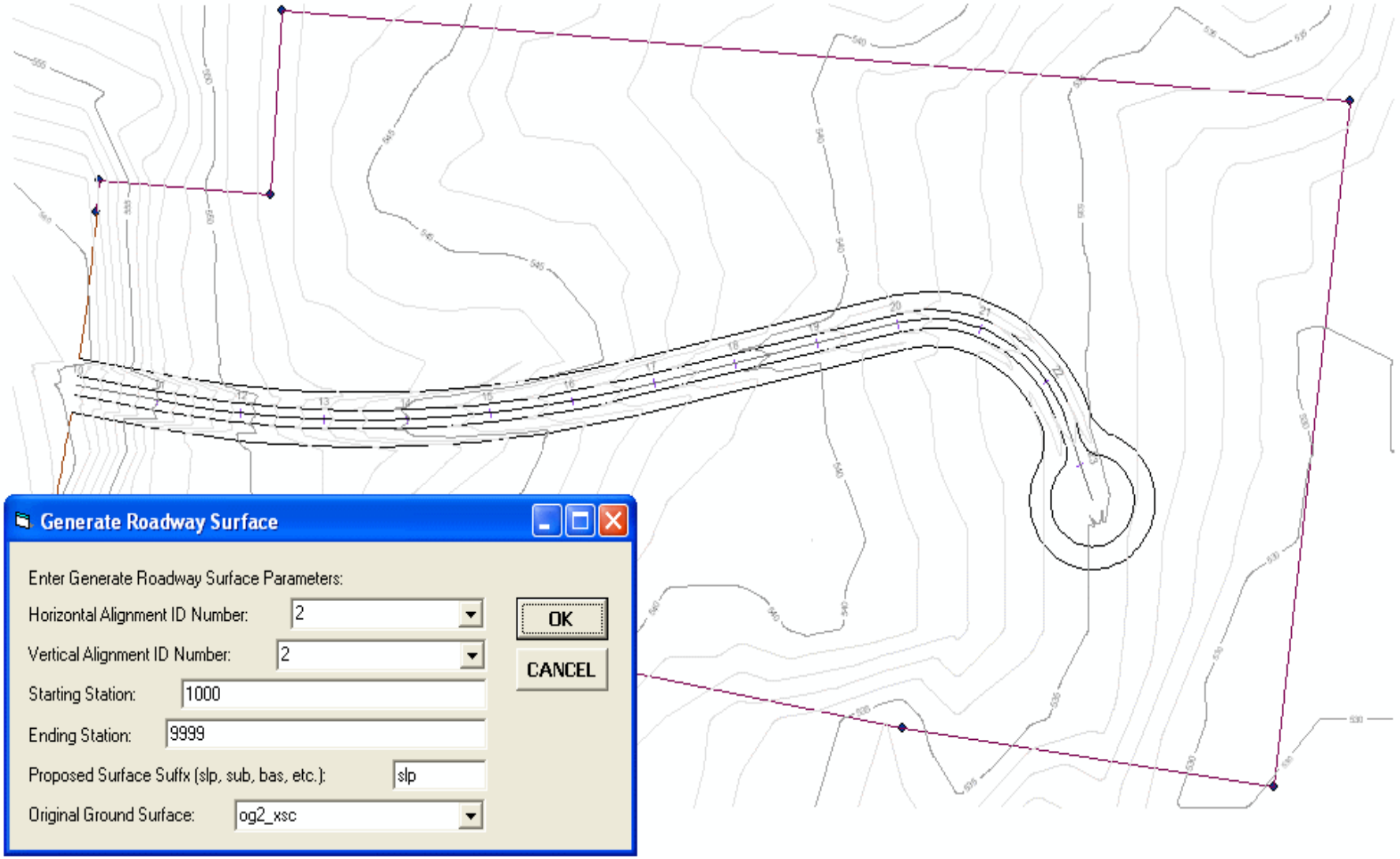


Proposed Ground Surface

Proposed ground surface created by combining:

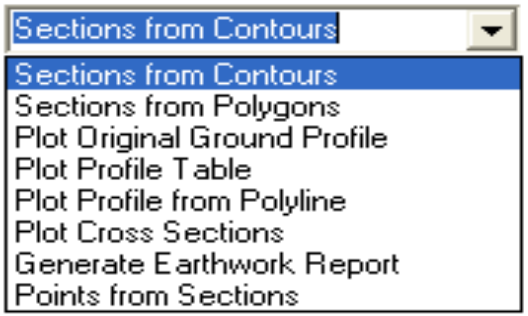
- **Horizontal Alignment**
- **Existing Ground Cross-Sections**
- **Vertical Alignment**
- **Proposed Ground Templates**

Site Contours created from the Proposed Ground Surface



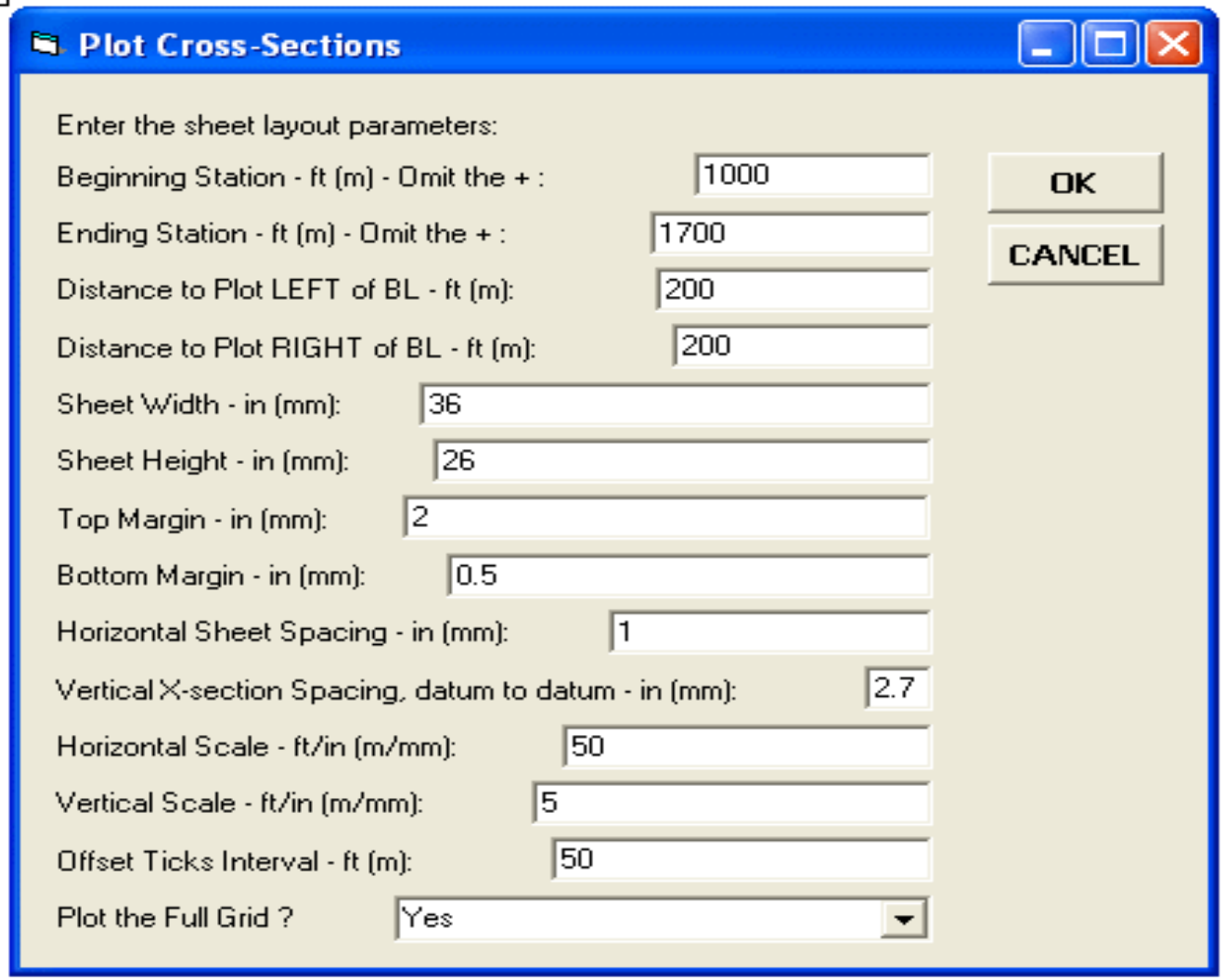
Cross-Section Plotting

Fully Annotated Cross-Sections are produced by using a custom command which stores the line and annotation features in a geodatabase



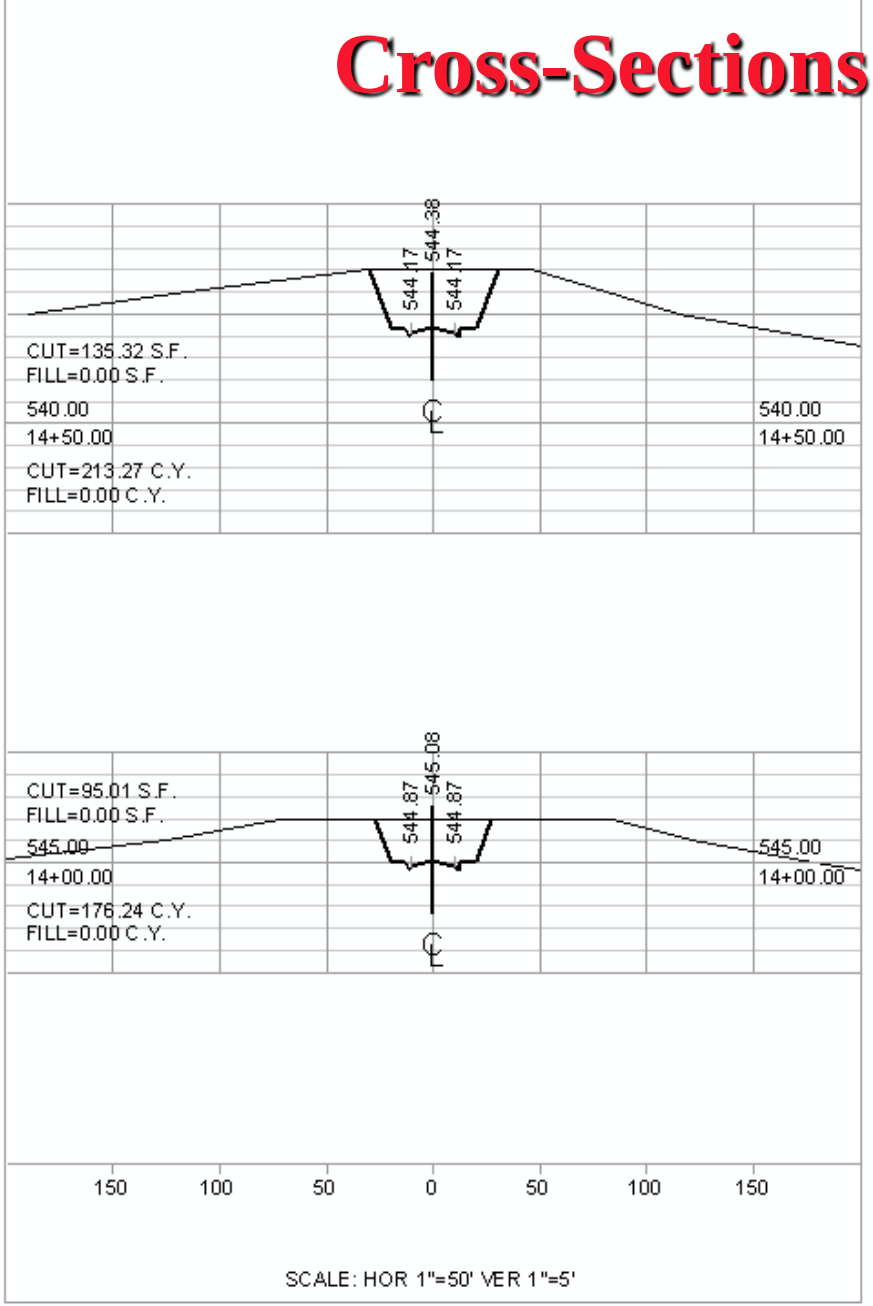
Menu combo box for cross section and profile plotting and computational reports.

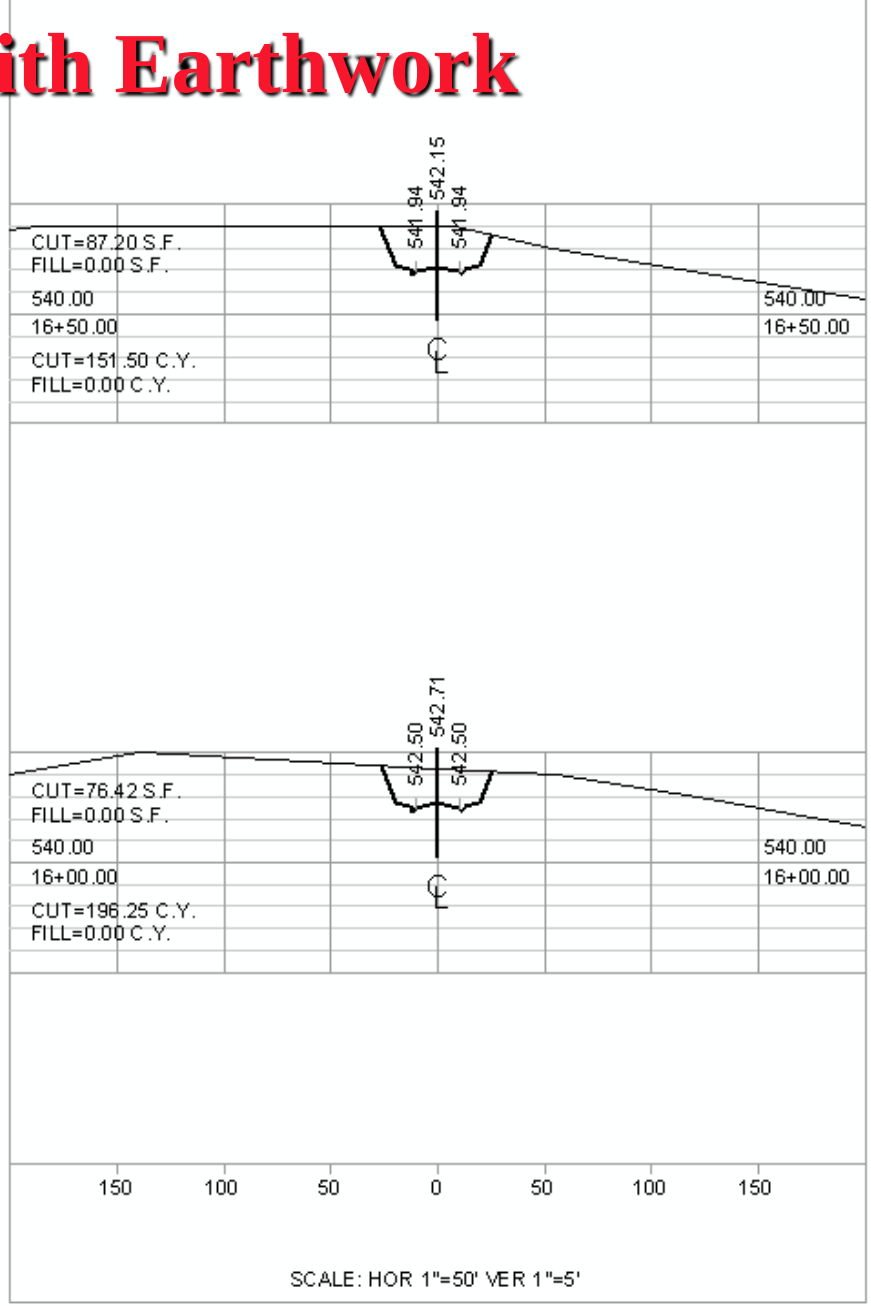
Dialog box for the specification of cross section plotting parameters



Cross-Section Parameters

Cross-Sections with Earthwork

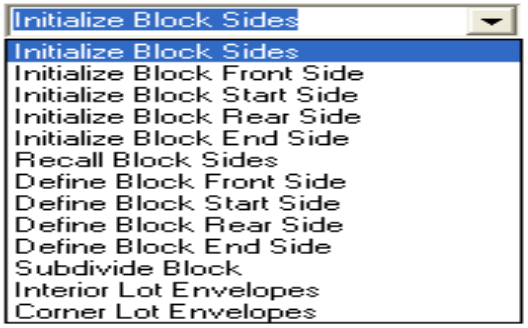




Subdivision Design

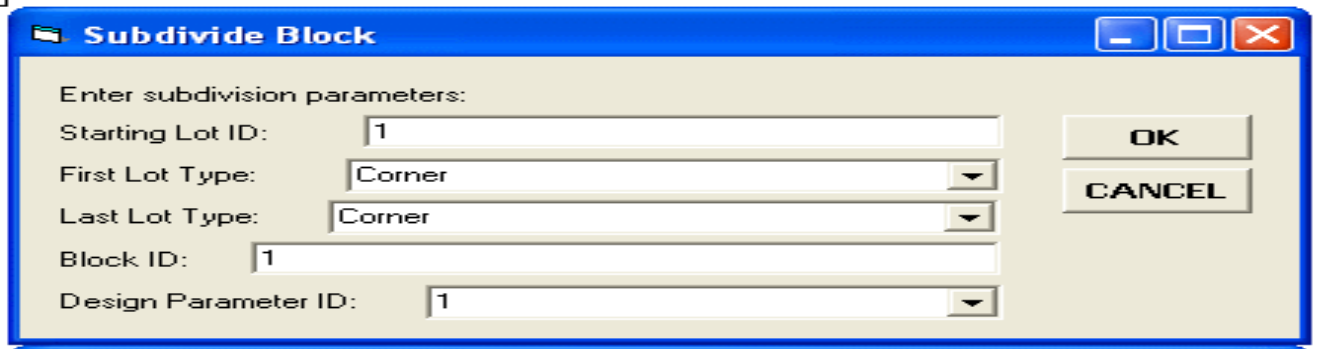
A "Block" of land can be subdivided into individual lots by specifying:

- **The four sides comprising the block and**
- **The design zoning criteria identifier**

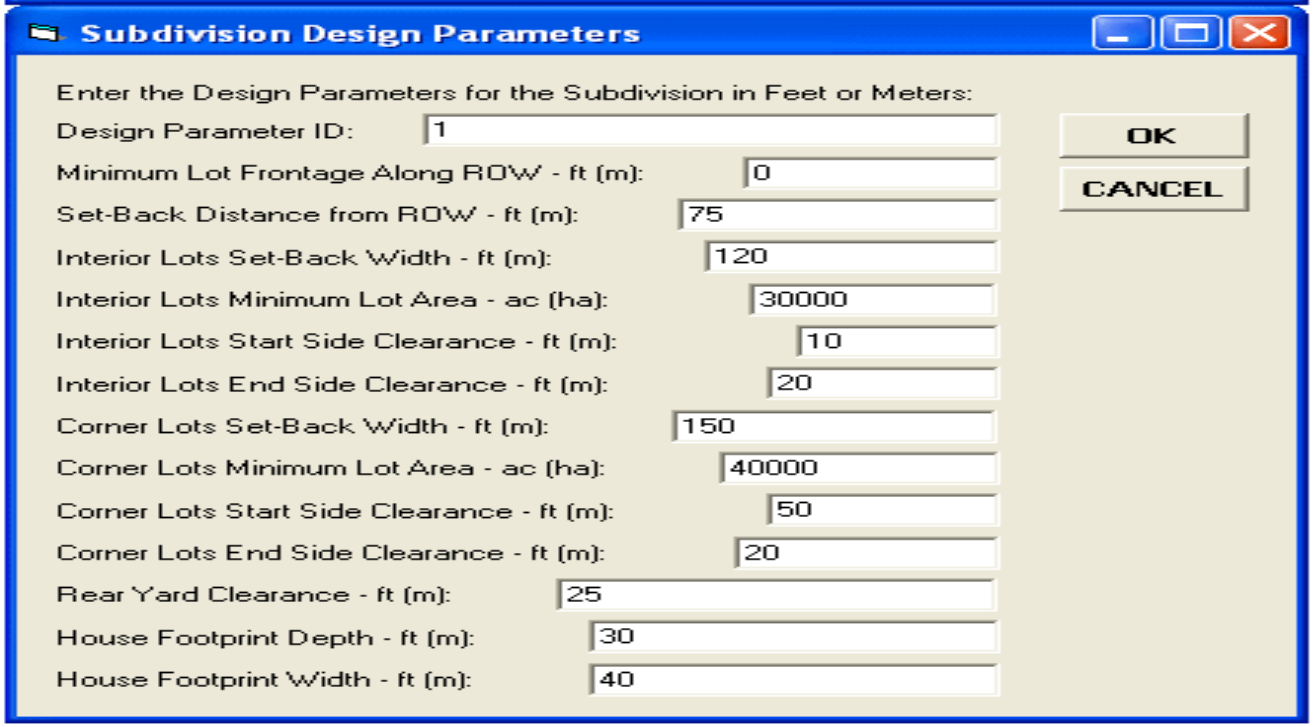


Menu combo box commands for automatically subdividing a parcel of land.

Dialog box for dividing a block into lots in accord of pre-established criteria.

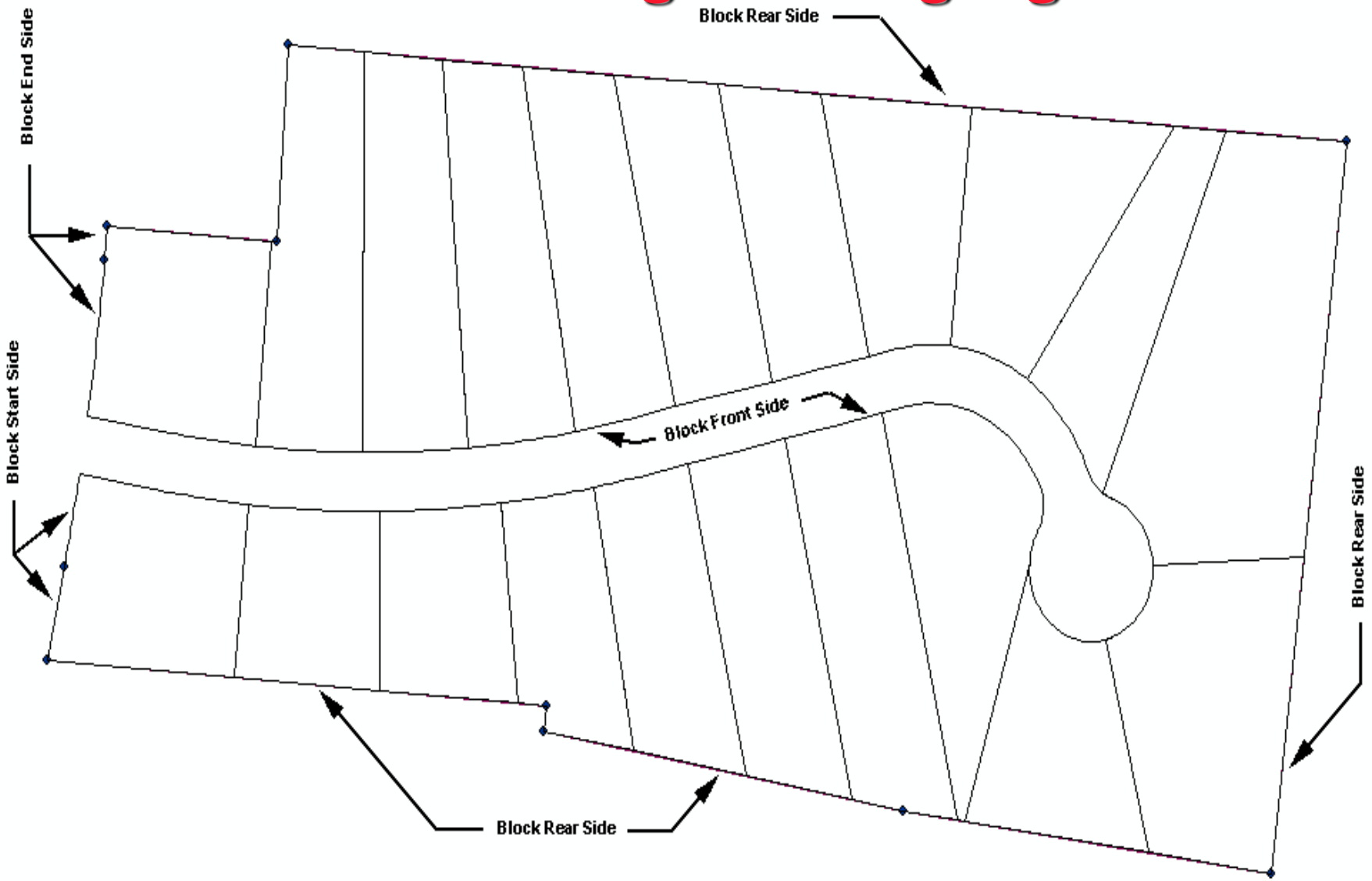


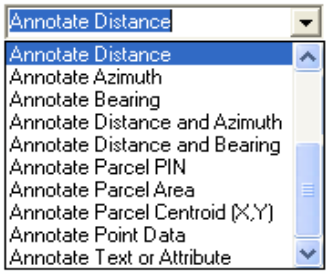
Dialog box for specifying the zoning criteria affecting the subdivision of a parcel of land.



Subdivision Design Data

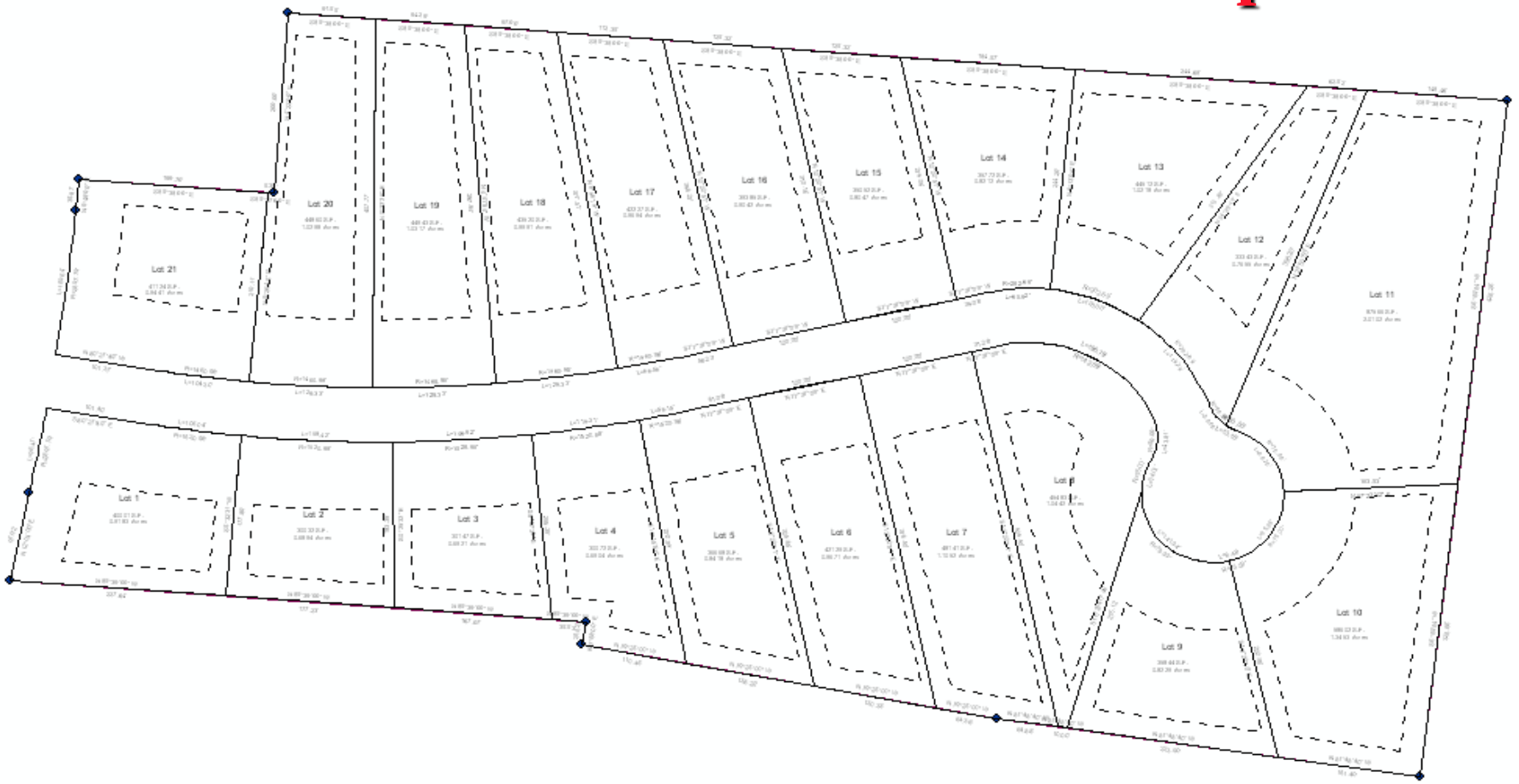
A four sided “Block” and its automatic division into lots conforming to zoning regulations





Mass Generation of

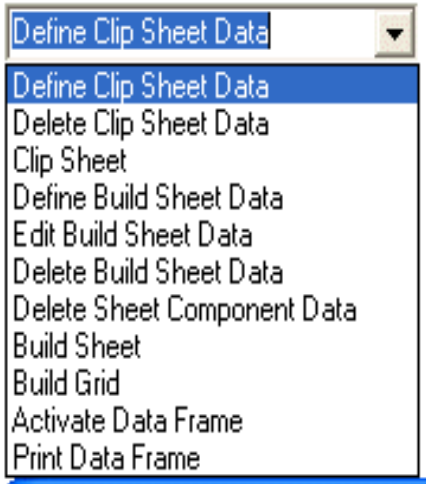
- Lots,
- Metes & Bounds and
- House envelopes



Plan and Profile Drawings

P&P Drawings are created by specifying:

- **A sheet identifier and**
- **The components to be included on the drawing, as the plan view, profile view, north arrow, drawing sheet border, etc.**



Menu combo box commands for creating final design drafting sheets.

P&P Drawing Components

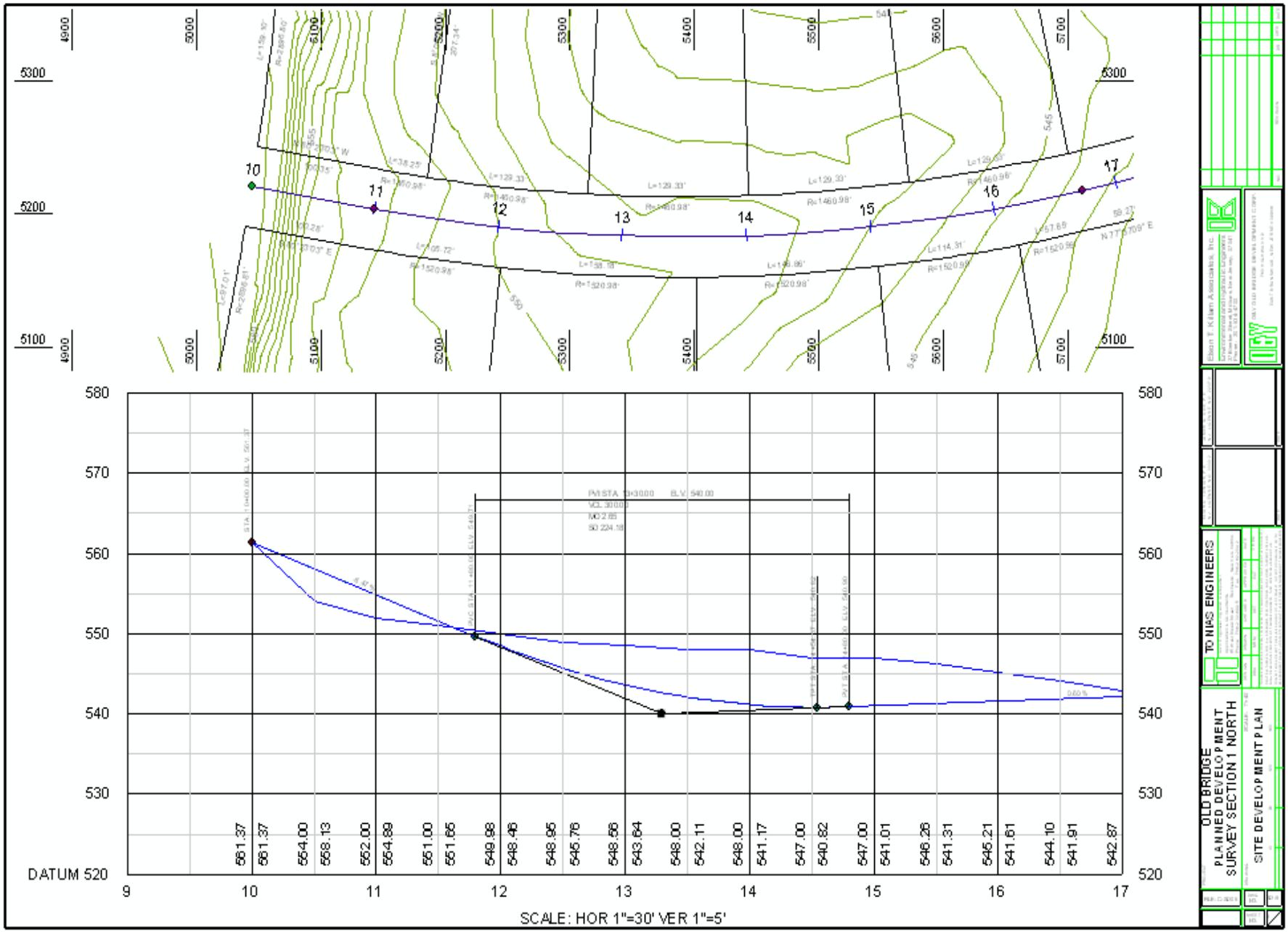
Dialog box for assembling final design drafting sheets

Edit Build Sheet Data

Enter Sheet Parameters for Sheet 1 (Page 1 of 1)

Shapefile or PGD FeatureClass	Scale	Rotation	Base X	Base Y	New X	New Y
C:\Proj02814\Site\Plan.mdb\Sheet_1	30	0	1204854.165683	785082.556093	1.5	14.4
C:\Proj02814\Site\Profile1.mdb\Sheet_1	1	0	0.000	0.000	4.510	1.850
C:\Proj02814\Borders\g_brd.mdb\g_brdln	1	0	0	0	0	0
C:\Proj02814\Borders\g_brd.mdb\g_brdtx	1	0	0	0	0	0
C:\Proj02814\Borders\g_brd.mdb\g_brdpg	1	0	0	0	0	0

OK Cancel


5300
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DATUM 520
9
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16
17
561.37
561.37
554.00
558.13
552.00
554.89
551.00
551.65
549.98
548.46
548.95
545.76
548.56
543.64
548.00
542.11
548.00
541.17
547.00
540.82
547.00
541.01
546.26
541.31
545.21
541.61
544.10
541.91
542.87
SCALE: HOR 1"=30' VER 1"=5'
TO NIAS ENGINEERS
OLD BRIDGE
PLANNED DEVELOPMENT
SURVEY SECTION 1 NORTH
SITE DEVELOPMENT PLAN

Design Data Exchange

During the design, pertinent information can be stored with the drawing features such as:

Lot Number	**Pipe Length**	**Street Name**
House Number	**Pipe Material**	**Design Speed**
Block Number	**Pipe Size**	**etc.**

data which is pertinent to the municipal client


Integration
with the 3D
Analyst

Summary

- ArcGIS can be used as a graphic engine for design and drafting applications.
- Performing the design in ArcGIS enables the engineer to provide a more compatible product for incorporation into the municipal client's GIS.

Summary

- The fundamental ArcGIS concept of combining data with graphics in one environment provides a path towards the total design process of a project.