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# STUDENT GUIDE

# Trimble Business Center HCE Software





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### **STUDENT GUIDE**

### **Business Center - HCE Software**

Version 3.20 Business Center - HCE Software Revision A June 2015



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CHAPTER 1

### Becoming Familiar with Trimble<sup>®</sup> Business Center – Heavy Construction Edition (HCE)

#### Welcome

Welcome to the Trimble<sup>®</sup> Business Center – Heavy Construction Edition (HCE) Becoming Familiar with Business Center - HCE Module. This module will walk you through the Business Center – HCE user interface, basic operations, and common settings.

This guide was developed by Trimble Navigation's Global Services Training and Support staff to support classroom instruction delivered by a Trimble Certified Trainer. The Trimble Certified Trainer will use this guide to lead you through getting started with Business Center – HCE using real world exercises. Please use this guide in conjunction with the Business Center - HCE help files and other product resources available.

#### **Overview**

Business Center - HCE is a powerful software tool used by professionals to make better project decisions, decrease costly mistakes, and increase efficiency in the office and on the job site. The software is composed of different modules that are purchased individually or as bundles, depending upon the needs of the user.

Business Center - HCE is structured in projects that are equivalent to construction projects in the real world. From bidding projects to planning construction throughout the construction phases, and it is all handled in Business Center - HCE.

You can prepare professional site earthworks and construction material quantity takeoffs quickly and accurately with expanded detail. You can also convert digital CAD cross-sections, rapidly extract cross-section information from Adobe PDF vector files, and quickly see locations and quantities of materials for road take-offs. Once the project has been awarded Buiness Center - HCE has tools which are used to create accurate, integrated 3D models for sites and corridors quickly and easily. You can then effectively and seamlessly manage data between the office, Trimble® SCS900 Site Controller Software, and Trimble machine control systems. All of these functions will be explained in more detail in later chapters.

Using the mass-haul functionality, contractors now have powerful tools to analyze sites and define the optimal way to complete the work with the user-defined machine resources available. Business Center - HCE also offers you the ability to generate reports and publish information to external applications for collaboration with the entire project team.

#### **Learning Objectives**

Getting Started in Business Center

- Understanding the User-Interface
- Setting up a New Project
- Project-Specific Settings
- System Settings
- Importing Data

#### **Files Needed**

For the training exercises, you should save the following files provided by your Certified Trainer onto your PC and note the location.

- Training Sample Data.dxf
- Training Sample Points.csv

#### **Getting Started in Business Center - HCE**

Let's get started, double-click the Business Center - HCE Icon <sup>6</sup> to launch the program.

#### Start Page

Upon launching Business Center - HCE you will by default be brought to the Start Page. Alternatively, this screen is accessed via the Support tab on the ribbon. Let's observe the Start page and get familiar with the components of its user-interface.

Start Page Plan View		
	BUSINESS CENTER - HCE	
	Data Review       Field Data       Data Prep       Site Takeoff       Condor Takeoff       Construction	
	Documentation YouTube	
	Tours and Tutorials Community Forum	
	Workflow Guides Check for Updates	
	@ Copyright 2006-0014 Trimele Navigation Ltd.	

**Ribbon Customization Options** – the buttons allow you to quickly adjust the layout of the Ribbon for the operation you want to preform.



**Quick Links** – these buttons quickly allow you to get to useful information or preform quick operations.

**Documentation** – allows you to get to some documentation quickly and easily; like the Read Me file, Release Notes, and Help System.

**Tours and Tutorials** – will open an internet browser window with the links to all of the Training Videos, Tutorials, and Data Sets.

*Workflow Guides* – allows you to get to all the workflow guides and workflow wizards quickly.

**YouTube** – will take you to all the Business Center – HCE videos located on YouTube.

**Community Forum** – will open an internet browser window to the Business Center – HCE Forum.

*Check for Updates* – allows you to quickly check for updates.

#### Business Center - HCE User Interface



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Show elevation		
Show disconnected points	-200p0	
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**Ribbon** - this holds the commands relative to the workflow selected.

**Quick Access Toolbar** - this toolbar holds the most commonly used commands, for one-click access.

*Note: The Quick Access Toolbar can be shown above or below the Ribbon.* 

100	Project	View	Edit	CAD S	urface Dat	a Prep	Takeoff	Site Mass Haul	10
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-	Project	View	Edit	CAD S	urface Dat	a Prep	Takeoff	Site Mass Haul	R
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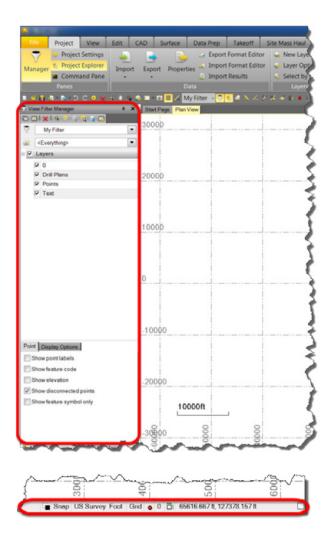
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**Graphical View Window** - data can be viewed in multiple view styles.

**Pane View** - selected commands are presented in pane views, allowing users to enter necessary values.



**Status Bar** - vital project information is always displayed here.

#### Ribbon Menu Layout

The ribbon layout makes related commands more visible and convenient to use on theme-based or workflowbased tabs. Notice the tabs and the associated commands in the ribbon below. In our case, we will be starting a new project. By selecting the Project tab, we now have numerous commands at our disposal. Each of these commands are associated with getting a project started. Generally, users should complete commands from left to right within a ribbon to complete that workflow and this holds true here.



*Note:* You can right-click anywere on the ribbon to customize your ribbon and quick access toolbar, or to move the location of the quick access toolbar.

#### **Quick Access Toolbar**

The Quick Access Toolbar is located directly above the Ribbon by default. It contains a collection of the most commonly used commands and is independent of the ribbon tab that is currently selected. Users are urged to

customize the Quick Access Toolbar commands to suit their organizations needs. In addition to customizing the command short-cuts, users also have the option of placing it above or below the ribbon.

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#### Customizing the Ribbon and Quick Access Toolbar

The Ribbon and Quick Access Toolbar customization is easily accomplished. The following exercise will demonstrate the flexibility that users have and how this function is completed.

1. Right-click in the ribbon or the quick access toolbar.

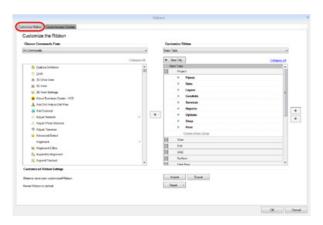
*Note: You will see the available options for ribbon and quick access toolbar customization.* 

2. Select Customize the Ribbon...



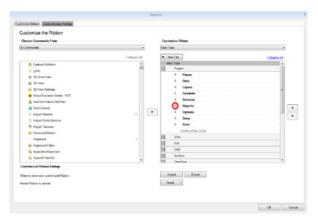
3. Make sure the *Customize Ribbon* tab is selected at the top of the Options window.

Note: By selecting the appropriate tab in the upper lefthand corner of the window you can customize both the ribbon and the quick access toolbar from this window.



# 4. Select the icon next to Reports to expand the Reports group.

Note: If the Project tab is not expanded under the Main Tabs list you can expand it by Double-clicking on it and all the groups of commands associated with that tab are displayed. If you would like to create a new group this option is available as well.



#### 5. Find Earthwork Report in the list of commands and left-click on it to select it.

Note: You will have to scroll-down the list to find the Earthwork Report but they are in alphabetical order. You may noticed two Earthwork Reports, select the upper one.

6. Make sure Reports is selected in the Main Tabs.

Note: It should already be selected from left-clicking on the 主 icon from step 4 but if you have left-clicked on any other items under the Main Tabs list it may not be.

7. Select the arrow button to move Earthwork Report into the Reports group on the right.

Note: The Earthwork Report command is now added under Reports in the Project Tab.

8. Select the Modify Item **/** icon on the Earthwork Report (Custom).

Note: To further customize the newly added command you can use the following options.



Modify the Command



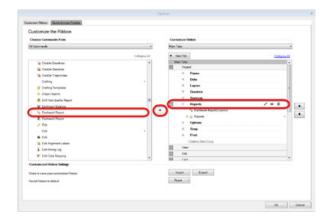
The Command is Visible

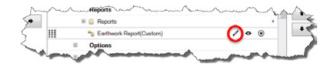


The Command is Invisible but still present



Deletes the Command from the Ribbon





9. After reviewing the options in the Modify the Tool

window, select Cancel

Note: You can easily change the names of any commands here. You also have the option to add or change an image and its size.

	Modify the	fool X
Caption of the Tool		
Main Tabs > Project :	> Reports >	Earthwork Report
Custom Image		
	age from belov	v or provide your own image.
+ add		
L		
Select an im	age from belov	or provide your own image.
+ add		
L		
Sizing Behaviors		
Preferred Size	Default	•
Minimum Size on Ribbon	Default	•
		OK Cancel

#### 10. Select OK in the Options window.

Note: At the bottom of this window you have the ablity to Import, Export and Reset commands.

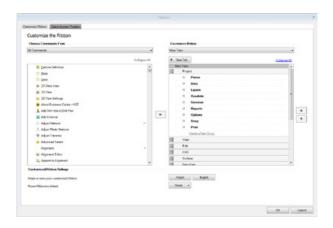
**Export** - allows you to export your ribbon and quick access toolbar.

*Import* - allows you to import a exported ribbon and quick access toolbar for your use.

**Reset** - allows you to reset a select Ribbon or All Custimizations.

#### 11. Select the Project tab on the Ribbon.

Note: You will notice a small icon in the Reports area under the Project Tab. If you put your curser over the icon, I box will popup explaining the icon. You will notice that this is the Earthwork Report that we just added in the Options window.





#### Starting a New Project

Now that we have familiarized ourselves with the layout of the user interface and the commands used in Business Center – HCE, let's start a new project.

#### 1. Select the File tab on the Ribbon.

*Note: The following menu becomes available. Let's briefly explain these options before proceeding.* 

*Save* – saves the current project to the specified location with the current name.

*Save Project As* – saves the current project to a new location and/or with a new name.

**Save Project As Template** – saves the current project with all associated settings as a project template. Layer names, styles, coordinate systems, and more are all saved as a template for future projects.

Note: You are urged to use this command, it is a big time saver!

**Open** – brings up an Open File window so that you can navigate to an existing project to open it.

*Close* – *closes the currently opened project.* 

**Info** – used to view the currently opened project's properties. Such as creation date, date last modified, description, and coordinate system summary.

**Recent** – allows users to quickly navigate to recently opened projects.

**New** – open a new project in Business Center – HCE.

**Print** – print the current contents of the view window. You can also access print preview and page setup as well.

**Reports** – access an array of reporting options for the current opened project.

*Help* – access numerous Business Center - HCE resources.

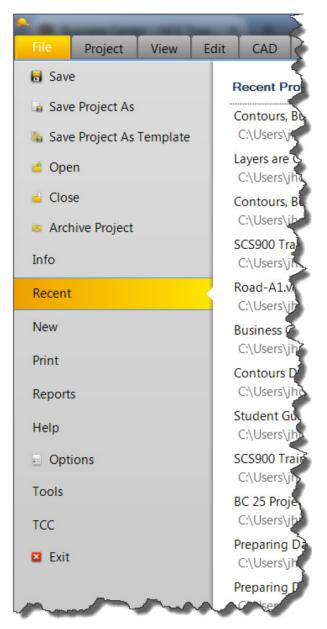
**Options** – access the system setting options menu.

**Tools** – access Business Center - HCE plug-ins and external tools.

**TCC** – access the Trimble Connected Community cloud environment.

Note: Users must have a TCC subscription.

**Exit** – Exit Business Center – HCE.

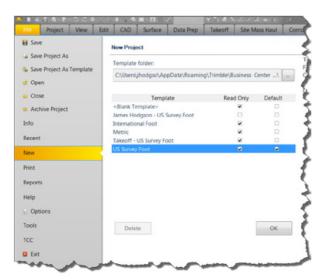


#### 2. Select New under the File tab.

Note: By default Business Center - HCE is installed with five templates and four of them are based on units. You can add more Templates by using the Save Project as Template discussed earlier. You can also select which Template is your default Template.

3. Left-click on US Survey Foot to highlight it and select OK.

*Note: A new project is opened using the units that were specified. By default the Plan View window appears.* 



#### Understanding the Status Bar

The status bar includes important project information like the current units, an error flag indicator (indicating computation errors), the number of currently selected objects, and a coordinate display are always readily available in the lower right corner of the Business Center - HCE window. The Status bar has shortcuts to commonly used features

1. Select the Toggle Background Color icon to change the background color between black and white.

 Snop US Survey Foot Grid • 0 1/11 65616 667 ft 127378 157 ft

Note: Many find the black background easier on the eyes. While the white background is useful to see how lines and colors will display in the field when exported to data collectors.

2. Select Snap to open the Running Snap Mode Options.

Note: This allows users to define how points and lines are selected with the cursor in the graphical view windows.

**Point** - If a point object is inside the pick aperture, the coordinate of the point is used.

**End point** - If the end point of a line or arc segment is inside the pick aperture, the coordinate of the end point is used.

*Insertion point* - *If any part of a text or block object is inside the pick aperture, the insertion point of the object is used.* 

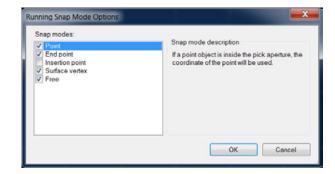
*Surface vertex* - *If the surface vertex is inside the pick aperture, the coordinate of the vertex is used.* 

*Free* - The coordinate at the intersection of the cross hairs will be used.

- 3. Select all but Insertion Point by left-clicking in the boxes to add or remove the checkmarks.
- 4. Select OK
- 5. Select US Survey Foot on the status bar.

Note: The following Project Settings window now appears. This allows you to change the units of the project, the unit formatting, and how units are displayed graphically.

6. Select Cancel



General Information	- Unit		
Coordinate System Units	Display.	US survey foot	
Coordinate	Foot definition	US survey foot	
Distance	- Formatting		_
Azimuth	Decimal precision:	0.123	
- Vertical Angle Pressure	Show trailing zeros.	Yes	
Temperature	Show trailing decimal:	No	
GPS Time	Rounding mode:	Normal	
Area	Automatic rounding	Yes	
Volume	Round to nearest:	0.001	
View Computations Easeline Processing RTX Post-Processing			

7.	Select	Grid	on the Status Bar.
----	--------	------	--------------------

*Note: The same Project Settings window opens but this time defaults to the Coordinate System.* 

8. Select



	Summary	
Coordinate System	Coordinate system group:	Default
eoid Model & Vertic	Zone:	Default
ocal Site	Datum transformation:	WGIS 1984 (None)
etwork Adjustment T	Geoid model.	None
rojection		
hift Grid		
ite Calibration		
Line .		
Computations		
Baseline Processing		
TXPost-Processing		
ietwork Adjustment		
Vetwork Adjustment Default Standard Erro		
We with Standard Erro	Change	

### 9. Select the Compute Project Needed <sup>(a)</sup> icon if it is visible on the status bar.

Note: The Compute Project Button indicates that changes were made to the project that have not yet been recalculated and also appears if changes made to the data require that final coordinates for points be recalculated.

Note: The computation applies the changes made to all affected observations and determines the coordinates for points in the chronological sequence a surveyor would typically expect. If conflicting data is available for the computation of a coordinate, the software gives preference to higher quality data over lower quality data.

- 10. The number to the right of the Compute Project Command indicates to the user how many objects are currently selected in the project.
- 11. The Plan View Dimensions icon indicates what coordinates are being displayed.

Note: When the icon is present it indicates that the coordinates displayed in the status bar are in reference to the XY dimensions of the current view window and if it is not present the coordinates displayed represent the true northing and easting of the current cursor location.

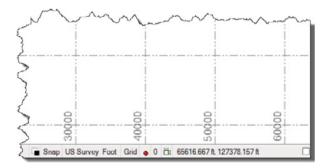
#### 12. Left-click on the box on the far right of the status bar.

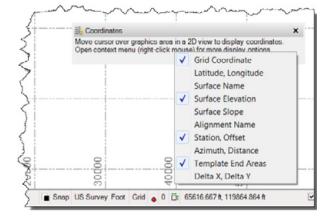
*Note: This opens the coordinate display window, that can be docked or remain floating.* 

#### 13. Right-click on the Coordinates box.

Note: These settings allow the user to indicate what values will be visible when the coordinate display checkbox is seleted. The values relate to the current location of the cursor and must be used within the plan view.

14. Left-click on the imes icon in the Coordinates box or uncheck the far right box on the status bar to close the Coordinates box.





#### Project Options

Project Options are system settings which means that changes made here take effect within all projects in Business Center-HCE. Project Options are accessible via the File tab and selecting Options as shown earlier, or via the Project tab and selecting Options on the ribbon.



1. Select the Options Options icon in the Option area under the Project Tab.

Note: You can also get to options by selecting File and then Detions.

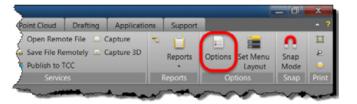
2. If not already selected, left-click on Startup and Display under the General folder to select it.

*Note: Descriptions of each of the options under Startup and Display are outlined below.* 

**Starting State** – Defines the state that Business Center - HCE opens in upon starting and your options are:

No project Open last project Open project command Display start page

Open a new default project



	Idding Community 2 Publick to TCC + Layout Mon Services Reports Options Ser
Control Control Control Desire Pro Locations Control Mase Internal Dominal Dominal Bervass Improvement Program Desired Processor	Tendor Options Nondorgana Carlor derarga Tarataga Reconstruction der Bartagas Reconstruction der Constructions der project mehr Bartagas
Protogenwery Port Code Indjee Process Motoring Network Device Pot Internet Device Pot Stead	Carginal Services Souther status Data provide Services Data provi
	Fees Odds and scrabe sides: Uncount have fair Operations Operations Uncount have fair Uncount have fai

*Start Page* – Defines what the start page will be if this was the option selected as the starting state.

**Recently-used file list** – Number of recent project files that will be listed at the bottom of the File menu, allowing quick access.

*Close start pages on project startup checkbox* - *Check this box to direct the start page to automatically close each time a new project is created or an existing project is opened.* 

**Display data tips** – Describes entities under the cursor in the graphical view.

Background color – Toggle the background color between black and white.

Highlight color – Color that selected objects are displayed in.

Cursor color - Color that the cursor is displayed in.

*Line Marking Color* – Color of line markers and labels so they are visible when shown over an image or *surface*.

*Pick Aperture* – *Determines the size of the cursor.* 

Highlight Line Width – Determines the size of selected lines.

Reverse Zoom Mouse Wheel – Determines how the mouse wheel zooms in and out.

Fonts – Determines the type of font set utilized by Business Center – HCE.

### 3. Left-click on File Locations under the General Folder to select it.

Note: You can set the following folder locations to suit your organization's needs. The different folder location settings are explained below.

**Project Management Folder** – Defines the folder location on the PC to be used as the default for saving new project files.

**Use Project Subfolders** – Select this to automatically have the program organize project data in subfolders.

**Export Folder** – This specifys where exported files are sent to from Business Center - HCE .

**Download and Import Folder** – This specifys where imported project files and imported field data is stored.

**Copy Imported Files to Import Folder** – Select this checkbox to direct Business Center - HCE to copy all files imported and store them in the appropriate project subfolder for easy reference.

**Template Folder** – Specifies the folder location for project templates.

*Format Definition Folder* – *Specifies the folder location for exported format definitions.* 

Note – A Format Definintion is used to create custom export format definitions that is utilized to export project data into text files. The format definition defines the record type and the fields to be included in the export.

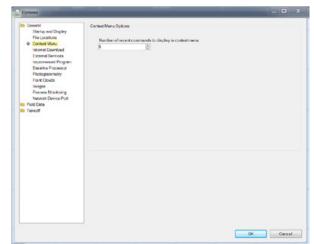
**Data Synchronization Area** – This specifies the folder location that is used to synchronize data between field devices and the PC. Office Synchronizer accesses this file and synchronizes files based on time stamps or file size (TCC).

Note: The default location is C:\Trimble Synchronizer Data\

Options	-	
General Startup and Display	Project Management Project management folder:	
File Locations	C:IUsers/jreinhalDocuments/Business Center - HCE/	-
Context Menu	Use project subfolders	
Internet Download	Export folder:	
External Services	CilUsers/jreinhalDocuments/Business Center - HCE/Unnamed	
Improvement Program	Download and import folder:	
<b>Baseline Processor</b>	C/Users/jreinhalDocuments/Business Center - HCE/Unnamed	
Photogrammetry	Copy imported files to import folder	
Point Clouds	Folder for intermediate report:	
Images Process Monitoring	CIUsers/jreinhalDocuments/Business Center - HCEUnnamed	
Network Device Port	Block definition file folder:	
Field Data	C:ProgramData(Trimble/Block Definitions)	
Takeoff	Templates Template folder:	
	C:Users'(reinhalAppData/Roaming)Trimble/Business Center - HCE Construction/21.0	_
	Custom Export Format definition faider:	
	C-IUsers/jreinhal/AppData/Roaming/Trimble/Business Center - HCE Construction/21.0.	-
	Office Synchronizer Data synchronization area (synchronizer root folder):	
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4. Left-click on Context Menu under the General Folder to select it.

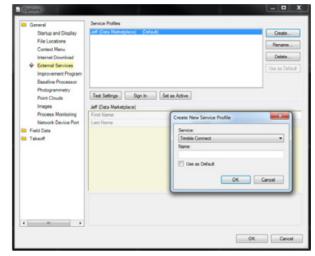
Note: If you change this to five. You will now see the five most recently used commands we have utilized when right-clicking anywhere in Business Center - HCE.



# 5. Left-click on External Services under the General Folder to select it.

Note: Business Center - HCE has the ability to integrate with external services such as Trimble Connected Community (TCC) and Bentley Project Wise. Multiple profiles can be created in Business Center - HCE. User login data, server location, and folder locations are set in the External Services options. Once set, users can open files remotely and save files remotely. This allows for seamless collaboration with users anywhere in the world.

- Service Profiles Users select the TCC or Bentley Project Wise profile they have previously set up or elect to create a New profile.
- New Profiles Upon subscription to the TCC, ProjectWise, VisionLink, or other services available. Users are provided with a server address, user name, password, and a folder structure within the cloud service. Enter this information after naming the new profile. Upon completion, users can select Test Connection to verify they have a valid connection.



6. Left-click on Photogrammetry under the General Folder to select it.

*Maximum number of station views* – This specifies the maximum number of station views Business Center - HCE will allow to be opened at the same time. If this value is set high and multiple station views are opened at once, the users PC may experience memory usage issues.

**Pixel Picker Aperture** – This value determines the size of the mouse cursor when measuring photo points on photo images.

**Display Pixel Picker in Grayscale** – If checked, Business Center - HCE will display the pixel picker in grayscale only.

**Dynamic Pixel Picker** – If checked, the pixel picker is in dynamic mode. This means the pixel picker is a magnifier with a reticle. This enables users to dynamically select the precise location for a measurement. If unchecked, the pixel picker is in static mode. This means the user must left-click to open a magnified view of the slection and then select the precise location for a photogrammatery measurement.

**Station View Field of Vision Indicator** – If checked, in the plan view a graphical indicator of the field of vision for each station view is displayed. As the field of vision parameters are changed, these changes are indicated in the plan view.

*Indicator Color* – Sets the color to use for the field of vision indicator in the plan view.

*Indicator Length* – This value determines the projection distance the field of vision indicator is extended in the plan view. It is set as a percentage of the projection distance.

*Indicator Transparency* – This value sets the transparency of the field of vision indicator.

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### 7. Left-click Point Clouds under the General Folder to select it.

Note: You can control the maximum number of points allowable for surface and volume applications. More allowable points results in a more precise surface or volume, but at the expense of slower performance. Depending on the PC being utilized, these settings can be raised or lowered to find the optimal balance between preciseness and PC performance.

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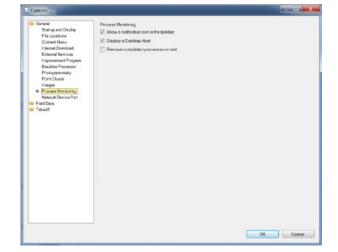
### 8. Left-click on Images under the General Folder to select it.

Note: These options control how station view and georeferenced images are displayed in Business Center -HCE. These options are customizable to allow users to balance image resolutions with system performance.

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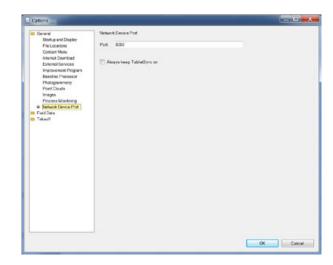
## 9. Left-click on Process Monitoring under the General Folder to select it.

Note: When processes such as surface creation, project clean-up, mass-haul analysis, etc. are being computed; these options specify various setttings that control the display of the process view tab.



### 10. Left-click on Network Device Port under the General Folder to select it.

Note: These controls allow the you to specify the port that you want to use to connect to a Trimble® Tablet. The port chosen needs to match the Trimble Tablet's port settings. The default port is 8000. By checking the option for Keep TabletSnyc Always On, you can specify Business Center to always be listening for a connection request from a Trimble Tablet.



# 11. Left-click on the Field Data folder in the Option window to select it.

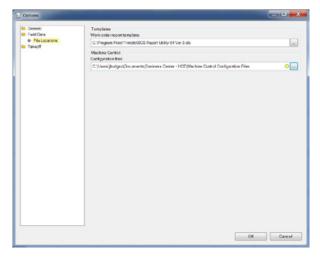
*Note: These settings direct Business Center were to look for field data file locations.* 

*Work Order Report Template* - When viewing the work order results imported from a data collector, Business Center requires a report template to use in conjuction

with the field data. Select the icon to open the Browse For File window, to select your Work order report template.

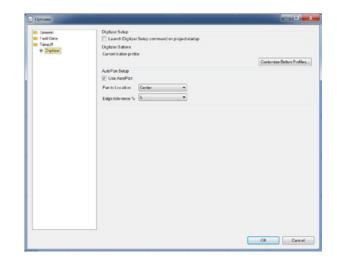
*Machine Control Configuration Files* – You can Import measure-up(.mch) and display(.dsp) files into your data synchronization area to make them available for your

machines using grade control systems. Select the icon to open the Browse For Folder window, to select the folder for your Machine Control Configuration files.



12. Left-click on Takeoff folder in the Option window to select it.

Note: Settings here allow you to set preferences for a digitizer. These settings enable you to customize the digitizer button profiles and specify auto-pan settings.



#### **Importing Data**

There are two ways that you can import data:

- Using the Importer that is accessible on the Quick Access Toolbar or on the ribbon under the Project tab.
- Dragging and dropping the file from the PC into the graphical view window of Business Center HCE.

Note: You get full access to an array of settings by using the importer. When dragging and dropping you lose access to these settings. It is recommended that you utilize the Importer until you are familiar with different file types and how they can be manipulated. These options will be described in more detail.

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1. Select the Import Import icon in the Data area under the Project tab.

Note: You can also select the Import icon from the Quick Access Toolbar.

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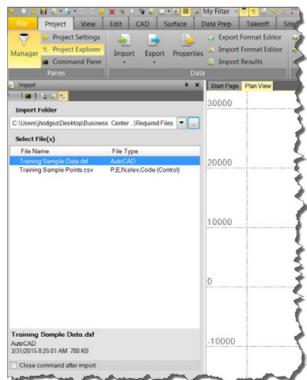
2. Left-click on Training Sample Data.dxf to highlight it.

Note: You may have to use the button to select the folder where the Training Sample Data.dxf file is saved on your PC.

Note: You can hide any files the importer does not recognize by selecting the Show only know file types icon. Unknown file types are labeled as Unknown in the File Type column of the importer.

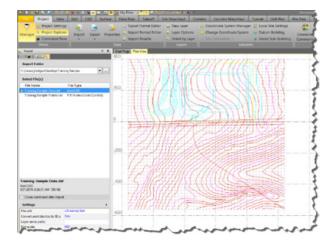
Note: CAD files import using the current project units.

3. Ensure the box in front of the Close command after import is unchecked.





Note: You will now see the  $\textcircled{1}{2}$  icon in from of the file name, which shows that this file has been imported.



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- 5. Using Windows Explorer go to the folder where you have stored the Training Sample Points.csv file.

### 6. Drag-and-drop the *Training Sample Points.csv* into the Graphical View Window in Business Center - HCE.

Note: The Import Format Editor displays because the file is recognized as a points file. You must now define the format of the points file so Business Center - HCE can properly import the data.

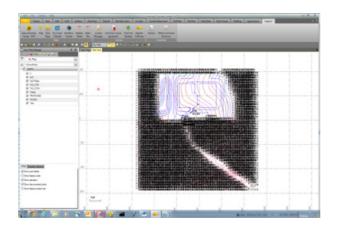
Note: The file name is shown in the middle of the Import Format Editor.

7. Select *P*, *N*, *E*, elev, Code (Control) in the Definition Name column.

Note: This is because we know our point file is defined in the order of point id, northing, easting, elevation and then feature code.

- 8. Select Import in the Import Format Editor.
- 9. Select Close in the Import pane.
- 10. Close the Windows Explorer window.

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#### Viewing imported data

You can review imported data in one of the following ways:

- Using the **Project Explorer**, which displays your data organized in a hierarchical tree structure.
- Using the **Properties** pane, which lets you review and edit some of the attributes of objects.
- Using a Spreadsheet view, which helps you check data by sorting and filtering on different criteria.
- Graphically, by zooming and panning in the **Plan View** or **3D View**.

#### Utilizing the Project Explorer to View Data

The Project Explorer is a great way to view your data in a organized hierarchical tree structure.

1. If the *Project Explorer* pane is not already displayed, you can left-click on Project Explorer in the Panes area on the Project tab.

Note: You can also press **[F9]** on the keyboard. The project explorer displays docked on the left side of the screen.

Note: If required, click the *icon* at the top of the pane to pin the explorer open.

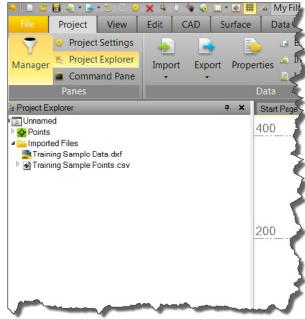
2. Left-click the bicon next to the Imported Files to expand the Imported Files.

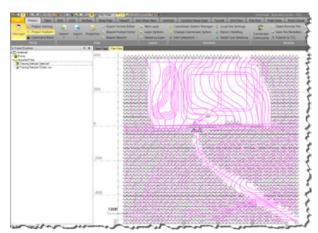
Note: If you expand the Training Sample Points.csv, the list is very long. So you will want to keep its list collapsed until you need to see it.

Note: You can click-and-drag the right edge of the Project Explorer pane to narrow or widen it.

3. Right-click on Training Sample Data.dxf under Imported Files in the Project Explorer and select Select Members.

Note: All the members that comprise that file are now highlighted in the Plan View.





#### Using the Properties Pane to View Data

The properties pane is a great way to view all the data associated with a selected object, in an organized and logical fashion. In addition to viewing data you can change the appearance of objects, the layer that an object resides on, the geometry of objects, and other pertinent information.

1. Right-click in the Graphical View Window and select Properties.

Note: You can also press F11 on the keyboard to display the Properties pane.

2. Left-click on the Building Pad line in the plan view.

*Note: The attributes with blue text are editable and the attributes that are greyed out are not.* 

3. Double-click in the Name box and change the name of the object to Building Pad.

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4. Right-click the pane's title bar and select *Floating*.

Note: The pane becomes undocked, enabling you to move it anywhere on the screen or even onto a second monitor. This is helpful when you have so much data in your project that you need more room for the graphical views.

5. Right-click the title bar and select *Floating* to re-dock the pane.

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#### Using the Spreadsheet View

1. Select New Points Spreadsheet Points icon in the Spreadsheets area under the View Tab.

Note: You can sort the points by clicking on the column heading that you would like to sort by.

2. Find the Point ID 1093 and double-click in the box to the left of the Point ID column next to it.

*Note: The row is selected and the properties for the point display in the properties pane.* 

Note: If you try editing the elevation in the Grid Coordinate group, you will discover that you cannot edit a point's elevation directly. You actually have to edit the coordinate object for the point.

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3. Select the Add Coordinate icon on the *Property* pane's toolbar.

*Note: This allows you to add a new coordinate record for the point.* 

- 4. Enter 462.25 in the *Elevation* box on the Add Coordinate pane.
- 5. Select OK on the Add Coordinate pane.
- 6. With the Point Spreadsheet selected in the graphical view, Left-click on the <sup>x</sup> icon to close it.

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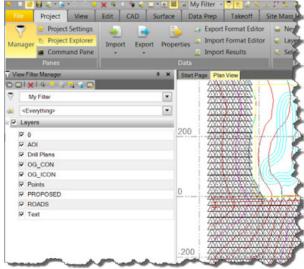
#### Using the Plan View

The Plan view is the default view for your project data. It displays a graphical view from above, as in a map display. Multiple plan views can be opened at the same time and the data that is visible is controlled by the View Filter Manager.

#### 1. Left-click on the View Filter Manager <sup>Manager</sup> icon to highlight it in the Panes area on the Project tab.

Note: You can also select the View Filter Manager  $\square$  icon on the quick access toolbar to highlighting it. If it is already highlighted you may have to click on the View Filter Manager tab at the bottom of the Pane view.

Note: If you close your plan view you can open a new one by selecting the New Plan View icon on the Quick Access Toolbar.



2. Change the View Filter from All to My Filter.

Note: By default the All filter is locked and cannot be edited. Once changed to My Filter you can edit layers and toggle them on and off.

3. Left-click on the *Points* check box to remove the check mark and notice that the points disappear in the plan view.

Note: If the Layers group is collapsed, you can expand the Layers group by left-clicking on the + icon in front of Layers.

- 4. Left-click on the *Points* check box to add the check mark and notice that the point data reappears.
- 5. Zoom and Pan in the *Plan View* into a small area that includes points so that you can see individual points and their labels.
- 6. Left-click on the *Point* tab near the bottom of the *View Filter Manager*.
- 7. Left-click on the check box next to Show point labels to add a check mark.

Note: You can now see all the point IDs (names). You can also choose to see other information by the points by checking other boxes.

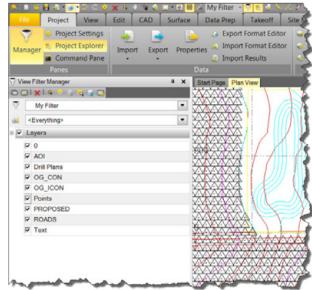
Note: None of the points are connected to surveyed baselines or vectors (processed baselines), so when you clear the Show disconnected points check box, all the points are hidden.

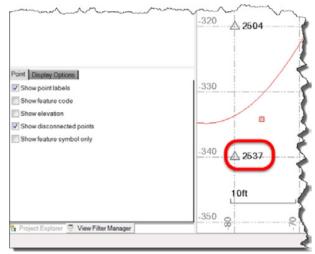
- 8. Left-click on the check box next to Show point labels to remove the check mark.
- 9. After exploring your data, left-click the Zoom Extents

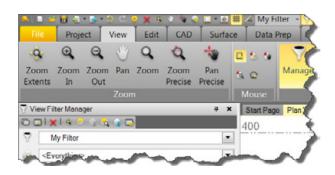
icon in the Quick Access Toolbar to zoom back to the extents of the data.

Note: You can also left-click on the Zoom Extents for the Zoom area under the View tab.

10. Left-click on the *Points* check box to remove the check mark.







### **Changing Layer Properties**

Notice that the building pad and parking lot are both blue. We will need to change the colors of these to make it easier to visualy reconizes the different components of the Plan.

1. Right-click the layer name OG\_CON in the View Filter Manager select Layer Options.

*Note: The Layer Options pane opens with the selected layer being the OG\_CON.* 

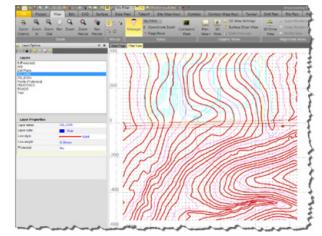
Note: The icons at the top of the Layer Options window allows you to create new layers, delete the current layer, and select all the members of the selected layer.

Note: To prevent a layer from being deleted or renamed, change the Protected box to yes. If you ever need to delete or rename the layer you can unprotect it in the future.

- 2. Left-click the Layer color in the Layer Properties section and select Blue for the color.
- 3. Left-click the Line Weight in the Layer Properties section and change it to .50 mm.
- 4. Select Close in the Layer Option pane.

*Note: Notice that the line weight has now changed but not the color.* 

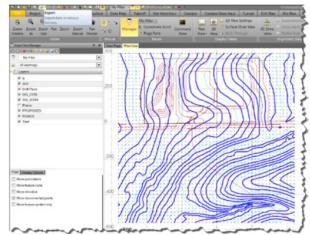
- 5. Left-click the Zoom Extents icon in the Quick Access Toolbar to zoom back to the extents of the data.
- 6. Drag a box around all the data in the plan view to select it.
- 7. Right-click in the graphical view and select properties.
- 8. Double-click in the Color cell under Appearance in the Properties pane, and select By Layer at the top of the drop-down list.
- 9. Select <u>Close</u> in the Properties pane.



	Proje	ect 1	View	Edit	CAD	Surfa	ce	Data	Prep	Tak	eoff
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1 <b>2</b> 19 All (1908) • <b>Appea</b>	] 🔮 🌻 908 objec		ed.			• •	•	Start Pag	$\left\langle \right\rangle$		

10. Left-click in an open area the graphical view to deselect all the items.

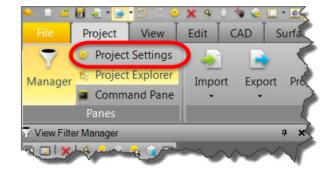
Note: The color has now changed to blue. You can preform steps 5 through 9 at the beginning of a project so that the changes made to a layer or items added to a layer update instantly in the graphical view.



## **Project Settings**

Use the Project Settings to set various parameters for your projects. These include setting coordinate systems, units, computations, and views. The setting are local to the specific project that is open and it is urged to save them into your organizations template. At the start of a new project, it is recommended that you review project settings to ensure they match your real-world project.

1. Select Project Settings in the Panes area under the Project tab.



- 2. Left-click on *General Information* folder and enter information about your Project.
- 3. Left-click on Company Information under the General Information folder and enter information about your company.
- 4. Left-click on User Information under the General Information folder and enter information about the User.

Note: By completing this information, it is stored in the project and visible on future reports.

General Information	- General Information				
Company Information User Information Coordinate System Units	File same: Created Last modified	Understading BCHCE vice 4(21)(2015 9:25:43 AM 4(21)(2015 4:22:55 FM (UTC -6)			
View	Using project folder: Reference number	Yes			
Bacolino Processing RTX Post-Processing Network Adjustment	Project name: Description:				
Ender Code Processin	Start date: End date:	4(21)2015 9:25 AM -06:00 5(21)2015 9:25 AM -06:00			
Abbreviations	<ul> <li>VisionLink</li> </ul>				
, , ,					
		OK Cancel			

- 5. Left-click on *Coordinate System* in the left pane and review the defaults.
- 6. Select Change ... in the Project Setting window.

	*	Summary	
Coordinate System		Coordinate system group:	Default
Geoid Model & Vertic		Zone:	Default
-Local Site	21	Datum transformation:	WGS 1984 (None)
Projection	11	Geold model:	None
Shift Grid Site Calibration		RTX datum.	No
Network Adjustment T FITX Datum Units View Computations Baseline Processing			
RTX Post-Processing Network Adjustment Default Standard Erro			
Feature Code Proces		Change	

## 7. Select New System... in the *Change Coordinate System* window.

Note: The Coordinate System Manager window will open and you can navigate through a series of options.

- 8. Close the Coordinate System Manager window.
- 9. Select Cancel in the Change Coordinate System window.

*Note: You should be back at the Project Settings window now.* 

#### 10. Left-click on the Units folder in the left pane.

*Note - Set these according to project specifications. The following options are available:* 

**Coordinate** - The order in which coordinates are displayed.

Distance - The unit used to display distance.

Angular - The type of angular units in the project.

**Azimuth** - Whether the project is in the North or South Azimuth.

*Vertical Angle* - Location of the slope ratio type. *Pressure* - The atmospheric pressure used.

Temperature - Fahrenheit, Celsius, or Kelvin.

**GPS Time** - Used to set the time zone for the project. **Station** - Specifies the style for Station formatting; 2

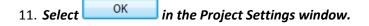
digits, 3 digits, or none.

**Area / Volume** - The assumed unit when displaying and evaluating areas or volumes.

Note: If you have time, explore the rest of the project settings folders on your own. They are commonly used for more advanced projects.

Select Coordinate Syste				-
Coordinate System and Zone				
Calibrated Ste				
Default projection (Transverse	Manadard			
> constant projection ( transverse	www.cator)			
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Australian Map Grid		Faja 3	Campo Inchauspe (Argenti	
Austria		Faja 4	Campo Inchauspe (Argenti	
Eangladesh		Faja 5	Campo Inchauspe (Argenti	
Eelgium		Faja 6	Campo Inchauspe (Argenti	
Eemuda 2000 (BDA2000)		Faja7	Campo Inchauspe (Argenti	
Eomeo RSO				
Eosnia				
Eotewana	-			
New System				
	2.2			

General Information		General
Coordinate System Units Coordinate Distance Angular Azimuth Vertical Angle		Undefined value: 7
Pressure Temperature GPS Time Station Area Volumo Volumo		
Computations     Baseline Processing     RTX Post-Processing	•	Undefined value: String used to indicate an undefined value





### Saving the Project as a Template

A template can be used for future projects, to ensure that they follow customer specifications. To do this, follow the workflow below.

1. Left-click on the File tab and select Save Project as Template.

Save	Recent Projects				
<ul> <li>Save Project As</li> <li>Save Project As Template</li> </ul>	Understading BCHCE.vce C:\Users\jhodgso\Desktop				
d Open	Corridor Takeoff.vce C:\Users\jhodgso\Desktop				
<ul> <li>Close</li> <li>Archive Project</li> </ul>	Corridor Takeoff Training Module.xce C\Users\ihodgso\Desktop\Corridor Training Module Corridor Takeoff Training Module.xce C\Users\ihodgso\Desktop				
Info					
Recent	Data Prep Manual Data Cleanup.vce C:\Users\jhodgso\Desktop				
New	Surfaces Created3.vce C:\Users\jhodgso\Desktop\Site Takeoff Module				
Print Reports	Surfaces Created2.vce C:\Users\jhodgso\Desktop\Site Takeoff Module				
Help	Surfaces Created.xce C:\Users\jhodgso\Desktop\Site Takeoff Module				
Options	Layers are Categorized.vce C\Users\ihodqso\Desktop\Site Takeoff Module				
Tools	Tutorial 9.vce C\Users\jhodgso\Desktop				
Exit	Contours, Building Pad, Parking Lot, and Storm Sewer Digitize				

## 2. Enter a descriptive name in the *Name* field for the template.

Note: If you plan on using this project template as the default template for your company, select



# 3. Select Save in the Save Project As Template window.

Note: The units and display format you set will be used in every project created with this template, and your user information can be included in every report you run using this template.

4. Left-click on the File tab and select Close.

Note: You you save a project as a template you need to close or start a new project to avoid accidentally saving data in your template.

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CHAPTER

## **Data Preparation**

### Welcome

Welcome to the Trimble<sup>®</sup> Business Center – Heavy Construction Edition (HCE) Data Preparation Module. This module incorporates tools to create high-accuracy linework and surfaces for stakeout, machine control, or takeoff calculations. The following procedures will teach you useful ways to clean up and prepare your data and create surfaces.

This guide was developed by Trimble Navigation's Global Services Training and Support staff to support classroom instruction delivered by a Trimble Certified Trainer. The Trimble Certified Trainer will use this guide to lead you through the Data Preparation Module using real world exercises. Please use this guide in conjunction with the Business Center - HCE help files and other product resources available.

### **Overview**

This module will teach you how to import CAD data and how to clean up this data using both automatic and manual tools. It will also show you how to create surfaces from this data, and how to import a PDF and drape it over a surface for added context.

## **Learning Objectives**

- Import CAD File
- Automated Project Cleanup
- Create and Edit CAD Data
- Elevate Data
- Create Surfaces
- Edit Surfaces
- Import PDFs
- Add Images to Surfaces

## **Data Preparation Commands Defined**

**Project Cleanup** – used during data preparation to automatically clean up your project data by removing unneeded objects, converting CAD lines into linestrings, joining lines, setting elevations on objects, and more. These optimizations can be done to selected objects or all of the objects in your project, but cleanup is most useful on imported CAD data.

**Explode** - Use the Explode command to break apart any objects that contain component objects that you want to move, modify, delete, or export individually. For example, you can explode a corridor to access the CAD points and polylines created from its corridor templates.

**Set Line Elevation** - Apply a single constant elevation to a 2D line to make it a 3D linestring. You can also specify a vertical offset from the elevation that you enter and a surface to which the linestring will be added.

**Contour (Elevate)** - Elevate a series of 2D lines representing surface contours by clicking one line at a time. The lines are elevated based on a specified starting elevation, increment direction, and contour interval. Typically, it is most efficient to elevate contour lines by their labels, and then elevate other contour lines by crossing before using this command.

**Contours by Crossing (Elevate)** - If your project contains zero-elevation or 2D lines that represent surface contours, you can quickly elevate them by crossing them with a line that applies elevations based on a specified starting elevation, increment direction, and contour interval.

**Contours by Label (Elevate)** - Use in-line elevation labels to quickly elevate 2D lines that represent topographic contours. The elevation is derived from the text of the label, not the elevation of the label. Lines with existing elevations are also elevated based on the label text.

**Lines (Elevate)** - Elevate 2D and 3D lines using a variety of objects that either intersect or lay nearby them. The elevations of text labels and their leader lines, points, and intersecting lines can be used to create and elevate vertical points of intersection (VPIs) along the lines.

**Spot (Elevate)** - To prepare for the Elevate Lines command, create 3D points near the lines you want to elevate from a variety of elevation spot indicators types and their label text. The points are created at the locations of the indicators and inherit the elevations of the text.

**Create Surface** – Create a TIN (Triangulated Irregular Network) surface from the data created or imported in the project.

**Edit a Surface by Adding and Removing Members -** Members are objects that are not part of a surface; they are simply used to define the surface. Edit a surface by adding to and removing from the set of members. As a result, the surface updates to reflect the changes.

**Drape an Image on a Surface -** Use to overlay one or more georeferenced images onto a surface to visualize how a job site's features relate to its topography. Draping an image on a surface enables you to correlate image details with surface elevations. To do this, simply add a georeferenced image to a surface as a member.

**Create Breakline** - Breaklines are simplified linestrings that help to define the shape of a surface as do other 3D line types that act as breaklines, by controlling how triangles in the surface mesh are formed. Triangles forming a surface never cross a breakline. Use breaklines of any type to more accurately reflect where surface topography changes.

**Trim Surface Edge -** Clean-up the edges of surfaces in your project so that you can accurately calculate volumes when comparing surfaces.

**Surface Edge Breakline -** Create a breakline on the outer edge of a surface when you want to prevent trimming or recalculated triangles on the current surface's edge. The edge breakline is added to the set of members that define the surface, and can subsequently be edited as a linestring.

**Surface Boundaries** - Define the extents of a surface by adding or removing one or more boundaries. You can also create holes and islands within or outside of a surface by adding additional boundaries.

**Create a Linestring -** Create linestrings (versatile single,multi-segmented linear, or curvilinear objects) to represent 2D or 3D linear objects. 3D lines can be defined and queried entirely from within the Plan View, and they provide a unique and versatile way of establishing the line's elevation or its vertical alignment. You can create linestrings in this software, or you can convert imported lines such as CAD polylines into linestrings as you edit them. In creating

a linestring, you specify the location of each point along the line, and how the segments between them are formed.

**Create a Polyline -** Create a multi-segment line at a constant elevation by either picking each segment's start and end points, or by streaming points (picking the polyline's start point, adding points as you hold down the button and move the cursor, and releasing the button at the end point). Polylines can only be created in the Plan View. To create or digitize a linestring that has multiple elevations, see Create and Edit a Linestring or Digitize a Linestring.

**Drape Objects** - Use the Drape Objects command to vertically project points, and 2D or 3D lines onto a surface to create new 3D line geometry lying on the surface. For draped lines, the geometry is dependent on the location and shape of the originating line and the surface's topography. Draped points are dependent on the location of the originating points and the surface's topography.

*Markers* are symbols that distinguish between horizontal segment end points, arc mid points, VPIs, and the overall line's start and end points.

- Filled circles denote linestring start points
- Filled triangles denote VPIs
- Smaller square dots denote "point on curve" mid points on arcs
- Smaller round dots denote segment end points
- Hollow circles denote linestring end points

Labels are annotations that indicate the elevation of vertical control points.

You can also display or hide markers and labels for horizontal and vertical values along lines in 2D views to make viewing, understanding, and editing them easier. Select *Project / Project Settings / View / Display Options / Marking* and then set *Line marking* to *Show*.

### **Files Needed**

For the training exercises, you should save the following files provided by your Certified Trainer onto your PC and note the location.

- Data Prep.dxf
- Office Park.pdf

## **Importing CAD Files**

In this section, we will import a CAD file and prepare the data for further processing. This section covers import, data cleanup and CAD editing.

- 1. Open Business Center HCE and Start a new project
- 2. Select the template for US Survey Foot.
- 3. Select the Import Import icon in the Data area under the Project Tab.

Note: You can also select the Import icon from the Quick Access Toolbar.

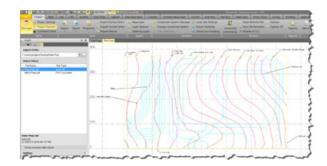
4. Left-click on Data Prep.dxf to highlight it.

Note: You may have to use the button to select the folder where the Data Prep.dxf file is saved on your PC.

Note: You can also drag and drop the Data Prep.dxf into the graphics window to import the CAD data.

Anager     Sector Sector     Command Pi     Project Sector     Command Pi     Panes	import Export Pro	Export Format Editor     Enport Format Editor     Import Format Editor     Enport Format Editor     Select by Lay     Layers	
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Settings File unit	R US survey feet		



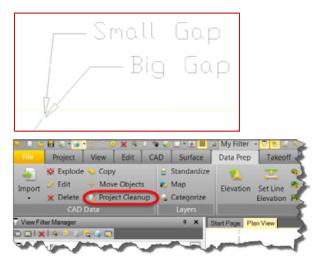


## **Automatic Data Cleanup**

1. Zoom and pan around your drawing to see what the data looks like.

Note: In this exercise the mistakes have been labelled so that you can find and examine them quickly. It is important to look carefully at each of the errors, so that you can find them in a real project in future.

*Note: Many of these errors can be fixed using the automatic Project Cleanup tool in Business Center - HCE.* 



## 2. Select Project Cleanup in the CAD Data area on the Data Prep tab.

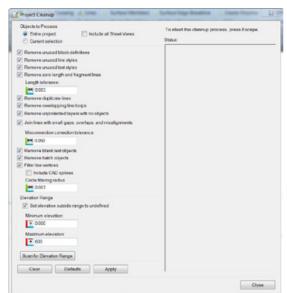
*Note: The following menu becomes available. Let's briefly explain these options before proceeding.* 

**Objects to Process** – Specify whether you want to clean up objects that are currently selected or all of you project data **Entire project** – Select this option to clean up the entire project.

Include all Sheet Views - Select this option to clean up all Sheet Views

*Current selection* – *Select this option to clean up just what is selected* .

**Remove unused block definitions** – Select this to delete all block definitions that no objects are referencing.



**Remove unused line styles** - Select this to delete all line styles that are not assigned to lines.

**Remove unused text styles** - Select this to delete all styles that are not being used by CAD text objects.

**Remove zero length and fragment lines** - Select this to delete all lines that have a length less than the specified tolerance.

*Length tolerance* - Specify the shortest allowable line length in the Length Tolerance box.

**Remove duplicate lines** - Select this to delete redundant lines. One line out of each set of duplicates is retained.

*Remove overlapping line loops* - Select this to break lines that overlap themselves into two separate linestrings.

**Remove unprotected layers with no objects** - Select this to delete all empty unprotected layers.

*Join lines with small gaps, overlaps, and misalignments* - Select this to merge two (and only two) lines that share an end point into one linestring. The lines must be on the same layer to be joined.

*Misconnection correction tolerance* - Specify the distance within which the end points are considered to be the same point.

**Remove blank text objects** - Select this to delete CAD text objects that contain no characters.

**Remove hatch objects** - Select this to remove hatch objects used by other software programs.

*Filter line vertices* - Select this to delete redundant points between two line segments where the point does not deviate from the previous segment's tangent by more than the specified tolerance.

*Include CAD splines* - Select this to filter not only polylines, but also splines.

*Circle filtering radius* - Specify the horizontal/radial distance that a node must deviate from the previous segment's tangent in order to be retained in the Cylindrical tolerance box.

#### **Elevation Range**

**Set elevation outside range to undefined** - Select this to set the elevation on all objects that fall outside of the specified elevation range to undefined (?) elevation.

*Minimum Elevation* – Set the Minimum Elevation for your elevation range.

Maximum Elevation –Set the Maximum Elevation for your elevation range.

**Scan for Elevation Range** - Select this to find the elevation range of your data, the results appear in the Minimum elevation and Maximum elevation boxes.

#### 3. Left-click on the Entire Project option under Object to Process to select it.

*Note: The Objects to Process selection is useful if you are importing CAD data into a pre-existing projects.* 

- 4. Select the following items:
  - Remove unused block definitions
  - Remove unused line styles
  - Remove unused text styles
  - Remove zero length and fragment lines
  - Remove duplicate lines
  - Remove overlapping line loops
  - **Remove unprotected layers with no objects**
  - ✓ Join lines with small gaps, overlaps, and misalignments
  - Remove blank text objects
  - Remove hatch objects
  - Filter line vertices
  - Set elevation outside range to undefined

*Note: The tolerance settings should be kept small because if they are set too large they can change your correct data.* 

5. Select Scan for Elevation Range under the Elevation Range.

Note: This is a handy tool to see the range of your data.

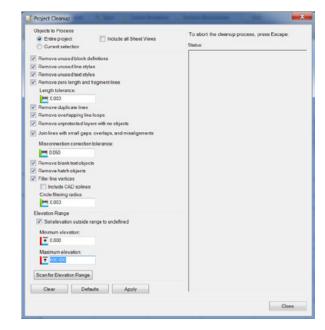
6. Double-click on the Maximum Elevation cell and change it to 600.

*Note: This will change the elevation of the line labelled as Elevation Outside Range in the drawing.* 

7. Select Apply to run the Project Cleanup.

Note: Almost all of the mistakes could be fixed automatically by changing the Project Cleanup tool's parameters. However, this is not a good idea from a data integrity point of view.

Note: A status report will be shown on the right side of the window. This explains which data has been changed by the Project Cleanup tool.



Objects to Process  Entire project  Current selection	To abort the cleanup process, press Escape. Status
Remove unused block definitions	Start project cleanup
Remove unused block demotes     Remove unused line styles     Remove unused led styles	Remove unused block definitions 0 unused block definitions were removed.
Remove zero largh and togment lines Length tolerance:	Remove unused line styles 1 unused line styles were removed.
Remove duplicate lines	Remove unused text styles 277 unused text styles were removed.
Remove overlapping line loops     Remove unprotected layers with no objects	Remove zero length and fragment lines 1 zero length line(s) were removed.
Join lines with small gaps, overlaps, and misalignments Misconnection connection trilerance:	Remove duplicate lines 1 duplicate line(s) were removed
Misconnection correction tolerance:	Remove overlapping line loops 0 overlapping line loop(s) were removed.
<ul> <li>Remove blank text objects</li> <li>Remove hatch objects</li> </ul>	Remove blank text objects 0 blank text object(a) were removed.
Filter Ine vertices	Remove hatch objects 0 hatch object(a) were removed.
Circle fitering radius	Filter line vertices 23 vertice(s) of the 1187 total vertice(s) were
Elevaton Range	removed.
V Set elevation outside range to undefined Minimum elevation:	Set elevation outside range to undefined 79 objects outside of the elevation range were setto undefined elevation.
	Join lines with small gaps, overlaps, and
Maximum elevation:	misalignments 34 Ine(s) wee joined.
€00 000	Remove unprotected layers with no objects 6 unused layers were removed.
Scan for Elevation Range	End project cleanup
Clear Defaults Apply	Cara backer caranaly

- 8. Select Close on the Project Cleanup window.
- 9. Pan and zoom around the data to see what has changed.
- 10. Delete the error label from any of the fixed errors.

*Note:* To delete the label, select it using either a box or *left-click on an item to select it:* 

- a. Right click and select Delete.
- b. Browse to the Data Prep tab and choose delete.
- c. Select 🔀 from the Quick Access Toolbar

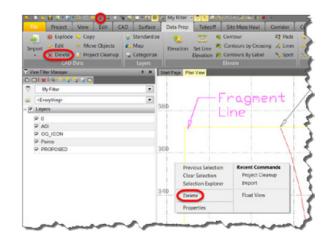
*Note: The corrected errors in this example are:* 

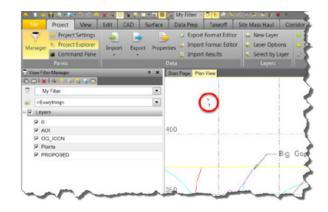
- Fragment Line
- Duplicate
- Small Gap
- Too Many Vertices
- Elevation Outside Range (check this one by looking at it in a 3D view)
- Line Not Joined
- 11. Left-click on File and select Save Project As.
- 12. Enter a File Name and select the location you would likd to save the file.

## **Manual Data Cleanup**

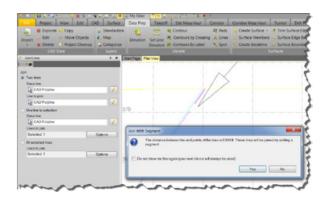
Now we will work through the remaining errors in the data using manual CAD editing.

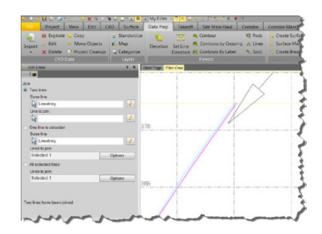
- 1. Pan and zoom until you can see the ??s at the top of plan view.
- 2. Select the ??s and delete them.

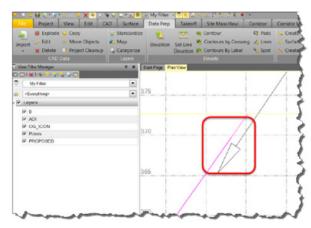




- 3. Pan and zoom until you can see the Big Gap at the top of plan view.
- 4. Select Join Lines in the Lines area under the Data Prep tab.







- 5. Left-click on the Two lines option under Join to select it.
- 6. With the curser in the Base Line cell, left-click on the line on one side of the gap to select it.
- 7. With the curser in the Line to Join cell, left-click on the line on other side of the gap to select it.

Note: A warning box will appear once the second line is selected. The warning will give you the distance between the end points of the lines and let you know that a segment will be added to join the lines.

8. Select Yes to create the joining segment.

*Note:* You will now see that the two lines have been joint, eliminating the gap.

9. Select Close on the Join Lines pain.

Note: Do not delete the error text for now, we will do this in a future step.

#### 10. Repeat steps 3 through 9 for the Small Overlap Error.

Note: The line will look like a solid line when you zoom in on it, but when selecting it you will notice that it is two separate lines.



## 11. Select the Zoom Extents **Extents** icon in the Zoom area under the View tab.

Note: This will Zoom you out or in so that you have the entire project visible on the screen. You can also select this from the Quick Access Toolbar by selecting the screen.

- 13. Left-click on the yellow outer box around the project to select it.
- 14. Right-click and select Properties.

Note: You can see that it is a CAD Polyline object. This is because it has been imported but not edited. Once any edits are performed it will change to a native Business Center Linestring object.

15. Left-click on AOI in the Name cell and change it from AOI to Boundary.

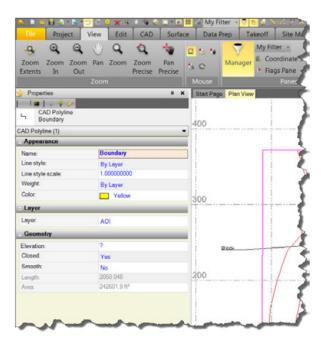
*Note: This will help us to identify the correct linework in the next error.* 

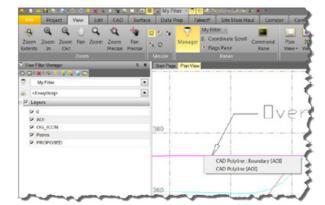
- 16. Select Close to exit the Properties pane.
- 17. Pan and zoom into the Overlapping Line Loop error in the plan view.
- 18. Left-click on the line near the point of the arrow.

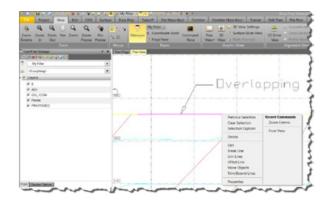
Note: You will see that two options come up for the selection. Business Center – HCE does this when there is more than one object in the graphics area that was selected. Since we renamed the correct boundary, it is easy to see which is an overlapping line.

- 19. Select the CAD Polyline [AOI].
- 20. Right-Click and select Delete.

*Note: Do not delete the error text for now, we will do this in a future step.* 







21. Pan and zoom into the Missing Line error in the plan view.

Note: We can see that this is part of a building pad when you zoom-out. So not only do we have to fill in the missing piece, we also must join it into one shape for future processes.

- 22. Select Create Linestring in the Lines are under the Data Prep tab.
- 23. Enter *Building Pad* in the name cell on the Create Linestring pane.
- 24. Click the victor at the end of the Layer cell and select <<New Layer>>.
- 25. Enter the below values for the new layer.

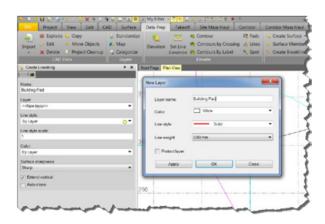
Layer name: FD Building Pad Color: Orange Line style: Solid Line weight: 0.50mm Protect Layer: 🔽

- 26. Then select OK in the New Layer window.
- 27. Select OK in the Create Linestring pane.

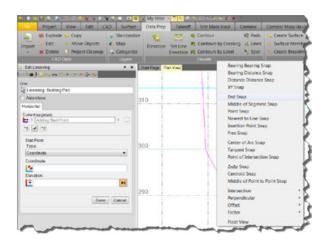
Note: The Edit Linestring dialog now appears. This is where you can enter the geometry for the empty linestring that you have just created.

- 28. Leave the Start Point Type as Coordinate and left-click in the Coordinate box.
- 29. Right-click in the graphics view to display the snap options.
- 30. Select End Snap.

Note: If you were creating linestrings by joining imported survey points the start point type would be set to Point ID, allowing you to click between points to create your line.



Layer name:	FD Building Pad	
Color.	Orange	
Line style:	Solid	•
Line weight	0.50 mm	•
Protect layer		



31. Left-click on the line for the East side of the Building Pad.

*Note: Once your curser is close to the line a red snap circle will be visible.* 

*Note: Once you have selected the start point you will see a red line extending from the starting point of your linestring to your curser.* 

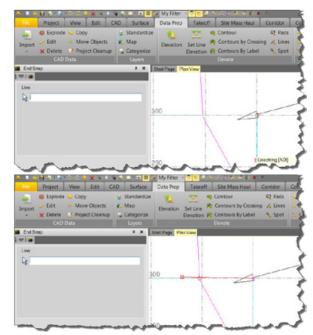
Note: If multiple lines are available when you click, check to see if two lines intersect at that point. If they do click either option, if not zoom in further until there is only one line shown.

- 32. Right-click in the graphics view to display the snap options.
- 33. Select End Snap.
- 34. Left-click on the line for the North side of the Building Pad.

*Note: There is now a line created between the two end points.* 

- 35. Select Close in the Edit Linestring pane.
- 36. Select Join Lines in the Lines area under the Data Prep tab.
- 37. If the new linestring you created is not already selected, make sure your curser is in the Base line cell and left-click on your newly created line.
- 38. With the Curser in the Line to join cell, left-click on the other two lines of the building pad.
- 39. Select Close on the Join Lines pane.

*Note: Do not delete the error text for now, we will do this in a future step.* 



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#### 40. Pan and zoom to the Boundary in the plan view.

*Note:* You can use the Zoom Extents to bring the whole project into view.

- 41. Left-click on the boundary line to select it.
- 42. Right-click in the graphical view and choose Offset Line.
- 43. Enter Boundary Offset for Name of the Offset Line.
- 44. Create a new layer for the Boundary Offset by entering the below values.

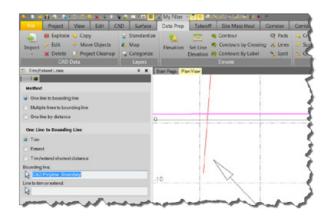
Layer name:	Boundary
Color: Brown	۱
Line style: So	olid
Line weight:	0.50mm
Protect Layer	· ·

- 45. Select
- 46. Enter 1 for the Offset distance.

OK

- 47. Select Left for the Side to Offset.
- 48. Select Apply in the Offset Line pane.
- 49. Select Close in the Offset Line pane.
- 50. Pan and zoom to the Trim Line error in the plan view.
- 51. Select Z Trim/Extend Lines in the Lines area under the Data Prep tab.
- 52. Left-click on One Line to Bounding Line under Method to select it.
- 53. Left-click on Trim under One Line to Bounding Line to select it.
- 54. With the curser in the Bounding line cell, left-click on the inner yellow boundary to select it.

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#### 55. With the curser in the Line to trim or extend cell, leftclick on the line that sticks out past the boundary.

*Note:* As soon as you click the line it will be trimmed to the boundary line.

56. Select Close in the Trim/Extend Lines pane.

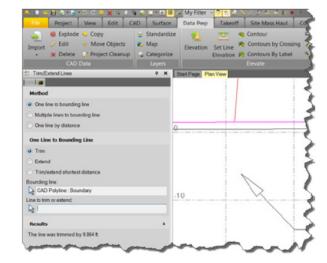
*Note: Do not delete the error text for now, we will do this in a future step.* 

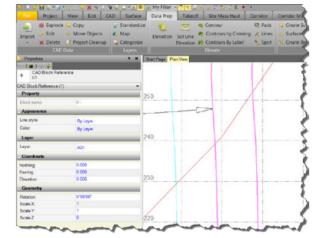
- 57. Pan and zoom to the Block error in the plan view.
- 58. Left-click on one of the two inner contour lines.

Note: Both contours will select, this indicates that it is a Block Reference.

59. Right-click in the graphical view and select Properties.

*Note: The Properties pane shows the selected contour lines as a CAD Block Reference.* 





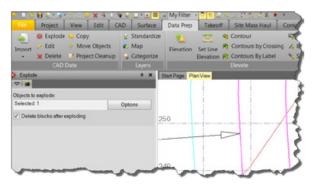
60. Select **\*** Explode in CAD Data area under Data Prep tab.

Note: You can also Right-click in the graphical view with the CAD Block Reference selected and select Explode.

- 61. Make sure the Delete blocks after exploding is selected.
- 62. Select OK in the Explode pane.

*Note: The contour lines are now two separate contour lines and the Explode pane has closed.* 

63. Select Close in the Properties pane.



- 64. Select the Advanced Select Advanced icon in the Selection area, under the Edit tab.
- 65. Unselect any currently selected lines by left-clicking in a open area in the graphical view.

Note: You can see how many items are currently selected under the Current Status in the Advanced Selection pane.

- 66. Left-click on All data, and replace the current selection under Apply This Selection To to select it.
- 67. Select CAD Multiline Text under the Data type dropdown list in the Select section.
- 68. Select Data with the following property in the Select section.
- 69. Select Color in the Select Section.
- 70. Select <> Not equals under That is in the Select section.
- 71. Select Magenta under This value in the Select section.
- 72. Select Apply in the Advanced Selection pane.
- 73. Select Current selection for Apply This Selection To.
- 74. Repeat steps 62 through 69 for Cyan .
- 75. Select Apply in the Advanced Selection pane.
- 76. Select OK in the Advanced Selection pane.

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- 77. Right-click in the graphical view and select delete.
- 78. Select Advanced Select Advanced Select icon in the Selection area, under the Edit tab.
- 79. Left-click on All Data and Replace the Current Selection under Apply This Selection To to select it.
- 80. Select Linestring under the Data Type drop-down list.
- 81. Select Data with the following property under the Select.
- 82. Select Color under Select.
- 83. Select = Equals under That is.
- 84. Select By Layer under This value.
- 85. Select Apply in the Advance

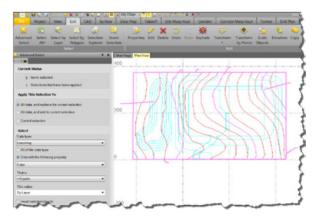
in the Advanced Selection pane.

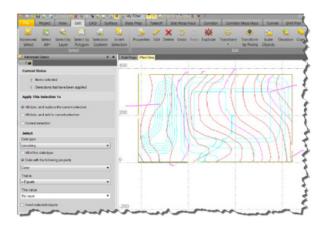
Note: You will notice that all the Arrows Lines, Boundary Offset, and Building Pad are highlighted.

- 86. Select OK in the Advanced Selection pane.
- 87. Hold down Control on the keyboard and left-click on the Boundary Offset and Building Pad to deselect them.
- 88. Right-click in the graphical view and select delete.

*Note: You will see all the arrow lines have been deleted but the arrow heads still remain.* 

- 89. Hold down Control on the keyboard and left-click on each of the arrow heads to select them.
- 90. Right-click in the graphical view and select delete.





## **Data Layering**

Now that we have cleaned up the geometry in our data we will now clean up the layer structure of the project.

1. In the View Filter Manager check and uncheck the boxes in front of the individual layers to see where the data is stored.

Note: As you can see currently the data is not very well organized, this will make elevating lines and creating surfaces difficult.

- 2. Right-click on any layer in the View Filter Manager and select Layer Options.
- 3. Select the Create New Layer sicon to create a new layers.
- 4. Create a new layer for the Original Ground by entering the below values.

Layer name: Original Ground Color: Blue Line style: Solid Line weight: 0.50mm Protect Layer: 🗹

5. Select Apply

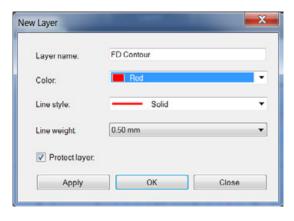
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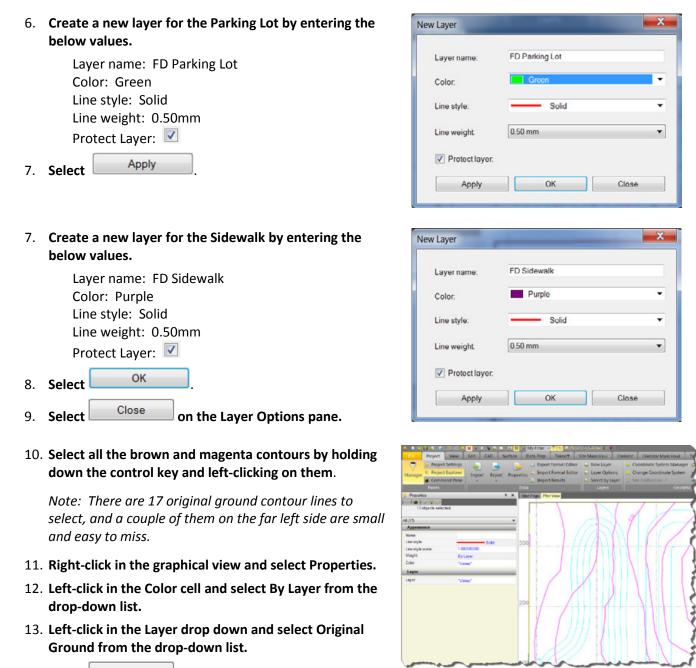
New Layer		×
Layer name:	Original Ground	
Color:	Blue	•
Line style:	Solid	•
Line weight	0.50 mm	•
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Apply	OK Close	

5. Create a new layer for the Finish Design Contours by entering the below values.

Layer name: FD Contour Color: Red Line style: Solid Line weight: 0.50mm Protect Layer: 🔽

6. Select Apply





14. Select Close in the Properties Pane.

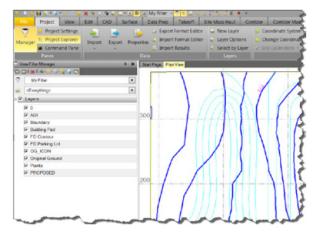
15. Left-click in an open area in the graphical view to unselect the Original Ground Contours.

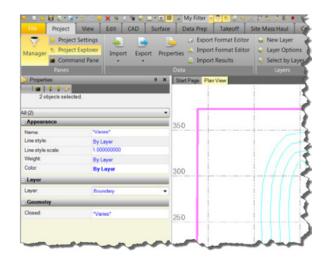
*Note: You will now notice that all of the Original Ground Contours lines have change color and size.* 

16. Uncheck the box in front of the Original Ground Layer in the View Filter Manager.

Note: You can now see that there is still some data such as contour labels which has not been moved.

- 17. Select the remaining magenta labels by holding down the control key and left-clicking on them.
- 18. Repeat Steps 10 through 13 for the Original Ground Contour Lables.
- 19. Select the original Boundary and the Boundary Offset by holding down the control key and left-clicking on them.
- 20. Right-click in the graphical view and select Properties.
- 21. Left-click in the Color cell and select By Layer from the drop-down list.
- 22. Left-click in the Layer drop down and select Boundary from the drop-down list.
- 23. Select Close in the Properties Pane.





- 24. Uncheck the box in front of the Boundary Layer in the View Filter Manager.
- 25. Uncheck the box in front of the Building Pad in the View Filter Manager.
- 26. Repeat steps 18 through 23 for the Finish Design Contours and Finish Design Contour Labels.
- 27. Repeat steps 18 through 23 for the Finish Design Contours Labels.
- 28. Repeat steps 18 through 23 for the Parking Lot.
- 29. Repeat steps 18 through 23 for the Sidewalk.

*Note: Now when looking at the pane view you will see some points.* 

- 30. Select all of the points by dragging a box around them.
- 31. Right-click in the graphical view and select Properties.
- 32. Change the Layer to Points and select
- 33. Left-click on the check box next to Layers in the View Filter Manager to turn on all layers.

Note: You will know see that all the data has been colored and sized by the layers that they have been assigned to.

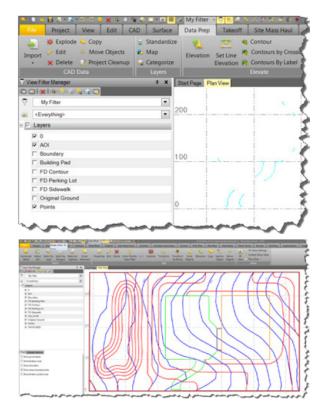
- 34. Select **Project Cleanup** in the CAD Data area on the Data Prep tab.
- 35. Select Apply in the Project Cleanup window.

Note: We are preforming the Project Cleanup to get rid of any layers that have no data and any errors from the manual cleanup. The errors are from the CAD block that we exploded earlier.

36. Select Close

in the Project Cleanup window.

Close





## **Elevating Data**

In this section we will elevate the data and then create surfaces from the elevated data. This section covers contour elevation, line elevation, surface creation, surface editing, PDF import, and image draping. Using the information provide in the data, we can now elevate the data so that it can be used to create surfaces.

1. In the View Filter Manager turn off all the layers except for the Original Ground layer.

*Note: The Major Contours are labeled with an elevation and they are in 5' increments.* 

Note: There are four Minor Contours between the majors, so the contours are on a 1' spacing.

- 2. Select the Elevate Contour Contour icon, in the Elevate area under the Data Prep tab.
- 3. Enter 5 for the Contour interval in the Elevate Contour pane.

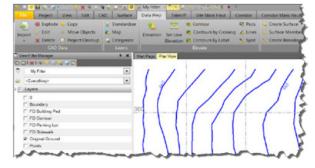
Note: We are going to elevate the Major Contours first so we inter the interval between majors, which is 5'.

#### 4. Select Up for the Increment direction.

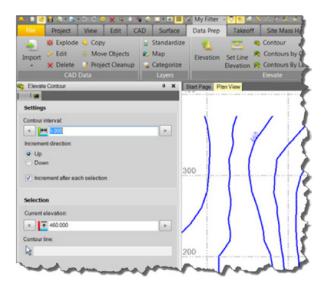
Note: We are going to start on the left side of the plan and work to the right, so the elevation numbers go Up from left to right.

*Note:* It is good practice to start at one side of the site and work across when elevating contours.

- 5. Select Increment after each selection by placing a check mark in its box.
- 6. Enter 460 in the Current elevation box in the Elevate Contour pane.





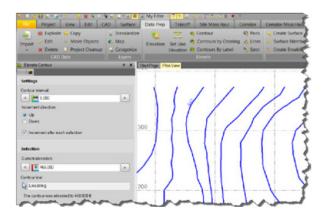


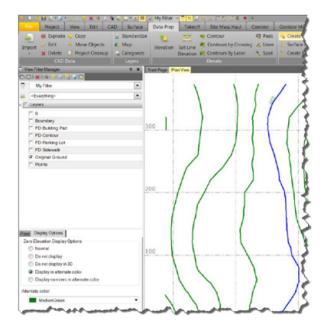
7. With the curser in the Contour line cell, left-click on the 460 Contour line the the graphical view.

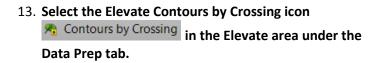
*Note:* You will notice after clicking on the 460 contour line that the Current elevation will read 465 and there is a note that says The contour was elevated to 460.000 ft.

- 8. Left-click on the 465 Contour line in the graphical view.
- 9. Left-click on the 470 Contour line in the graphical view.
- 10. Select Close in the Elevate Contour pane.
- 11. Select the Display Options tab in the View Filter Manager.
- 12. Select Display in alternate color under Zero Elevation Display Options and select MediumGreen for the Alternate color.

*Note: You will now notice that the only blue lines are the Major Contours that you have just elevated.* 









14. Select Automatic for the Elevate Method by putting a check mark in its box.

*Note: You have to have at least two elevated contours to use the Automatic Elevation Method.* 

- 15. With the curser in From: cell, left click in the graphical view just to the left of the 460 contour line.
- 16. Left-click just to the right of the 465 contour line in the graphical view.

Note: You have to cross at least two elevated lines to beable to elevate the unelevated lines.

*Note: You will now see four contours have been elevated and will turn blue.* 

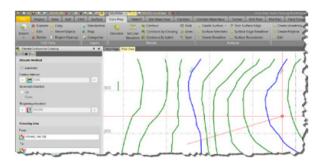
## 17. Elevate the rest of the contour lines using steps 15 and 16.

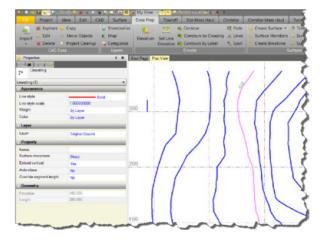
Note: You have to cross at least two elevated lines. They can either be right next to each other or have unelvated lines between them.

- 18. Select Close in the Elevate Contours by Crossing pane.
- 19. Select one of the elevated contours by left-clicking on it in the graphical view.
- 20. Right-click in the graphical view and choose Properties.

*Note:* You can check that you elevated the contours correctly by looking at their Elevation. Left-click on other lines to check their elevations also.

Note: On larger plans you may want to check your elevations occasionaly while elevating so that you do not get off on the elevations.





#### 21. Left-click on the 460 text in the graphical view.

*Note: You will notice that none of the Major Contour Text is elevated.* 

22. Left-click in the Elevation cell and enter 460 and hit enter on the keyboard.

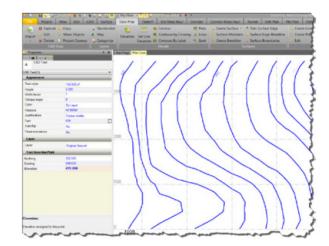
Note: You have now elevated the 460 text item.

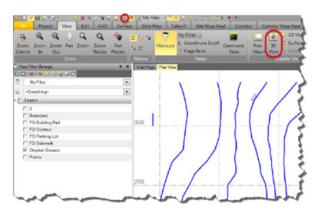
- 23. Repeat steps 21 and 22 for the other two Major Contour Text.
- 24. Select Close in the Properties pane.



25. Select the New 3D View view icon in the Graphic Views area on the View tab.

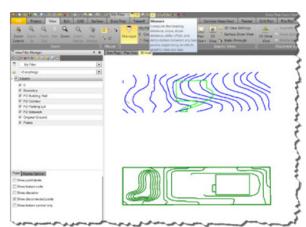
Note: You can also select the New 3D View icon in the Quick Access Toolbar to bring up a 3D View.



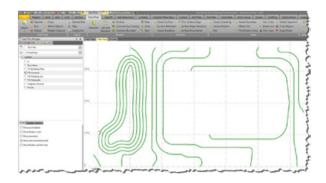


- 26. Turn on all the layers in the View Filter Manager.
- 27. Pan and Zoom around in 3D View.

Note: You can see that all the Original Ground Contours, Contour Labels, and the Parking Lot have been elevated.



- 28. Turn off layers except for FD Contour in the View Filter Manager.
- 29. Select the Plan View tab at the top of the Graphical view.



## 30. Elevate the FD Contours in the same way as you did with the Original Ground Contours.

Note: The interval distance between contours are different on the FD Contours. As you can see from the Contour Labels, there is 2' between contours.

Note: Becareful when using Contours by Crossing around the retention pond. You will either want to cross going into the bottom or cross from the bottom out.

Note: Once all FD Contours are elevated you can check them by using properties like we did with the Original Ground contours or by viewing them in 3D View.

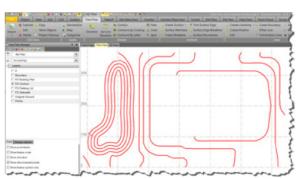
31. Turn on the FD Building Pad and FD Sidewalk in the View Filter Manager.



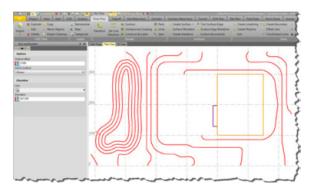
- 32. Select Elevation in the Elevate area under the Data Prep tab.
- 33. With the curser in the Line: cell under Elevation in the Set Line Elevation pane, left-click on the Building Pad.
- 34. Enter 467' in the Elevation cell and hit enter on the keyboard.

Note: As there is no text showing the elevation inside the building pads, we cannot use the Elevate Pads command.

- 35. Left-click on the Sidewalk.
- 36. Enter 467' in the Elevation cell and hit enter on the keyboard.
- 37. Select Close in the Set Line Elevation pane.



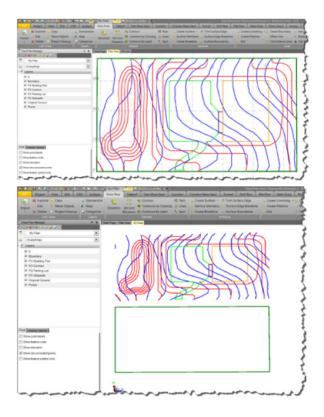




- 38. Turn on all the layers in the View Filter Manager.
- **39.** Pan and Zoom around in Plan View and **3D** View.

Note: Everything except for the Boundary should be elevated. If there is something not elevated, you will need to repeat the steps from earlier to elevate it.

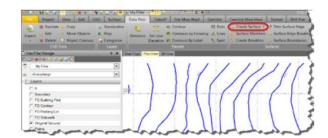
Note: The Boundary does not need to be elevated.



## **Creating and Editing Surfaces**

Now that the data in our project is elevated, we can now create surfaces.

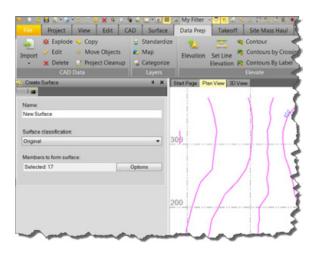
- 1. Turn off all the layers except Original Ground in the View Filter Manager.
- 2. Select Create Surface r in the Surfaced area under the Data Prep tab.



- 3. Enter Original Ground in the Name cell.
- 4. Select Original as the Surface classification.
- 5. Select all of the Original Ground Contours by dragging a box around them in the graphical view.

Note: You should only have 17 items selected. If you have more it is because you have selected the Contour Labels. You can hold down control on the keyboard and left-click on each of the Contour labels to unselect them.

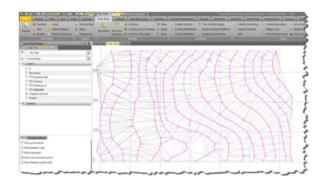
Note: You could create and move the labels to an Original Ground Text layer. That way you will not accentually use them in the creation of a surface.

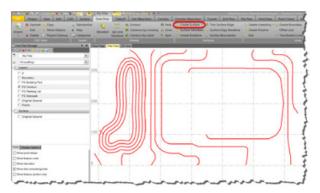


6. Select OK to create the surface and exit the Create Surface pane.

Note: As you can see, the surface has not been created all the way to the edge of the project. We will need to add a boundary to create a clean surface edge.

- 7. Turn off all the layers and surfaces except for the FD Contour in the View Filter Manager.
- 8. Select Create Surface In the Surfaces area under the Data Prep tab.





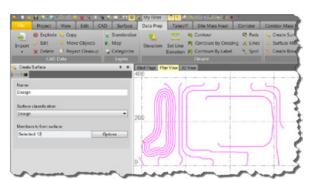
- 9. Enter Design in the Name cell.
- 10. Select Design in the Surface classification drop-down.
- 11. With the curser in the Members to form surface cell, select all the Finish Design Contours in the graphical view.

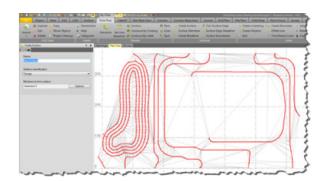
Note: Make sure not to select the two Finish Design Contour Labels.

12. Select Apply

in the Create Surface pane.

Note: The Surface was created using the FD Contours but did not include the FD Parking Lot, FD Building Pad, or FD Sidewalk.





- 13. Turn on the FD Building Pad, FD Sidewalk, and FD Parking Lot layers in the View Filter Manager.
- 14. Select Surface Members in the Surface area under the Data Prep tab.
- 15. Select Design in the Surface cell.
- 16. With the Curser in the Members to add or Remove cell, left-click on the Building Pad, Parking Lot, and Sidewalk.
- 17. Select Add in the Add/Remove Surface Members pane.

Note: After selecting Add the Design Surface is updated using these new surface members.

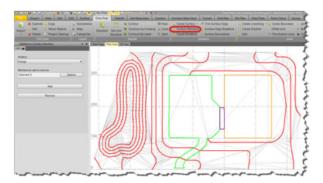
*Note:* You have some yellow flags on the surface which indicates an error.

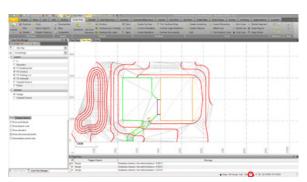
- 18. Select Close in the Add/Remove Surface Members pane.
- 19. Select Cancel in the Create Surface pane.
- 20. Select the **u** icon in the Status Bar in the bottom right of the screen.

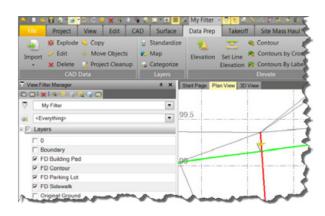
Note: The Flags Pane opens to give more information about the errors. The errors in this surface are Breaklines Intersect.

#### 21. Pan and Zoom in to the uppermost flag.

*Note: We can see that the contour line extends through the edge of the parking lot.* 







- 22. Select Break Line in the Lines area under the Data Prep tab.
- 23. With the Curser in the Line cell, select the contour line.

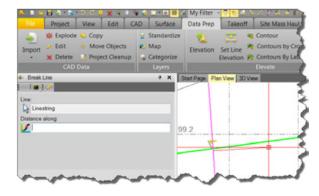
Note: There is a line that extends from the curser to the contour line. This is the point where the line will be broken when you left-click again.

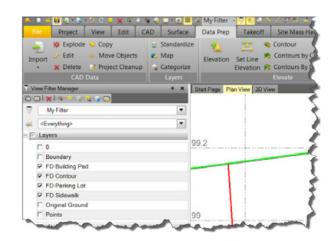
24. With the Break line just outside the Parking Lot line, left-click to break the Contour line.

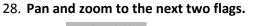
*Note: The contour line is now broken at this point and is two seprate lines.* 

- 25. Select Close in the Break Line pane.
- 26. Left-click on the small piece of the Contour line that is inside the Parking Lot.
- 27. Right-click in the graphical view and select Delete.

Note: The line is deleted and the Flag has disappeared.



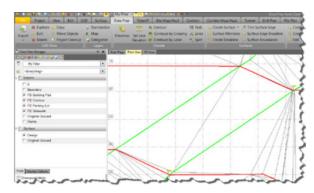




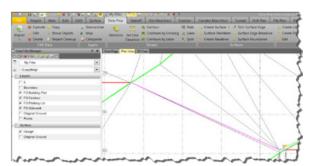
- 29. Select Break Line in the Lines area under the Data Prep tab.
- 30. With the curser in the Line cell, left-click on one of the contour lines with the Flag to select it.
- 31. With the Break line just out side the Parking Lot leftclick.

Note: You may have to pan and zoom in on the location to make sure you are just outside the Parking Lot line before you left-click.

- 32. With the curser in the Line cell, left-click on the same contour line on the side of the break that is in the Parking Lot.
- 33. With the Break line just outside the other side of the Parking Lot, left-click to break the contour line.



- 34. Select Close
  - in the Break Line pane.
- 35. Left-click on the section in the Parking Lot that you just Broke into 3 lines.



36. Right-click in the graphical view and select delete.

Note: The flag should disappear as soon as the line is deleted. If the flag is still visible, zoom and pan in close to make sure the contour does not still overlap the Parking Lot.

37. Repeat steps 36 through 43 for the other contour line.



In this exercise we will import a pdf and drape it onto the surface to provide more context for the project.

- 1. Select the Measure icon in the quick access toolbar.
- 2. With the curser in the From cell, left-click on one of the upper corners of the Building Pad.

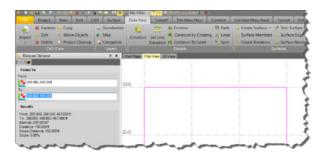
Note: If you turn on the Building Pad layer, you can snap to the end points for the From and To points to get the most accurate measurement.

3. With the curser in the To cell, left-click on the other upper corning of the Building Pad.

Note: The distance shown should be 150ft. We will use this edge to scale the imported PDF.

4. Select Close in the Measure Distance pane.







- 5. Select in the CAD Data area under the Data Prep tab.
- 6. Left-click on Office Park.pdf to highlight it and select

Note: This will open the place image command.

- 7. Select Known distance for the Method.
- 8. Enter 150 in the Distance cell under Know Distance.
- 9. With the curser in the From pixel cell, left-click on one of the upper corner of the Building Pad on the PDF image.

Note: It may be slightly difficult to see the data if the program automatically puts the PDF over the linework. The building pad on the PDF is red.

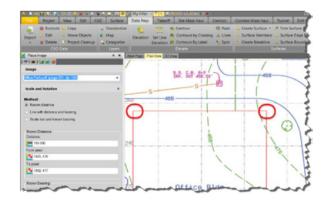
- 10. With the curser in the To pixel cell, left-click on the other upper corner of the Building Pad on the PDF image.
- 11. Select <u>Compute</u> in the Place Image pane.

*Note: The PDF has now been scaled, but is still not in the correct position.* 

12. Select the Georeference Image icon at the top of the Place Image pane.

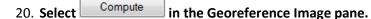
*Note: The Georeference Image is used to place the PDF image in the correct location.* 

- 13. Select Office Park.pdf as the image.
- 14. Select Add under Points on the Georeference Image pane.
- 15. With the curser in the Pixel cell, left-click on a corner of the Building Pad in the PDF.
- 16. With the curser in the Location cell, left-click on the corresponding corner in the drawing.





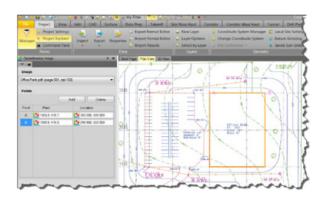
- 17. Select Add under Points on the Georeference Image pane.
- 18. With the curser in the Pixel cell, left-click on another corner of the Building Pad in the PDF.
- 19. With the curser in the Location cell, left-click on the corresponding corner in the drawing.



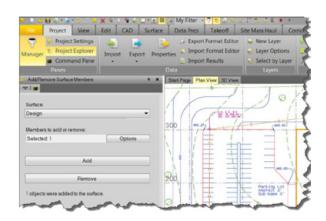
Note: You will notice that there are slight discrepancies between the PDF and the drawing. This is due to different accuracies of the imported files. As the PDF is only being used to add context, it is ok that it is not a perfect match.

- 21. Select Close in the Georeference Image pane.
  22. Select Close in the Place Image pane.
- 23. Select Close in the Import pane.
- 24. Expand the Imported Files folder in the Project Explorer and left-click on the Office Park.pdf to highlight it.
- 25. Right-click and select Add/Remove Surface Members.
- 26. Select Design in the Surface cell.
- 27. Select Add in the Add/Remove Surface Members pane.
- 28. Select Close in the Add/Remove Surface Members pane.





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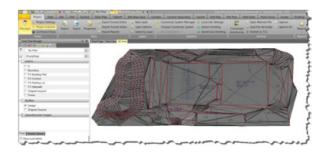
- 29. Turn off everything except for the Design surface and Georeferenced Images in the View Filter Manager.
- 30. Select the 3D view tab at the top of the graphical view window and examine your surface.

Note: If you do not have a 3D View tab, you can open

one by selecting the New 3D View icon from the Quick Access Toolbar.

Note: If the PDF data is not visible on your surface in the 3D view just close the 3D view and open it again.

Note: You can turn off the Wireframe in the Surface Properties to get a cleaner view.



CHAPTER **3** 

## **Corridor Takeoff**

## Welcome

Welcome to the Trimble<sup>®</sup> Business Center – Heavy Construction Edition (HCE) Corridor Takeoff Module. The corridor takeoff module incorporates tools that enable you to perform a corridor takeoff quickly and with accuracy. This is typically for pre-construction estimating purposes. Business Center - HCE allows for the import of multiple file types that are used to create original ground and finished design surfaces.

This guide was developed by Trimble Navigation's Global Services Training and Support staff to support classroom instruction delivered by a Trimble Certified Trainer. The Trimble Certified Trainer will use this guide to lead you through the Data Preparation Module using real world exercises. Please use this guide in conjunction with the Business Center - HCE help files and other product resources available.

## **Overview**

The goal in performing a corridor takeoff is to calculate cut/fill and material volumes needed for a roadway. This is usually for the purpose of bidding on a construction project. This module will guide you through creating finish grade and subgrade surfaces, specifying materials for each course in the corridor, and running a report to determine the volumes of cut and fill needed along the corridor.

## **Learning Objectives**

- Create Horizontal and Vertical Alignments
- Creating Corridors
- Create Corridor Templates
- Managing Material Layers
- Define Strata on a Site
- Review Surfaces to check for Accuracy
- Generate Reports

## **Files Needed**

For the training exercises, you should save the following files provided by your Certified Trainer onto your PC and note the location.

• Corridor Takeoff Training Module.vcl

## **Creating Alignments**

An alignment defines a linear feature, such as a road centerline. Alignments consist of horizontal geometry as seen in the plan view and optional vertical geometry as seen in the profile view. Alignments have associated stationing, and can also include station equations.

Each vertical alignment is associated with a horizontal alignment, and there can be multiple vertical alignments for each horizontal alignment. The values you can enter depend on the alignment settings for the project.

Alignments can be imported, created using the Alignment Editor, or by appending linestrings to an alignment. The alignment editor and the appending method will be explored in this module.

- 1. Open Business Center HCE and start a new project.
- 2. Select the template for US Survey Foot.
- 3. Select the Import icon in the Data area under the Project Tab.

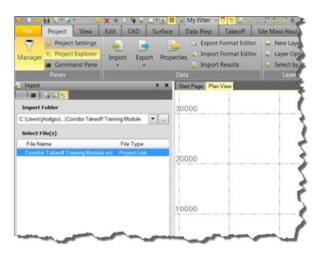
Note: You can also select the Import icon from the Quick Access Toolbar.

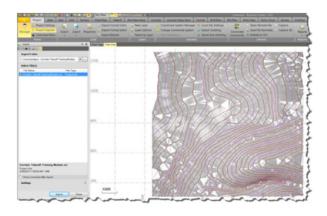
4. Left-click on the Corridor Takeoff Training Module.vcl to highlight it.

Note: You may have to use the button to select the folder where the Data Prep.dxf file is saved on your PC.

Note: You can also drag and drop the Data Prep.dxf into the graphics window to import the CAD data.

- 5. Select Import in the Import pane.
- 6. Select Close to close the Import pane.





- 7. Turn off the OG\_CON and OG\_ICON Layers in the View Filter Manager.
- 8. Turn off the OG Surface in the View Filter Manager.





- 9. Select the Create Alignment Alignment icon in the Alignment area on the Corridor tab.
- 10. Enter Training Road in the Name cell.
- 11. Select the drop-down arrow in the *Layer* cell and create a new layer with the following settings.

Layer name: Training Road CL Color: Red Line style: Solid Line weight: 0.50mm Protect Layer:

- 12. Select OK
- 13. Left-click on Define Individual Segments for the Horizontal Geometry Definition to select it.

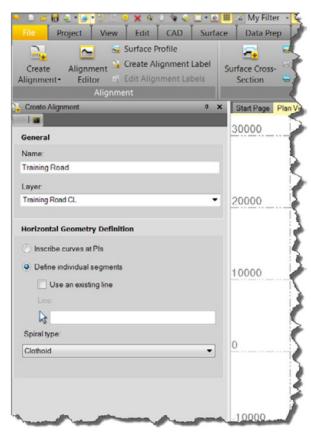
*Inscribe curves at PI's* – This method is used to build an alignment from data with values for curves at consecutive Points of Intersection (PI's).

**Define individual segments** – This method is used to build an alignment from data with values for consecutive line, arc, and spiral segments.

**Use an existing line** – If an existing line's geometry is to be used to define the alignment, check this box and select the reference line. If the line is in 3D, a vertical alignment (VAL) will be created.

#### 14. Select Clothoid in the Spiral type drop-down list.

Note: This setting defines the spiral definition in the Business Center - HCE project. Simply ensure that the spiral type defined here matches the spiral definition of the engineer's design.



## 15. Select OK in the Create Alignment pane.

*Note: The Alignment Editor will appear and the focus will be on the Horizontal Alignment editor.* 

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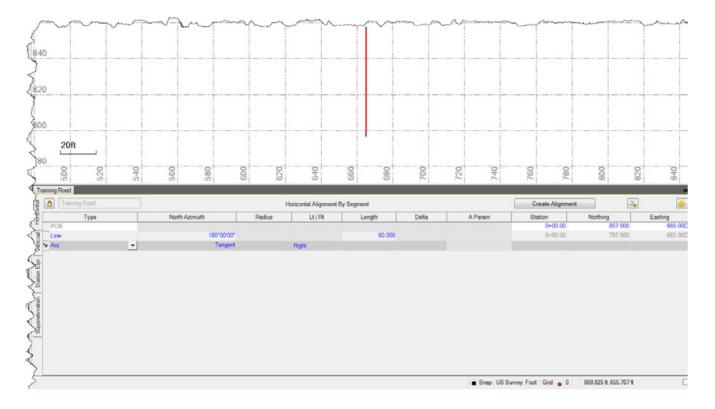
16. Enter 857 for the Northing and 665 for the Easting, and hit Enter on the keyboard.

*Note: The first type of segment is the Point of Beginning (POB). By default the stationing starts at 0+00.* 

*Note:* Using the tab key easily allows users to progress to the next cell during the data entry process.

- 17. Select Line for the next segment type.
- 18. Enter a North Azimuth of 180°00'00" and a Length of 60', and hit Enter on the keyboard.

Note: The POB and the first segment is now visible in the plan view. You may have to Pan and Zoom-in to see the POB and first segment.



#### 19. Select Arc for the next segment type.

Note: By default the North Azimuth is now set to tangent so as to match the azimuth of the last segment.

20. Enter 180 for the North Azimuth and hit tab on the keyboard.

Note: Notice that the minutes and seconds were automatically populated.

- 21. Enter 200' for the Radius and hit tab on the keyboard.
- 22. Select Left to turn the arc towards the left and hit tab on the keyboard.
- 23. Enter 200' for the length and hit enter on the keyboard.

*Note: The arc segment is now visible in the plan view.* 

- 24. Select Line for the final segment type.
- 25. Select tangent in the North Azimuth cell.
- 26. Enter 587' for the length and hit enter on the keyboard.

*Note:* The Horizontal Alignment is now complete and should look similar to the alignment in the plan view below.



- 27. Left-click the Vertical tab on the left-hand side of the alignment editor to select it.
- 28. Select Create Vertical Alignment in the Vertical Alignment editor.

Note: The name is automatically populated with the same name as the HAL that was just created. VAL's must be associated with a HAL and since there is only one HAL in this project the VAL is automatically associated with it.

- 29. Enter 461.56' for the elevation of the POB at station 0+00 and hit tab on the keyboard.
- 30. Select Grade Break for the next PI type and enter 0+16 for the station.
- 31. Enter 461.24' for the elevation and hit enter on the keyboard.

Note: The slope of the segment is populated and is -2.00%.

- 32. Select Symmetrical Vertical Curve for the next PI type and enter 4+50.60 for the station.
- 33. Enter 478.10' for the elevation and 200' for the curve length, and hit enter on the keyboard.

*Note: The values for the Slope, Approach Curve Length, and the Departure Curve Length are all populated for the Symmetrical Vertical Curve.* 

- 34. Select Grade Break for the next PI type.
- 35. Enter 8+55.36 for the station and 477.97' for the elevation, and hit enter on the keyboard.



36. Select the New Profile View View icon in the View area under the Corridor tab.

Note: The profile of the road should look the profile view shown below.

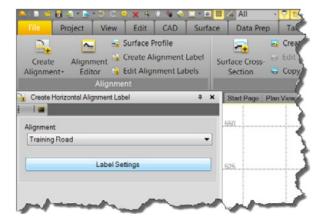
Note: When selecting New Profile View it will appear over the Alignment Editor. If you want it in another area, you can just click and drag it into another window.

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## **Creating Alignment Labels**

You can easily create horizontal alignment labels to display values for stations, station equations, horizontal alignment points, and abbreviations for other key points along an alignment by utilizing the Create Alignment Label command. These labels will be included in outputs when you print views that show them.

- Select the Create Horizontal Alignment Label
   Create Alignment Label icon in the Alignment area under the Corridor tab.
- 2. Select Training Road under the Alignment drop-down list.
- 3. Select Label Settings on the Create Horizontal Alignment Label pane.



4. Enter 100' in the Spacing cell in the Tick column.

Note: This is how often a Major tick mark will be drawn.

- 5. Select Text for the layer under the Layer drop-down list in the Ticks column.
- 6. Enter 0.5 in the Tick Size (inch) cell in the Tick column.

Note: This is the length of the tick that is drawn.

7. Select Center from the Side drop-down list in the Tick column.

*Note: This determines how the tick mark will be drawn in relation to the alignment.* 

- 8. Select Each tick from the Label every drop-down list in the Text column.
- 9. Select Text for the layer under the Layer drop-down list in the Text column.
- 10. Select Standard from the Text style drop-down list in the Text column.
- 11. Select Right from the Side drop-down list in the Text column.
- 12. Select Perpendicular from the Orientation drop-down list in the Text column.
- 13. Select OK in the Alignment Label Settings window.

Major Minor HAL Points Station Equations Ger	neral		
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(if applicable)	Perpendicular		
	OK Cancel		

14. Select OK in the Create Horizontal Alignment Label pane.

Note: In the plan view you will notice that the ticks are labeled upside down. This is because the alignment stationing works from the north towards the southeast direction.

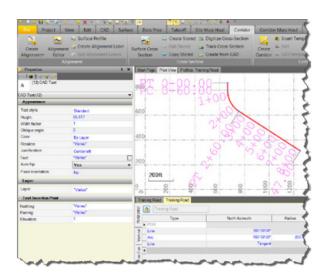
- 15. Select all the labels and right-click in the graphical view.
- 16. Select properties.
- 17. Select Yes in the Auto-Flip cell.

Close

Note: All the labels are now displayed correctly.

18. Select

in the Properties pane.



19. In the Project Explorer, expand Alignments and the Training Road alignment.

*Note: There is a new category called labeling.* 

- 20. Right-click on Labeling under the Training Road in the Project Explorer and select Edit.
- 21. Left-click on the Minor tab in the Alignment Label Settings window to select it.
- 22. Check the box to Label Intermediate Stations.
- 23. Select 4 from the Ticks per major segment drop-down list in the Ticks column.
- 24. Select the Text layer under the Layer drop-down in the Ticks column.
- 25. Enter 0.15 in the Tick size (inch) cell under the Ticks column.
- 26. Select Right from the Side drop-down list in the Ticks column.
- 27. Select No Labels from the Label every drop-down list in the Text column.

*Note: Often if the minor ticks are labeled in addition to the major ticks the labeling becomes too busy.* 

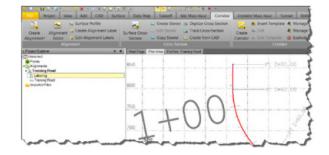
- 28. Left-click on the HAL Points Tab in the Alignment Label Settings window to select it.
- 29. Check the box to Label Alignment Points.
- 30. Select the Text layer under the Layer drop-down list in the Line column.
- 31. Enter 1.5 in the Line length (inch) cell in the Line column.
- 32. Select Left from the Side drop-down list in the Line column.
- 33. Select the Text layer in the Layer drop-down list in the Text column.
- 34. Select Sketchflow 0.10 from the Text style drop-down list in the Text column.
- 35. Select Centered in the Location drop-down list in the Text column.

Aajor Minor HAL Points Station Equation			
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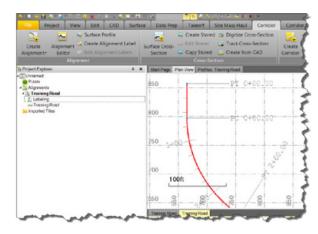
36. Select OK in the Alignment Label Settings window.

*Note: The Major stationing text is much too large.* 



- 37. In the Project Explorer, right-click on Labeling under the Training Road alignment and choose edit.
- 38. Select *Symbol 0.10 in* in the Text style in the Text column under the Major tab.
- 39. Select OK in the Alignment Label Settings window.

Note: If station equations were a property of this alignment that could easily be labeled as well Using the Station Equation tab in Edit Alignment Label settings.



## **Managing Material Layers**

Use the Manage Material Layers pane to specify the available material layers in your project by adding them to the Material layers list. Each material layer can represent a different surface within a corridor. For example, in addition to the default "Finish" layer, you might specify layers for "Base course" and "Subgrade."

Each time you create a corridor template instruction, you can select one or more material layers from the Layers list on which the line segment created by that instruction appears.

When creating or editing a corridor, you can specify its "current material layer" by selecting it from the Layers list. This is the layer that will display in the Plan View and 3D View. If you export the corridor, this is the layer used to create the exported corridor surface. The line segments appearing on the current material layer are used to build the corridor surface.

For this exercise we will assume a 3" asphalt material on top of a 12" base course material on top of the subgrade surface. The first step in defining the different layers that comprise a roadway is to create the material layers. Next, reference nodes need to be created representing the center line of the base course and subgrade respectively.

- 1. Select the Manage Material Layers A Manage Materials icon in the Corridor area under the Corridor tab.
   Manage Materials
- 2. Select New and name the material Base Course.
- 3. Select New and name this material Subgrade.

Note: The up and down arrows are utilized to put the material layers in the correct order as defined by the cross-section of the roadway.

4. Select Close in the Manage Material Layers pane.

	7   🔤				
Ma	terial layers:				
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	Base Course				
Þ	Subgrade			 	
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## **Materials and Site Improvement Manager**

When preparing for corridor takeoff calculations, it is necessary to define all the native materials that will be encountered during construction and materials that will be imported to complete construction. The definition of materials and site improvements as used in Business Center - HCE is:

- **Material** a naturally-occurring or manufactured substance from which a site improvement can be made at a construction site. Examples include soil, rock, sand, flex-base, limestone, cement concrete, asphaltic concrete, PVC pipe, ductile iron, etc.
- **Site Improvement** an object that is built out of materials on a construction site. Examples include curbs, sidewalks, parking lots, and building pads.

Business Center - HCE utilizes an MSI Manager to define all the materials, both native and man-made that will be encountered on a construction project. Using the MSI Manager, site improvements are then defined using these materials.

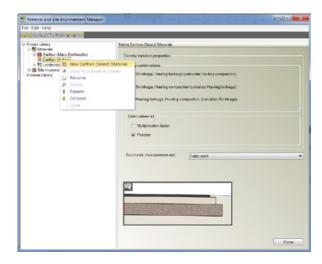
For this exercise, all of the materials that will be encountered during construction need to be defined in the MSI manager. We will only be concerned with defining materials and not site improvements, for the purpose of performing a corridor take-off. The materials that need to be defined are:

- Ashpalt
- Flex-Base
- Subsoil Earthen Clay

1. Select the Material and Site Improvement Manager

Manager icon in the Strata area under the Corridor tab.

- 2. Left-click on the 📩 icon in front of Materials to expand it.
- 3. Right-click on the Earthen (Select) category and select New Earthen (Select) Material.



- 4. Enter Flex Base for the Name.
- 5. Enter 0 in the Shrinkage and Hauling bulkage cells.

*Note: This is because flex base does not shrink or swell during excavation or material placement operations.* 

6. Enter 15 in the Procurement unit cost cell.

Note: The Procurement cost is the cost per cubic yard to either purchase the material or to extract the material as cut.

7. Select Magenta from the Color drop-down list under Shading.

*Note: This is the color that will be used in the graphic views to represent the material.* 

8. Do not specify a Texture under Shading for this exercise.

*Note: If desired, an image file could be specified here so that the Add Surface Texture command could be applied to make visualization of the 3D model more realistic.* 

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- 9. Right-click on the Earthen (Select) category and select New Earthen (Select) Material.
- 10. Enter Asphalt for the Name.
- 11. Enter 0 in the Shrinkage and Hauling bulkage cells.
- 12. Enter 90 in the Procurement unit cost cell.
- 13. Select Orange from the Color drop-down list under Shading.
- 14. Do not specify a Texture under Shading for this exercise.
- 15. Left-click on the 🛨 icon in front of Earthen (Mass Earthworks) to expand it.
- 16. Right-click on the On-Site Soil material and select rename.

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- 17. Enter On-Site Clay for the name of the material.
- 18. Select Ordinary Soils from the Material nature drop-down list.

Note: There are three options available for Material nature and they are explained below.

**Ordinary Soils** – Select this to identify a material that can potentially be utilized as fill on site.

**Topsoil** – Select this to identify a top of ground material. Topsoil materials can not be utilized as fill on site.

**Rock** – Select this to identify a rock material that may need to be ripped or blasted.

Earthen (Mass Earthworks)	
Name:	On Site Clay
Material nature	Ordinary soils Soil Properties
Shrinkage (%):	80
Hauling bulkage (%)	100
Hauling compaction (%):	16.4
Off-site borrow unit cost	12.00 / Cubic yard
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	Name: Material nature Shrinkage (%): Hauling bulkage (%) Hauling compaction (%): Offeite borrow unit cost Shading Color Tenture:

## 19. Select Soil Properties and set the Percent usable for fill to 100%.

*Note: If there was a portion of the material on-site that is not of the required quality to be used as fill. You can enter a estimated percentage here to attain a more accurate earthwork report.* 

#### 20. Enter 8 in the Shrinkage cell and 10 in the Hauling bulkage cell.

*Note:* The hauling compaction value is calculated based on the values entered for the Shrinkage and Hauling bulkage. Each of these values are defined below:

*Shrinkage* = the percent by which the material will shrink when it is cut and then used as compacted fill.

*Hauling Bulkage =* the percent by which the material will increase in bulk when it is cut and hauled in a *loose* state.

*Hauling Compaction =* the percent by which the material will shrink when it is taken from its loose condition and placed into compacted fill.

#### 21. Enter 12.00 in the Off-site borrow unit cost cell.

*Note: The Off-Site Borrow Unit Cost is the price to excavate, transport, and deliver the material on-site from a borrow source. This cost only applies to material that must be imported (borrowed).* 

#### 22. Select Brown from the Shading Color drop-down list and do not associate a texture file.

23. Select Close in the Material and Site Improvement Manager.

## **Creating Corridors**

A corridor is a 3D model of a linear structure, such as a road or waterway. The corridor is based on a horizontal and a optional vertical alignment. Business Center - HCE utilizes templates that define cross-sections at specific stations along the length of the corridor.

After completing this section you should be able to:

• Create a corridor

- Create and edit corridor templates
- Manage template nodes
- Manage material layers

#### Create a Corridor



- 1. Select comdor in the Corridor area under the Corridor tab.
- 2. Enter Training Road in the Name cell.
- 3. Select Training Road from the Horizontal Alignment and Vertical Alignment drop-down lists.
- 4. Select Finish from the Current Material layer dropdown list.

Note: The current material layer is user define, and is what surface is displayed in the graphical views and exported. An example of this is if subgrade is chosen then the subgrade surface is displayed and exported.

5. Select OG from the Original Ground drop-down list.

Note: An original ground surface is required to define tie slopes from the design to the original ground. Without defining an original ground those corridor definition instructions will not be available.

6. Select On-Site Clay from the Native material dropdown list.

*Note: The Native material is the most representative earthen material of the original ground.* 

7. Leave the borrow material as undefined.

*Note: This is because the project does not require an import.* 

Note: The Borrow material is the material that is to be obtained from off-site sources should there be a deficit on-site.

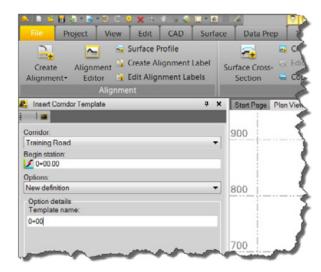
- 8. Do not select a reference line or reference surface.
- 9. Select OK in the Create Corridor pane.

*Note: The Insert Corridor Template pane will now appear.* 

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- 10. Select Training Road from the Corridor Cell drop-down list.
- 11. Enter 0+00 in the Begin Station cell.
- 12. Select new definition from the Options drop-down list.
- 13. Enter 0+00 in the Template name cell.
- 14. Select Insert Orridor Template pane.

*Note: The Edit Corridor Template window appears as well as the cross-section view at station 0+00.* 



### Corridor Templates

A corridor template is a cross-section definition at a specific station along an alignment. Template instructions are the tools used to specify what the template looks like. They define the offsets and slopes necessary to accurately represent the road edge of pavement, edge of shoulder, lane widening, superelevations, ditches, and more.

Corridor templates are made up of nodes and instructions. Nodes for example are the edge of pavement point, centerline of road, inside of ditch line, outside of ditch, and the point where a tie slope meets existing ground. The instructions are the definition of how we get from one node to the next. The centerline of road or alignment definition is normally the starting node from which the rest of the corridor template is built.

When nodes are created they are typically associated with a material layer. The material layer defines which surface it will be a part of. For example, a node with the subgrade material layer definition will be a part of the subgrade surface and not the finish grade surface. Multiple material layers can be assigned to a single node.

#### **Corridor Template Instruction Types**

With the following instruction types complex roadways and corridors can be accurately modeled. Following are definitions of each of the instruction types available in Business Center - HCE.

<u>Offset/Slope</u> - This instruction type defines a node based on the offset and slope relative to one or more other nodes in the template. For example, this would be used to define the edge of road in relation to the centerline.

<u>Offset/Elevation</u> - This instruction type defines a node based on the offset and elevation change relative to one or more other nodes in the template.

<u>Slope/Slope</u> - This instruction defines a node based on the intersection of slopes from two other nodes in the template.

<u>Slope/Elevation</u> - This instruction type defines a node based on the slope and elevation change relative to one or more other nodes in the template.

<u>Side Slope</u> - This instruction type defines a side slope node based on a cut slope and/or a fill slope. An optional ditch width can be added, if required. For example, defining the cut and fill slopes, and ditch profile to get from the edge of shoulder to existing ground.

**<u>Connect Nodes</u>** - This instruction type connects two nodes with a line segment.

<u>Surface instruction</u> - This instruction type creates a corridor from an existing surface.

#### **Important Corridor Template Concepts**

In Business Center – HCE, templates are always building to the next template. For instance, if a cross-section template is defined at station 0+00 of an alignment, the template will be carried the length of the alignment. If there is a lane widening that begins at station 2+00 and ends at 3+00 – the original template will need to be added at 2+00 and then a template representing the full lane width inserted at station 3+00.

With typical complex roadways there could be dozens of templates required to build an accurate surface in this method. The preferred way to build sophisticated corridors is by using tables within a corridor template.

In the remainder of this exercise a corridor consisting of a superelevation and lane widening; constising of an asphalt layer, base course layer, and subgrade layer will be constructed using one corridor template that utilizes the instructions and tables mentioned above.

1. Select Offset/Slope from the Instruction Type dropdown list.

*Note: We will start by defining the right edge of road in reference to the CL.* 

2. Select 1 > Training Road from the Offset/slope from drop-down list.

*Note: This is the starting point or otherwise defined as node 1.* 

3. Select Table from the Offset: drop-down list by leftclicking on the *left* icon.

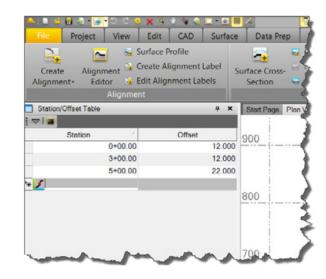
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3. Left-click on the button under Offset.

Note: A Station/Offset Table pane is presented and we will use this table to horizontal location of the edge of pavement for the right travel lane.

Note: For this exercise assume a 12' wide travel lane from staton 0+00 to station 3+00. The right lane will then transition from 12' to 22' wide, and this transition happens from station 3+00 to station 5+00. From station 5+00 to the end of the corridor the right hand travel lane will remain 22' wide.

- 4. Enter 0+00 for the Station and 12 for the Offset in the first row.
- 5. Enter 3+00 for the Station and 12 for the Offset in the second row.
- 6. Enter 5+00 for the Station and 22 for the Offset in the third row.
- 7. Select OK in the Station/Offset Table pane.
- 8. Select Table from the Slope: drop-down list by leftclicking on the icon .



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#### 9. Left-click on the button under Slope.

*Note: In the Station/Slope Table pane we will define the superelevations and cross slope of the right travel lane.* 

Note: The training road starts out in a full superelevation of 6% from station 0+00 to station 2+60. The road transitions from full superelevation to the typical cross slope of -2% between station 2+60 and station 5+00.

- 10. Enter 0+00 for the Station and 6 for the Slope in the first row.
- 11. Enter 2+60 for the Station and 6 for the Slope in the second row.
- 12. Enter 5+00 for the Station and -2 for the Slope in the third row.
- 13. Select OK in the Station/Slope Table pane.
- 14. Enter EP in the Name cell.

Note: EP is short for edge of pavement. The names are labels for the nodes and can be displayed in the crosssection views and also are utilized by the drafting module when plotting cross-sections.

- 15. Leave the Code cell as Undefined.
- 16. Select Finish for the Material layer.

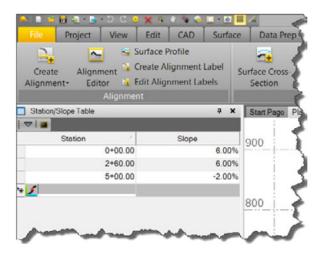
*Note: This is the finish surface that we are defining.* 

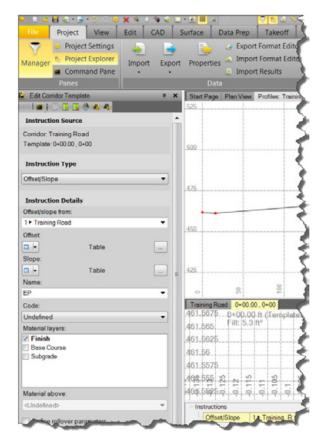
Note: The material above option is not selectable. This is because the Finish material layer is selected.

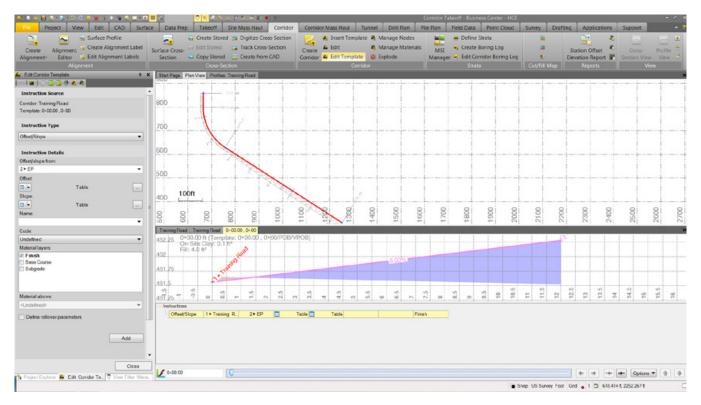
*Material Above =* an Earthen (Select) material that is above the subgrade surface segment being defined.

17. Select Add in the Edit Corridor Template pane.

Note: You will notice that the right-hand travel lane is now defined and can be viewed in the plan view and cross-section view to check for accuracy.







#### 18. Select Offset/Slope from the Instruction Type dropdown list.

*Note: This is to define the left edge of road in reference to the CL.* 

#### 19. Select 1 > Training Road in the Offset/slope from dropdown list.

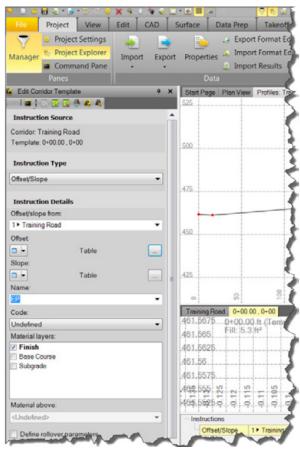
*Note: This is the starting point or as otherwise defined as node 1.* 

#### 20. Enter EP in the Name cell.

*Note: We are entering EP because we are defining the left travel lane edge of pavement with thess instructions.* 

#### 21. Select Finish for the Material layer.

Note: This is the finish surface that we are defining.



#### 22. Left-click on the button under Offset.

Note: A Station/Offset Table pane is presented and we will use this table to horizontal location of the edge of pavement for the left travel lane.

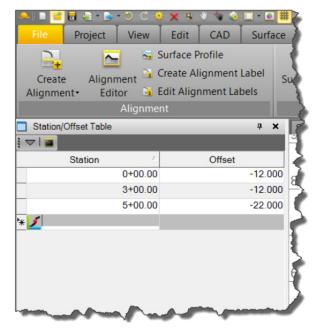
Note: For this exercise assume a 12' wide travel lane from staton 0+00 to station 3+00. The left lane will then transition from 12' to 22' wide, and this transition happens from station 3+00 to station 5+00. From station 5+00 to the end of the corridor the left hand travel lane will remain 22' wide.

23. Enter 0+00 for the Station and -12 for the Offset in the first row.

Note: When setting a Offset left of a centerline you will use a negative number and when setting an Offset to the right of the centerline it is a positive value.

- 24. Enter 3+00 for the Station and -12 for the Offset in the second row.
- 25. Enter 5+00 for the Station and -22 for the Offset in the third row.

26. Select OK in the Station/Offset Table pane.



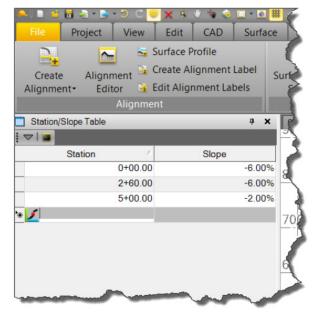
#### 27. Left-click on the button under Slope.

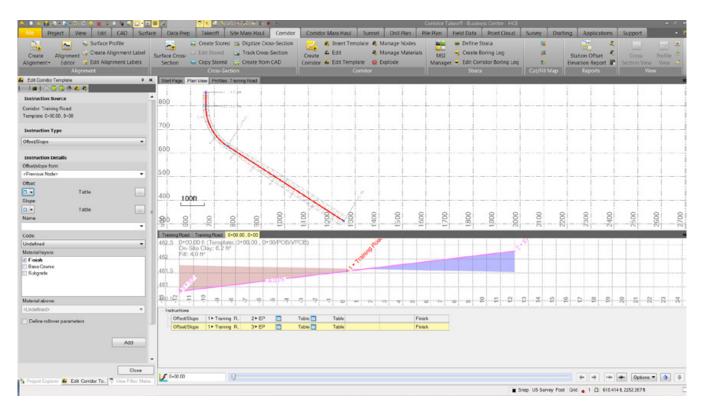
*Note: In the Station/Slope Table pane we will define the superelevations and cross slope of the left travel lane.* 

Note: The training road starts out in a full superelevation of -6% from station 0+00 to station 2+60. The road transitions from full superelevation to the typical cross slope of -2% between station 2+60 and station 5+00.

- 28. Enter 0+00 for the Station and -6 for the Slope in the first row.
- 29. Enter 2+60 for the Station and -6 for the Slope in the second row.
- 30. Enter 5+00 for the Station and -2 for the Slope in the third row.
- 31. Select OK in the Station/Slope Table pane.
- 32. Select Add in the Edit Corridor Template pane.

Note: You will notice that the left-hand travel lane is now defined and can be viewed in the plan view and cross-section view to check for accuracy.





33. Select Offset/Slope from the Instruction Type dropdown list.

*Note: We will be defining the edge of the shoulder for right travel lane.* 

Note: For this corridor the shoulder is 4' wide and maintains a consistent -6% slope.

34. Select 2 > EP in the Offset/slope from: drop-down list.

Note: We selected 2 > EP since this is the edge of the right travel lane.

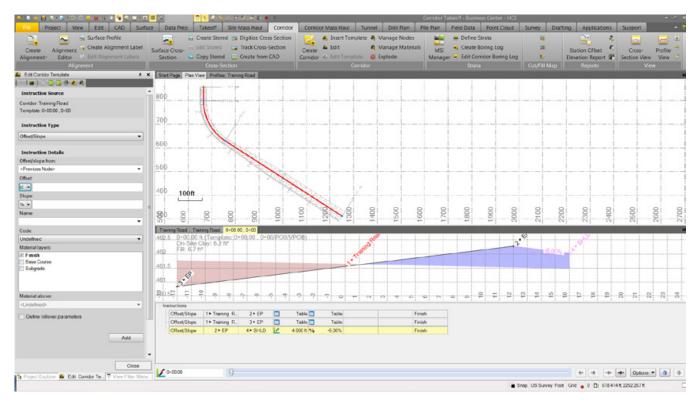
- 35. Select Offset from the Offset: drop-down by leftclicking on the icon.
- 36. Enter 4 in the Offset cell.
- 37. Select Slope Percent from the Slope: drop-down by left-clicking on the icon
- 38. Enter -6 in the Slope cell.
- 39. Enter SHLD in the Name cell.

Note: SHLD is short for shoulder.

- 40. Select Finish for the Material layers.
- 41. Select Add in the Edit Corridor Template pane.

Note: You will notice that the right-hand shoulder is now defined and can be viewed in the plan view and cross-section view to check for accuracy.

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#### 42. Select Offset/Slope from the Instruction Type dropdown list.

*Note: We will be defining the edge of the shoulder for left travel lane.* 

Note: For this corridor the shoulder is 4' wide and maintains a consistent -6% slope.

43. Select 3 > EP in the Offset/slope from: drop-down list.

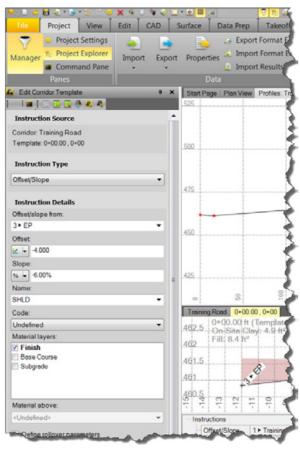
Note: We selected 3 > EP since this is the edge of the left travel lane.

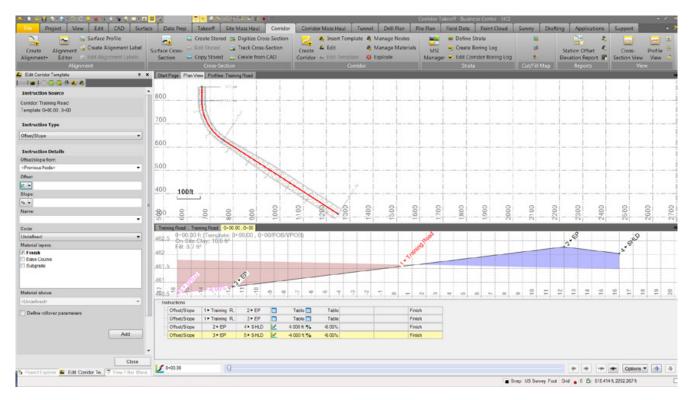
- 44. Enter -4 in the Offset cell.
- 45. Enter -6% in the Slope cell.
- 46. Enter SHLD in the Name cell.

Note: SHLD is short for shoulder.

- 47. Select Finish for the Material layers.
- 48. Select Add in the Edit Corridor Template pane.

Note: You will notice that the left-hand shoulder is now defined and can be viewed in the plan view and cross-section view to check for accuracy.





#### 49. Select Offset/Elevation from the Instruction Type dropdown list.

Note: We are defining the inside of the ditch from the edge of the right shoulder using an offset/elevation instruction.

- 50. Select 4 > SHLD in the Offset/slope from: drop-down list.
- 51. Enter 6 in the Offset cell.

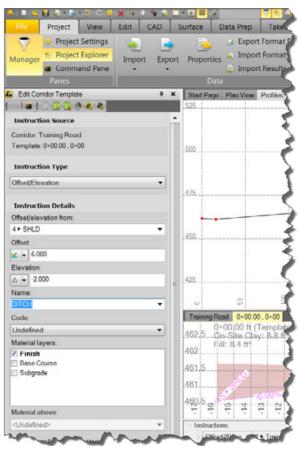
*Note: This defines the horizontal location of the inside of the ditch as being 6' from the edge of shoulder.* 

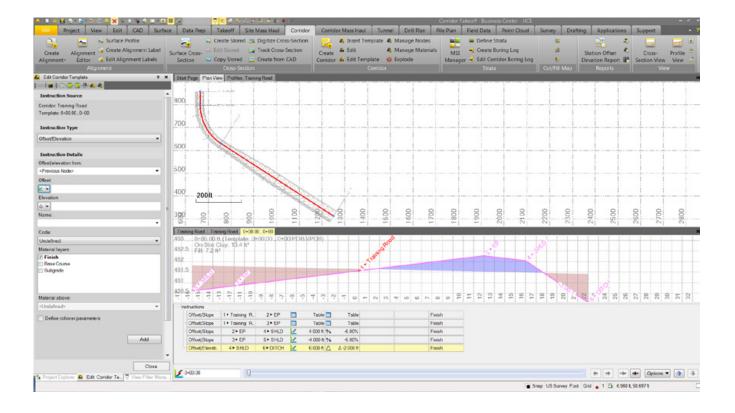
52. Enter -2 in the Elevation cell.

*Note: This defines the elevation of the inside of the ditch to be 2' lower than the elevation of the shoulder.* 

- 53. Enter DITCH in the Name cell.
- 54. Select Finish for the Material layer.
- 55. Select Add in the Edit Corridor Template pane.

Note: You will notice that the right-hand ditch is now defined and can be viewed in the plan view and cross-section view to check for accuracy.





# 56. Select Side Slope in the Instruction Type drop-down list.

Note: The last definition for the finish grade surface on the right travel lane is to define the ditch width and tie the cut and fill slopes to the original ground.

#### 57. Select 6 > DITCH in the Side slope from: drop-down list.

#### 58. Select OG in the Target surface drop-down list.

*Note: This is the surface from which the cut and fill slopes tie into.* 

#### 59. Enter 3:1 in the Cut slope cell.

60. Enter 3 in the Cut ditch width: cell.

Note: This defines that when in a cut to get to the finish grade of the road a 3' ditch will be defined prior to sloping at a 3:1 to tie to existing.

#### 61. Enter 3:1 in the Fill slope: cell.

Note: This defines that when filling to get to grade on the road the slope from the inside ditch line to existing will be 3:1.

#### 62. Enter TIE in the Name cell.

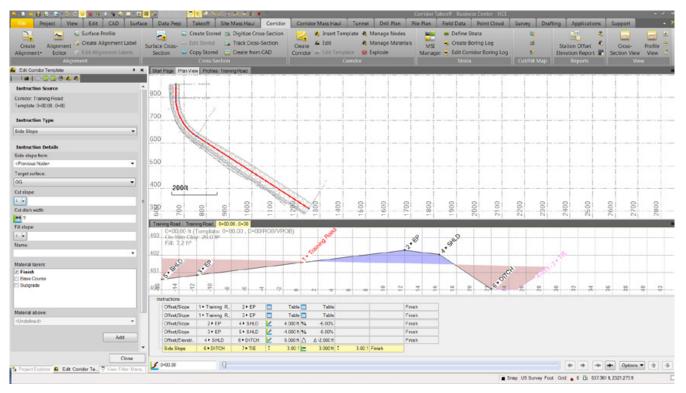
*Note: TIE is short for the point where the side slope intersects the original ground.* 

#### 63. Select Finsih for the Material layer.

64. Select Add in the Edit Corridor Template pane.

Note: You will notice that the right-hand Ditch is now tied to the Original Ground and can be viewed in the plan view and cross-section view to check for accuracy.

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#### 65. Select Offset/Elevation in the Instruction Type dropdown list.

Note: We are defining the inside of the ditch from the edge of the left shoulder using an offset/elevation instruction.

- 66. Select 5 > SHLD in the Offset/slope from: drop-down list.
- 67. Enter -6 in the Offset cell.

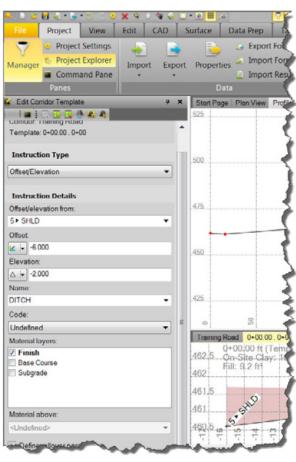
*Note: This defines the horizontal location of the inside of the ditch as being 6' from the edge of shoulder.* 

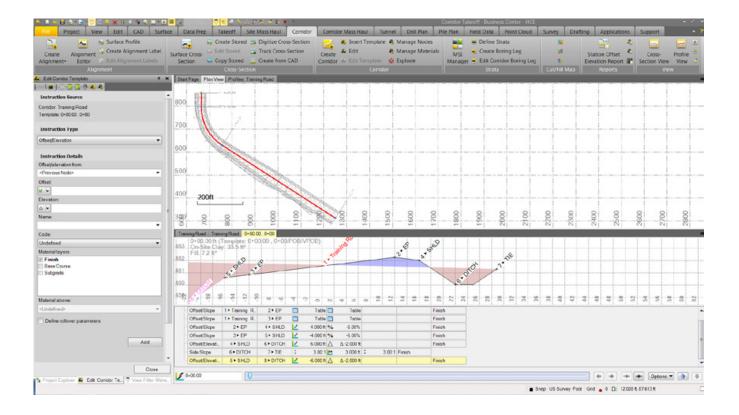
68. Enter -2 in the Elevation cell.

*Note: This defines the elevation of the inside of the ditch to be 2' lower than the elevation of the shoulder.* 

- 69. Enter DITCH in the Name cell.
- 70. Select Finish for the Material layer.
- 71. Select Add in the Edit Corridor Template pane.

Note: You will notice that the left-hand ditch is now defined and can be viewed in the plan view and cross-section view to check for accuracy.





# 72. Select Side Slope in the Instruction Type drop-down list.

Note: The last definition for the finish grade surface on the left travel lane is to define the ditch width and tie the cut and fill slopes to the original ground.

#### 73. Select 8 > DITCH in the Side slope from: drop-down list.

#### 74. Select OG in the Target surface drop-down list.

*Note: This is the surface from which the cut and fill slopes tie into.* 

#### 75. Enter 3:1 in the Cut slope cell.

76. Enter 3 in the Cut ditch width: cell.

Note: This defines that when in a cut to get to the finish grade of the road a 3' ditch will be defined prior to sloping at a 3:1 to tie to existing.

#### 77. Enter 3:1 in the Fill slope: cell.

Note: This defines that when filling to get to grade on the road the slope from the inside ditch line to existing will be 3:1.

#### 78. Enter TIE in the Name cell.

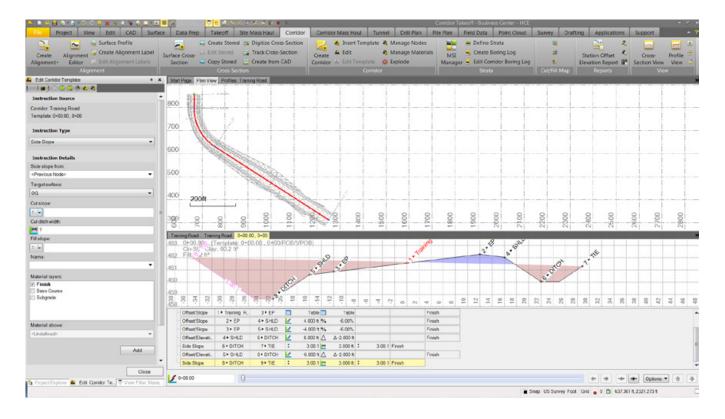
*Note: TIE is short for the point where the side slope intersects the original ground.* 

#### 79. Select Finish for the Material layer.

80. Select Add in the Edit Corridor Template pane.

Note: You will notice that the left-hand Ditch is now tied to the Original Ground and can be viewed in the plan view and cross-section view to check for accuracy.

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## **Defining Corridor Subgrades**

So far we have defined the finish grade surface. As indicated earlier this particular road consists of 3" of asphalt and 12" of base course atop the subgrade. The next step in completing the cross-section definitions is to define the base course surface. The first step in this process is to create a base course centerline node.

- 1. Select Offset/Elevation in the Instruction Type dropdown list.
- 2. Select 1 > Training Road in the Offset/elevation from: drop-down list.
- 3. Enter 0.0 in the Offset cell.

*Note: The centerline of the base course should be directly beneath the finish surface centerline.* 

4. Enter -.25 in the Elevation cell.

*Note: Entering -.25' is the same as going beneath the finish surface by 3 inches.* 

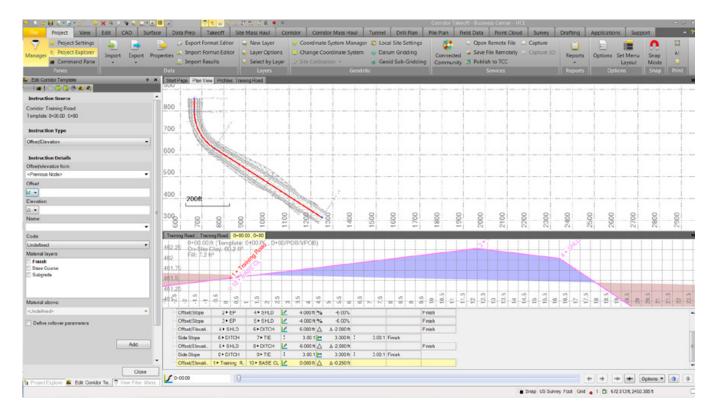
- 5. Enter BASE CL in the Name cell.
- 6. Unselect all material layers under Material layers by Left-clicking on any boxes that have a checkmark to remove the checkmark.

Note: We do not want to create a segment between node 1 and the newly created node that becomes part of a surface. The node is simply needed as a reference to build the segments that will make up the base course surface.

7. Select Add in the Edit Corridor Template pane.

Note: You will notice that the 10 > BASE CL point is now directly below the 1 > Training Road and can be viewed in the cross-section view to check for accuracy.

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Note: Next we need to define the right travel lane of the base course. It should mirror the right travel lane of the finish surface through lane widenings and superelevations. Instead of re-defining the superelevations and lane widenings again via tables, let's direct Business Center - HCE to simply follow the finish surface definition.

- 8. Select Offset/Elevation in the Instruction Type dropdown list.
- 9. Select 10 > BASE CL in the Offset/elevation from: dropdown list.
- 10. Select Node to node from the Offset: drop-down list by left-clicking on the *left-clicking* icon.
- 11. Select 1 > Training Road in the first node drop-down list and select 2 > EP in the second node drop-down list.

Note: This says that our newly created node should mirror the offset from 1 > Training Road to 2 > EP.

- 12. Select Node to node in the Elevation: drop-down list by left-clicking on the icon.
- 13. Select 1 > Training Road in the first node drop-down list and select 2 > EP in the second node drop-down list.

*Note: This defines the elevation of the newly created node to match the elevation definition of node 2.* 

- 14. Enter BASE in the Name cell.
- 15. Select Base Course under Material layers.

Note: Since the material layer is a subgrade layer the Material Above option is enabled.

16. Select Earthen (Select) > Asphalt in the Material above drop-down list.

*Note: That only materials defined in the Earthen(Select) category are available.* 

17. Select Add in the Edit Corridor Template pane.

Note: You will notice that the left-hand Road Base is now added and can be viewed in the plan view and cross-section view to check for accuracy.

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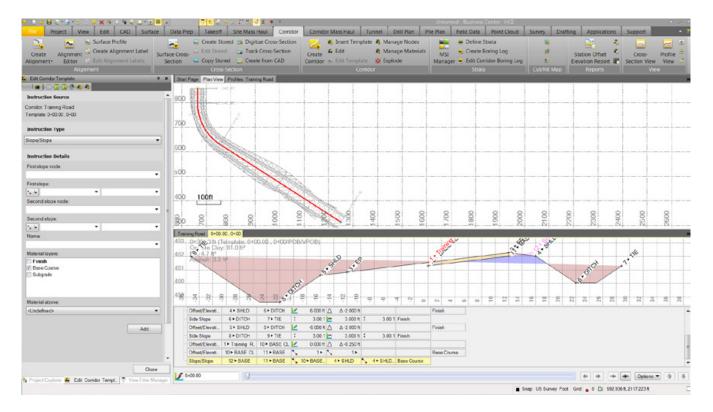
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- 18. Select Slope/Slope in the Instruction Type drop-down list.
- 19. Select Node to node in the First slope node: drop-down list by left-clicking on the view icon.
- 20. Select 11 > BASE in the First slope node drop-down list.
- 21. Select 10 > BASE CL in the First slope node 1 dropdown list and select 11 > BASE in the node 2 dropdown list.
- 22. Select Node to node from the Second slope node: drop-down list by left-clicking on the view icon.
- 23. Select 4 > SHLD in the Second slope node drop-down list.
- 24. Select 4 > SHLD in the Second slope node 1 drop-down list and select 6 > DITCH in the node 2 drop-down list.

Note: We just defined the new segment starts at node 11 > BASE and maintains the same slope as node 10 > BASE CL to 11 > BASE until it intersects the slope defined from node 4 > SHLD to 6 > DITCH.

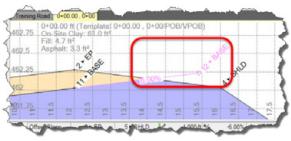
- 25. Enter BASE in the Name cell.
- 26. Select Base Course under Material layers.
- 27. Select Earthen (Select) > Asphalt in the Material above drop-down list.
- 28. Select Add in the Edit Corridor Template pane.

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Note: You can scroll the slider of the cross-section view down the length of the alignment and notice that node 11 stays 3" beneath node 2 at all times and the slope is held from node 10 as expected.

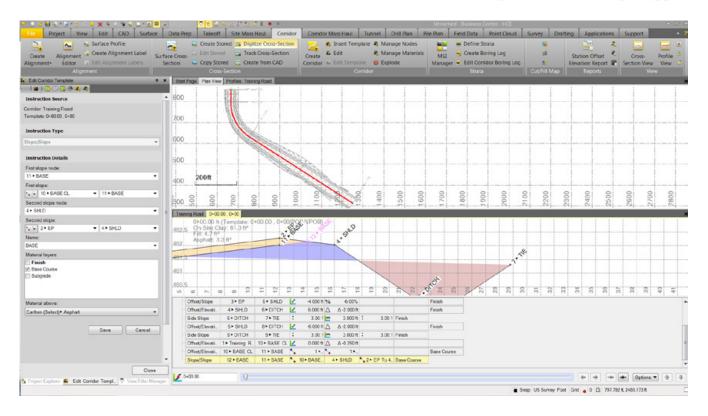
Note: You will notice that the newly created line goes past the 2 > EP to 4 > SHLD line at station 0+00.00 to 4+32.42 and then it terminates at the line 4 > SHLD to 6 > DITCH correctly from station 4+32.42 to the end. We will edit the last Slope/Slope instruction to end at the line 2 > EP to 4 > SHLD to make station 0+00.00 to station 4+32.42 correct. We will then fix station 4+32.42 to the end later in the excercise.



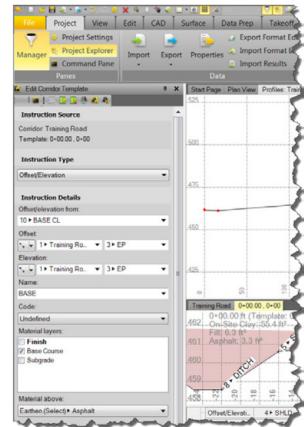
- 29. Right-click on the last Slope/Slope instruction in the list and select Edit.
- 30. Change the Second slope node 1 to 2 > EP and change the node 2 to 4 > SHLD.
- 31. Select Save in the Edit Corridor Template pane.

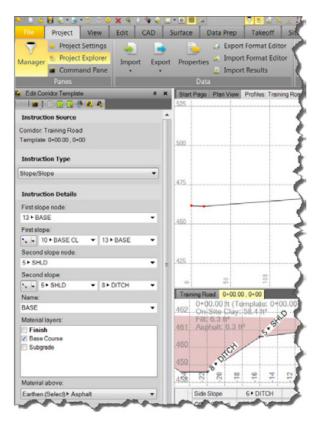
Note: You will notice that the line now terminates at the 2 > EP to 4 > SHLD line correctly from station 0+00.00 to station 4+32.42.

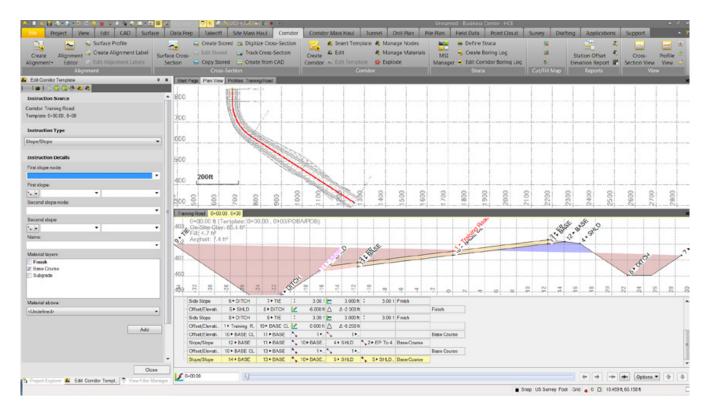
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- 32. Select the Add instruction icon at the top of the Edit Corridor Template to add a Instruction.
- 33. Select Offset/Elevation in the Instruction Type dropdown list.
- 34. Select 10 > BASE CL in the Offset/elevation from dropdown list.
- 35. Select 1 > Training Road in the Offset node 1 dropdown list and select 3 > EP in the node 2 drop-down list.
- 36. Select 1 > Training Road in the Elevation node 1 dropdown list and select 3 > EP in the node 2 drop-down list.
- 37. Enter BASE in the Name cell.
- 38. Select Base Coure under Material layers.
- 39. Select Earthen (Select) > Asphalt in the Material above drop-down list.
- 40. Select Add in the Edit Corridor Template pane.
- 41. Select Slope/Slope in the Instruction Type drop-down list.
- 42. Select 13 > BASE in the First slope node drop-down list.
- 43. Select 10 > BASE CL in the First slope node 1 dropdown list and select 13 > BASE in the node 2 dropdown list.
- 44. Select 5 > SHLD in the Second slope node drop-down list.
- 45. Select 5 > SHLD in the Second slope node 1 drop-down list and select 8 > DITCH in the node 2 drop-down list.
- 46. Enter BASE in the Name cell.
- 47. Select Base Course under Material layers.
- 48. Select Earthen (Select) > Asphalt in the Material above drop-down list.
- 49. Select Add in the Edit Corridor Template pane.







Note: The last portion of the corridor that needs to be defined is the subgrade. To get to the centerline of the subgrade a node needs to be created at an offset of 12" down from the centerline of the base course to represent the thickness of the base course.

- 50. Select Offset/Elevation in the Instruction Type dropdown list.
- 51. Select 10 > BASE CL in the Offset/elevation from dropdown list.
- 52. Select Offset in the Offset drop-down list by leftclicking on the clicking.
- 53. Enter 0.0 in the Offset cell.
- 54. Select Delta elevation in the Elevation drop-down list by left-clicking on the icon.
- 55. Enter -1 in the Elevation cell.
- 56. Enter SG CL in the Name cell.

Note: SG CL is short for subgrade centerline.

57. Unselect all material layers under Material layers by left-clicking on any boxes that have a checkmark to remove the checkmark.

Note: Do not choose a material layer. If a material layer is chosen then a segment between node 10 and the new node will be created and added to the surface and that would create an error in the surface.

58. Select Add in the Edit Corridor Template pane.

Note: You will notice that the 15 > SG CL point is now directly below the 10 > BASE CL and can be viewed in the cross-section view to check for accuracy.

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- 59. Select Slope/Slope in the Instruction Type drop-down list.
- 60. Select 15 > SG CL in the First slope node drop-down list.
- 61. Select 10 > BASE CL in the First slope node 1 dropdown list and select 11 > BASE in the node 2 dropdown list.
- 62. Select 4 > SHLD in the Second slope node drop-down list.
- 63. Select 4 > SHLD in the Second slope node 1 drop-down list and select 6 > DITCH in the node 2 drop-down list.

Note: With the steps above we defined the new segment will start at node 15 and the segment will mirror the slope defined from node 10 to node 11. The new segment shall terminate into the slope created from node 4 to node 6.

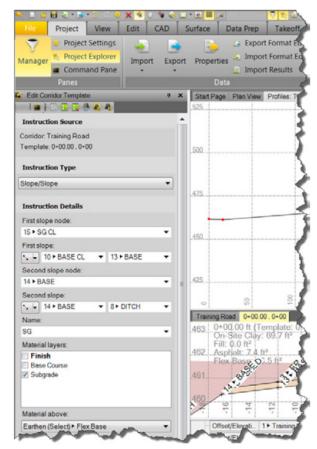
- 64. Enter SG in the Name cell.
- 65. Select Subgrade under the Material layers.
- 66. Select Earthen (Select)>Flex Base in the Material above drop-down list.
- 67. Select Add in the Edit Corridor Template pane.

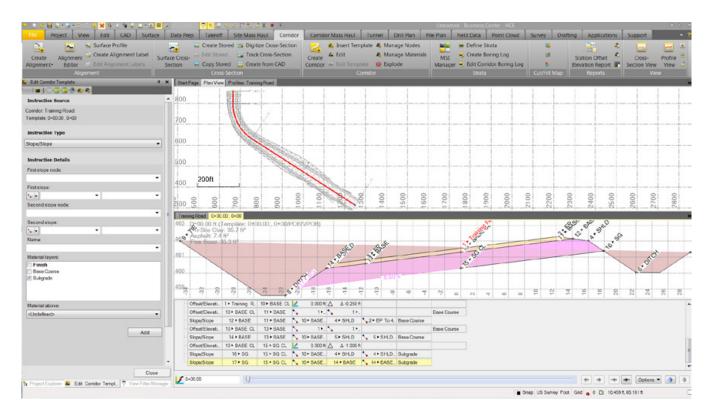
Note: You will notice that the right-hand Subgrade is now added and can be viewed in the plan view and cross-section view to check for accuracy.

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- 68. Select Slope/Slope in the Instruction Type drop-down list.
- 69. Select 15 > SG CL in the First slope node drop-down list.
- 70. Select 10 > BASE CL in the First slope node 1 dropdown list and select 13 > BASE in the node 2 dropdown list.
- 71. Select 14 > BASE in the Second slope node drop-down list.
- 72. Select 14 > BASE in the Second slope node 1 dropdown list and select 8 > DITCH in the node 2 dropdown list.
- 73. Enter SG in the Name cell.
- 74. Select Subgrade under Material layers.
- 75. Select Earthen (Select)>Flex Base in the Material above drop-down list.
- 76. Select Add in the Edit Corridor Template pane.

Note: You will notice that the left-hand Subgrade is now added and can be viewed in the plan view and cross-section view to check for accuracy.





77. Scroll the slider of the cross-section view past station 4+32.42.

Note: You can see the line that extends through the line of 4 > SHLD to 6 > DITCH. We will have to add a Corridor Template to take care of station 4+32.42 to the end.

- 78. Select the Insert Corridor Template Insert Template icon in the Corridor area under the Corridor tab.
- 79. Select Training Road in the Corridor drop-down list.
- 80. Enter 4+32.42 in the Begin station cell.
- 81. Select Copy definition in the Options drop-down list.
- 82. Enter 4+32.42 in the Template name cell.

Insert

- 83. Left-click on 0+00.00 , 0+00 in the Copy from template cell to highlight it.
- 84. Select

in the Insert Corridor Template.

*Note: The Edit Corridor Template pane will open for Station 4+32.42.* 

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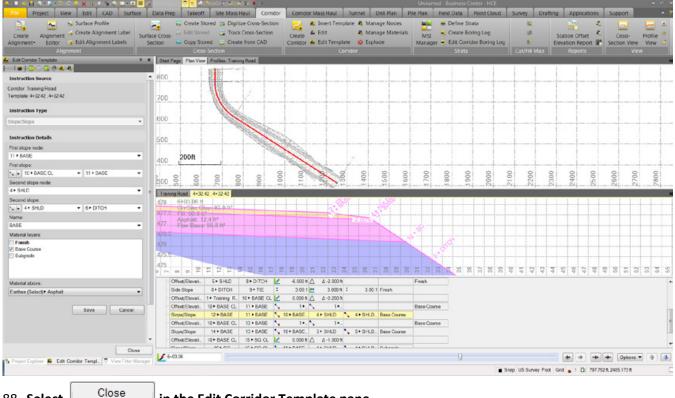
85. Left-click on the Slope/Slope instruction for 12 > BASE to 11 > BASE to select it.

Note: You will see the instruction in the Edit Corridor Template pane once the instruction is selected.

- 86. Change the Second slope node 1 to 4 > SHLD and change the node 2 to 6 > DITCH.
- Save 87. Select in the Edit Corridor Template pane.

Note: You will notice that the line now terminates at the 4 > SHLD to 6 > DITCH line correctly from station 4+32.42 to the end.

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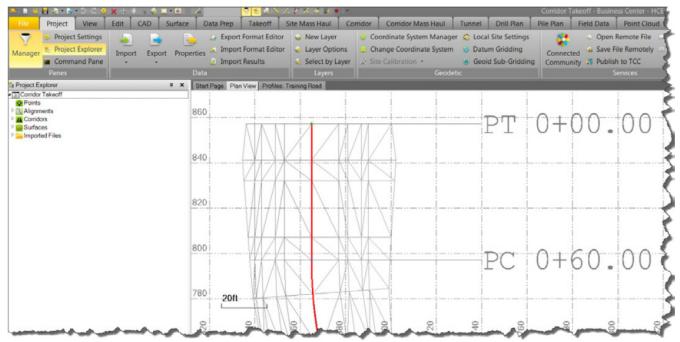


88. Select

in the Edit Corridor Template pane.

## **Corridor Surface Creation**

It is important to realize there are project settings that greatly impact the accuracy of the corridor surface that Business Center - HCE creates. Turn on only the Training Road surface in the view filter manager and the plan view should look very similar to that of the image below. Take notice of the density of the triangles that form the surface.



- 1. Select Project Settings in the Panes area under the Project tab.
- 2. Left-click on the Computations folder to expand it and Left-click on Corridor to select it.
- 3. Enter 10 in the Maximum sampling distance cell.

*Maximum sampling distance* = this represents the maximum distance along an alignment between automatically generated corridor templates. The lesser the distance the more accurate the corridor surface, but also the larger the file.

- 4. Select OK in the Project Setting window.
- 5. Pan and zoom in the Plan view to observe the surface.

*Note: You will notice the triangles that form the surface are more dense, thus creating a more accurate surface.* 

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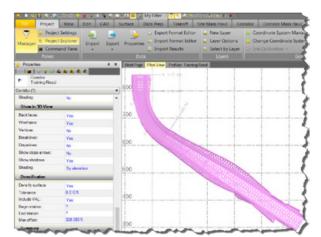
- 6. Select the Corridor in the Plan view by left-clicking on it.
- 7. Right-click in the graphical view and select Properties.
- 8. Scroll-down in the Properties pane until the Densification section appears.
- 9. Left-click in the Densify Surface cell and select Yes.
- 10. Ensure that the Tolerance set to 0.010'.

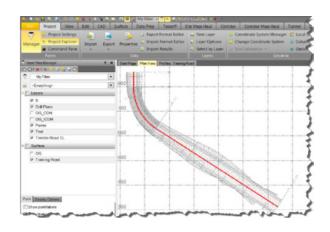
Note: This value says that if the error between the surface created and the surface intended is greater than 0.010 then more triangles are created and added to the surface until the surface is within this value.



in the Properties Pane.

Note: Notice the mesh of triangles forming the surface is more dense in this region – creating a surface that meets the tolerances specified in the properties.





## **Corridor Takeoff Reporting**

The Corridor Earthwork Report in Business Center - HCE is used to calculate the following values:

- Accumulated bank excess/deficit volume
- Accumulated cut and fill volumes at each station
- Subgrade Material Quantities Asphalt, Flex Base, etc.
- 1. Select the Reports rea under the Project tab.
- 2. Select Corridor Earthwork Report from the Reports drop-down list.
- 3. Select Training Road in the Corridor drop-down list.
- 4. Enter 50 in the Station increment cell.
- 5. Ensure that the Only include subsection box is unchecked.

Note: If only a portion of the corridor is desired to be reported on then the checkbox for "only include subsection" should be checked. Then a start and end station for the reporting parameters could be defined.

6. Select Account for shrinkage and bulkage and Account for curve adjustment by placing a checkmark in their boxes.

Account for shrinkage and bulkage = select this since we defined a native material for the corridor and associated material properties to the On-Site Clay in the MSI Manager.

**Account for curve adjustment =** select this to more accurately account for volumes due to the larger areas of earthworks on the outside of curves.

**Include horizontal alignment points =** select this to report cut/fill volumes at horizontal alignment points of intersection.

*Include vertical alignment points* = select this to report cut/fill volumes at vertical alignment points of intersection.

7. Select OK in the Corridor Earthwork Report pane.

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#### 8. Scoll through the report.

Note: The total fill supplied is 309.6 cy less than the total available bank cut available. Remember that the shrinkage factor for the On-Site Clay material was 8%. The total fill supplied is equal to 92% of the total available bank cut and accounts for the shrinkage property.

*Note:* The subgrade quantities table displays the total volume of Asphalt and Flex Base as defined by the corridor templates created.

Project file data		Coordinate System	
Name:	C:\Users\jhodgso\Documents\Business	Name:	Default
	Center - HCE\Corridor Takeoff Chapter Run 3.vce	Datum:	WGS 1984
Size:	4 MB	Zone:	Default
Modified:	6/5/2015 2:08:12 PM (UTC:-6)	Geold:	
Time zone:	Mountain Standard Time	Vertical datum:	
Reference number:			
Description:			

## **Corridor Earthwork Report**

Corridor name:	Training Road
Native material:	Earthen (Mass Earthworks) : On-Site Clay
Borrow material:	<undefined></undefined>

Start station:	0+00.00
End station:	8+47.00
Account for curve adjustment:	Yes
Account for shrinkage/bulkage:	Yes

# Cut Quantities

Material	Volume (yd°)
Earthen (Mass Earthworks) : On-Site Clay	3,869.3
Total	3,869.3

# Subgrade Quantities

Subgrade Material	Volume (yd³)
Earthen (Select) : Asphalt	313.3
Earthen (Select) : Flex Base	1,444.5
Total	1,757.8

Mass Earth	work
	Volume (yd <sup>s</sup> )
Total available bank cut	3,869.3
Total fill supplied	3,559.7
Total fill required	630.0
Total mass haul exports	0.0
Total mass haul imports	0.0
Total computed waste	0.0
Total computed borrow	0.0
Total excess (yd <sup>a</sup> )	2,929.8

Note: At each station an area value is given that shows the total area of cut and total area of volume required in that station range.

Note: In the volume columns the following values are displayed.

**Available Bank Cut** = the volume of material available in its natural or in situ state.

*Fill Supplied =* this value is obtained by multiplying the usable in situ bank cut by the material's shrinkage factor.

*Fill Required =* this value represents the compacted fill required and is reported in its in-place density state.

*Excess/Deficit =* the excess or deficit of material at this station range.

**Accumulated Excess/Deficit** = The total excess or deficit of material from the beginning of the corridor to this station.

Area (ft²)		Volume (yd³)			
Fill Required	Available Bank Cut	Fill Supplied	Fill Required	Excess/Defi cit	Excess/Deficit
0.0					
	155.4	142.9	1.0	141.9	141.9
1.0					
	94.9	87.3	16.8	70.5	212.4
16.0					
	49.0	45.1	31.6	13.4	225.9
16.0					
	56.1	51.6	19.7	31.9	257.8
3.9					
	90.3	83.1	3.9	79.2	337.0
	151.0	138.9		138.9	475.
	242.3	222.9		222.9	698.8
	371.6	341.9		341.9	1,040.
	525.7	483.6		483.6	1,524.3
		525.7	525.7 483.6	525.7 483.6	525.7 483.6 483.6 483.6

#### **Corridor Exporting to Trimble GCS900**



- 1. Select in the Data area under the Project tab.
- 2. Left-click on the Construction tab to select it and then left-click on the Machine Job Site Design exporter.
- 3. Select Road surface in the Model type drop-down list.

Note: By selecting Road surface instead of simply a surface you have the ability to export an alignment with the road surface.

4. Select Training Road in the Surface drop-down list.

*Note: If this surface was not densified a warning would be present in the form of a yellow dot.* 

- 5. Select Training Road in the Alignment drop-down list.
- 6. With the curser in the Objects to add or remove cell, left-click on the Corridor: Training Road in the plan view to select it and select Add.

Note: The design map is the linework that gets exported and displayed on the CB460 for the operators reference.

*Note: Notice that the corridor was ignored and no linework was added. The corridor needs to be exploded.* 

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- 7. Left-click on the Project Explorer tab to bring up the Project Explorer pane.
- 8. Ensure the Corridor: Training Road is still selected.
- Select Explode in the Edit area under the Edit tab.

10. Select Apply in the Explode pane.

Note: Notice that all of the nodes created in the corridor template are now available to be selected individually in the plan view.

- 11. Select Close in the Explode pane.
- 12. Left-click on the Export tab at the bottom of the Pane View, if the Export pane is not already visible.
- 13. Select Add under Design Map.

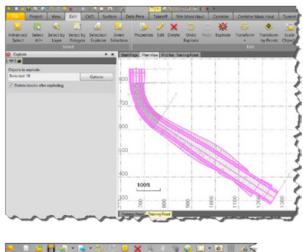
Note: You will now notice that the Selected: 22 items are now added in the Number of objects.

- 14. Enter Training Road in the File Name cell and then select Export.
- 15. Navigate to the Project Folder location via Windows Explorer.

*Note: The following machine control files are now present:* 

Training Road.svd (surface file)

Training Road.svl (linework file)



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CHAPTER **4** 

# Site Takeoff

#### Welcome

Welcome to the Trimble<sup>®</sup> Business Center – Heavy Construction Edition (HCE) Site Takeoff Module. The site takeoff module incorporates tools that enable users to perform a site take-off quickly and with accuracy. This is typically for pre-construction estimating purposes. Business Center - HCE allows for the import of multiple file types that are used to create original ground and finished design surfaces. General contractors have the ability to assign site improvements to the finished design to accurately estimate all material and site improvement quantities in addition to mass earthwork quantities. Alternatively, an earthwork contractor whom does not have interest in any quantities other than mass earthworks can apply simple subgrade adjustments to the finished design to quickly obtain a subgrade surface. The subgrade surface is then compared to the original ground surface to get the mass earthwork quantities.

#### **Overview**

The assortment of commands available in the site take-off module can be divided into three categories; data organization and layering, material and site improvement identification, and earthwork take-off.

The first step is to organize the imported data and filter out any unnecessary data. This is done by standardizing layering conventions, mapping layers from their source to the user's standardized layering convention, and to categorize these standardized layers as containing objects that comprise the original ground and finished design surfaces.

After the data is organization, users must build or import a Material and Site Improvement library (MSI). This is where all materials "native and man-made" that will be utilized during the construction phase are defined. These materials are used in the MSI to define site improvements. For an example, let us consider a building pad. The building pad consists of 12" of sand, 6" of gravel and 12" of 3000 PSI concrete. This means that the building pad site improvement consists of the materials sand, gravel and 3000 PSI concrete.

Once all of the site improvements are added to the MSI library for the project, users will be able to assign them to the appropriate areas of the project.

Take-off commands are then used to define topsoil stripping, topsoil replacement, and over-excavation areas. Take-off commands are also available to define the earthen strata that will be encountered on the site and to create boring logs. We create boring logs to represent locations where core sample data exists which describe the existing strata of earthen materials on the job site.

You can also generate a take-off report that quantifies mass earthwork material volumes, topsoil material volumes and area, site improvement volumes and area, and material quantities. This data can be output in a number of different ways determined by the user's needs.

#### **Objectives**

- Import a PDF image
- Digitize linework from a PDF
- Understand layer categorizing
- Understand layer protection
- Utilize the Material and Site Improvement Manager
- Assign site improvements
- Understand and build takeoff surfaces
- Utilize takeoff reporting

#### Site Take-off Commands Defined

**Standardize Layers** – Manually move imported objects from their source layers onto the appropriate standard layers that you use for every project. When using this command and picking an object, all of the data on that object's source layer is selected. Then you can relayer those selected objects onto the desired standard layer.

**Map Layers** – Use the Map Layers command to move imported data from its unfamiliar source layers onto your organization's standard layers. These standard layers can be assigned to takeoff categories, and appropriate site improvements that are defined within the external material and site improvement library. When doing multiple projects with similar layering standards, this command automates layer mapping.

**Categorize Layers** – To prepare for takeoff calculations you have to assign the layers that your objects reside on to different categories. The four categories are Original, Design, Utility and Unused. The "Contains Potential Boundary Lines" also resides within this command.

**Contains Potential Boundary Lines** – Checking this makes the lines on the layer usable as site region boundaries in the Identify Site Regions command.

**MSI Manager** – All materials and site improvements encountered on-site are defined here. Native earthen materials (clay, rock,topsoil,etc.), earthen select materials (flex base, sand, etc.), and man-made materials (concrete, pvc pipe, rebar) are all defined along with their associated material properties. Site improvements consisting of these materials and are defined here as well.

**Identify Site Regions** – This command assigns site improvements that were defined in the MSI Manager to the appropriate areas of the project.

**Validate Areas** – Confirm that the regions identified for site improvements are correct by uniquely shading each region.

Name/Label Site Regions – Name and label the site improvement regions for reporting and plotting purposes.

**Configure Subgrade** – Instead of using the MSI Manager, this is an alternative command that can be used to account for site improvement thicknesses to generate an accurate subgrade surface. This is normally used by earthworks contractors that are only concerned with mass earthworks quantities.

**Define Areas of Interest** – This command allows users to define an area of interest with a closed line. During takeoff reporting, you can then generate quantities solely based on the defined area of interest as opposed to the entire project.

**Define Topsoil** – This command is used to define areas of topsoil stripping, the material that is being stripped, and the thickness of the material to be stripped.

**Use Excess Topsoil** – After defining topsoil stripping areas and topsoil replacement areas, this command is used to define non-structural fill areas on site that excess topsoil can be utilized as fill instead of exporting at a higher cost.

**Overexcavation** – Use the Overexcavation command to create a surface to represent the result of excavation within areas that need to be cut below an intended finished or subgrade surface (overexcavated). This is typically done to accommodate layered replacement and compaction of the excavated material in controlled lifts as needed to achieve a specified material density to a designated depth.

**Define Strata** – Define the earthen material strata that exist on your job site to make the depths and thicknesses for each stratum definable when you create boring logs.

**Create Boring Log** – Create boring logs to represent locations where you have core sample data describing the existing strata of earthen materials on the job site. Before you create boring logs, define the strata that was encountered on-site. Once you specify the top elevation, or depth and thickness of each stratum for each boring log location; the depth surfaces are then created which enables you to calculate subgrade material volumes in the Takeoff Report.

**Build Surfaces** – Build or update the surfaces that are automatically created by certain takeoff commands or when you have made changes to layers, site improvements, boring logs, topsoil areas, or objects that affect those surfaces.

Takeoff Report – Use this command to generate a concise takeoff report.

#### **Files Needed**

For the training exercises, each user should save the following files provided by your Certified Trainer onto their PC and note the location.

- Office Park.pdf
- Office Park.mxl

#### **Import a PDF Image**

A PDF image is one of many file types that Business Center - HCE accepts. In order to perform a takeoff we need to build multiple surfaces that the program can then compute volumes for or between them. A few examples of these surfaces are the original ground, finished design, and subgrade surface. As opposed to starting from scratch building all the linework and the subsequent surfaces, we will import a PDF image into Business Center - HCE and utilize this data as our starting point.

You can import data in the following ways:

- Drag and drop the files into the graphical view of Business Center HCE.
- Use the Import command in the project ribbon.

There are two types of PDF documents, which are the vector PDF and raster PDF. A raster PDF document is simply an image composed of colored pixels and does not have intelligent data. Once it is imported and placed users must use the *Digitize* commands to create the digital linework necessary to complete a site takeoff. A vector pdf is an image that is composed of lines, dashed lines, and text that is intelligent. This means that the vector pdf image can be imported, placed, and scaled the same as a raster PDF. Then you can run the Import Vector PDF Data command and all the linework in the pdf image is converted into digital linework.

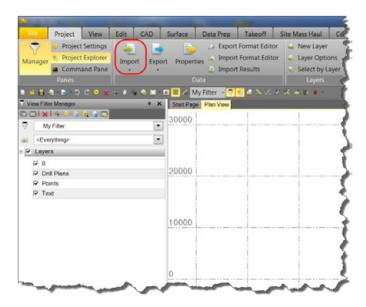
For this exercise, we will utilize the importer to demonstrate all the settings available during the import process.

Note: Importing a pdf image is one way to get started performing a takeoff and is used as the example in this exercise because often times CAD drawings are not accessible to contractors during the estimating phase.

*Realize that CAD files, landxml, and other file types can also be used as a starting point. Reference the Help utility in Business Center - HCE to see all the supported file types.* 

- 1. Open Business Center HCE and start a new project.
- 2. Select the template for US Survey Foot.
- 3. Select the Import icon in the Data area under the Project Tab.

Note: You can also select the Import 🔤 icon from the Quick Access Toolbar .



4. Left-click on the Office Park.pdf file to highlight it and select Import

Note: You may have to use the button to select the folder where the Office Park.pdf file is saved on your PC.

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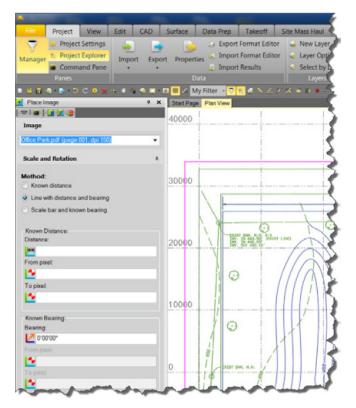
- 5. Left-click on Line with distance and bearing under Method to select it.
- 6. Enter 650 in the Distance cell under Known Distance.

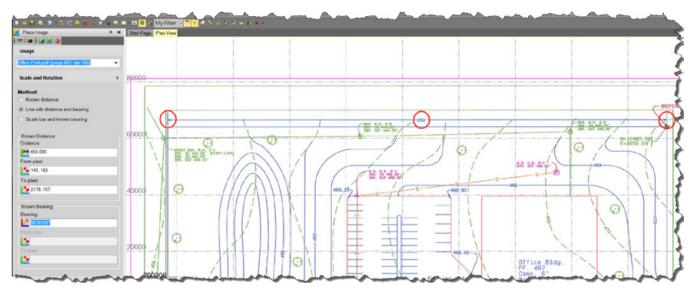
Note: The Place Image command must be performed in order to scale and rotate the .pdf properly. There are three methods for scaling and rotating the data.

*Known distance* – you enter the distance of a line and then select the beginning and ending pixels.

*Line with distance and bearing* – *The known distance method is utilized and the bearing of the line is used to rotate the data.* 

*Scale bar and known bearing* - Utilize this to specify the known distance as well as a bearing between two pixels.





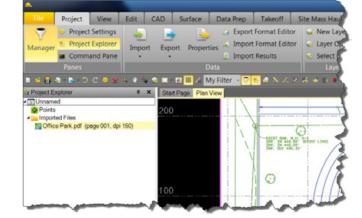
- 7. With the cursor positioned in the *From pixel* cell, select the start point for the line dimensioning the site north of the building pad.
- 8. With the cursor positioned in the *To pixel* cell, select the other end of the same line.
- 9. Enter 90 in the Bearing cell under Known Bearing.
- 10. Select <u>Compute</u> and the linework from the imported PDF will now be scaled and rotated correctly.
- 11. Select Close to close the Place Image work panel and do the same for the Import work panel.

- 12. Select Project Explorer under Panes in the Project tab.
- 13. Expand the Imported Files to view the Office Park.pdf.

Note: You can tell if this PDF is a Raster PDF or Vector PDF by looking at the icon.

📕 = Raster PDF Image

🔯 = Vector PDF Image



*In the case of the Office Park.pdf file, it is a Raster PDF.* 

## Digitize the Image

Since the Office Park.pdf is a raster PDF image we will need to digitize the linework in, that will eventually be used to build all of the necessary takeoff surfaces and represent material quantities such as storm sewer pipe. It is important to think about what surface each line will be used to build when digitizing, so that they can be properly layered. By organizing the data while digitizing, you will keep it organized and make life easier later on. For this exercise, we will have an Original Ground, FD Contours, FD Building Pad, FD Parking Lot, and Utilities layer.

**Tip:** When creating the layers that the digitized data will be placed on, always enable layer protection. This designation prevents the layer from being renamed or deleted.

1. Select the Digitize Contour icon in the Digitize area under the Takeoff Tab.

Note: Original Ground linework is shown with the green dashed lines in the plan view and Finished Design Ground linework is shown with the blue solid lines. When Digitizing Contour lines it is good practice to start on one side of the project and work your way across.

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- 2. Enter Contour in the Name cell.
- 3. Select the drop-down arrow in the *Layer* cell and create a new layer with the following settings.

Layer name: Original Ground Color: Blue Line style: Solid Line weight: 0.50mm Protect Layer: 🗹

- 4. Select OK in the New Layer window.
- 5. Enter 2 in the Contour Interval cell.

Note: This is determined by looking at the elevation change between two contours on the plan set.

- 6. Left-click on Up under Increment direction to select it.
- 7. Left-click on Set Increment after each contour to add a checkmark to its box.
- 8. Enter 456 in the current elevation cell.

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- 9. With the cursor in the Digitize Next Points cell, zoom into the 456 contour in the plan view. Left-click where it begins.
- 10. Continue to trace the line and left-click where the contour changes directions.

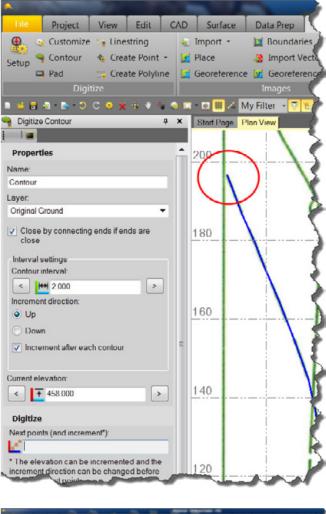
Note: You will begin to see the blue line be created over the dashed green line from the image. The screen will also Auto Pan when you click on the line close to the edge of the screen. You can also trace the line by just holding down on the left-click and following the line.

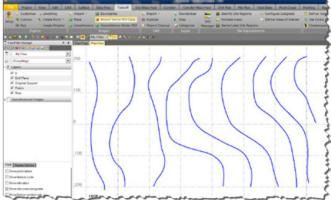
- 11. Continue to trace the line until you get to the end of the 456 contour line.
- 12. Select New in the Digitize Contour pane.

Note: The current elevation is now 458' and the layer is still Original Ground.

- 13. Repeat steps 8 through 11 until all of the Original Ground green-dashed contour lines have been digitized into the project.
- 14. Go to the View Filter Manager and turn off the Georeferenced Image by unchecking the box.

*Note: The plan view on your screen should look similar to this.* 





- 15. In the View Filter Manager turn the Georeferenced Image back on by checking the box and turn off the Original Ground layer by unchecking the box.
- 16. Select the Digitize Contour tab at the bottom of

the Work Pane or select **Contour** in the Digitize area under the Takeoff tab.

- 17. Enter FD Contour in the Name cell.
- 18. Select the drop-down arrow in the *Layer* cell and create a new layer with the following settings.

Layer name: FD Contour Color: Red Line style: Solid Line weight: 0.50mm Protect Layer: 🗹

19. Select

in the New Layer window.

20. Enter 2 in the Contour Interval cell.

OK

Note: This is determined by looking at the elevation change between two contours on the plan set.

- 21. Left-click on Down under Increment direction to select it.
- 22. Ensure that Increment after each controur has a checkmark in its box.
- 23. Enter 470 in the Current elevation cell.

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24. With the cursor in the Digitize Next Points cell, zoom into the 470 contour in the plan view. Leftclick where it begins.

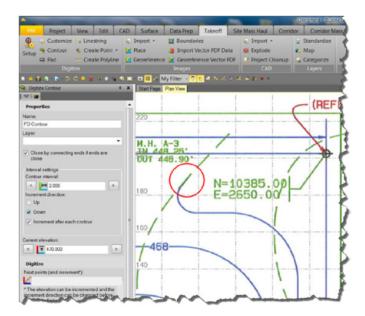
*Note: The 470 Contour is on the East side of the page.* 

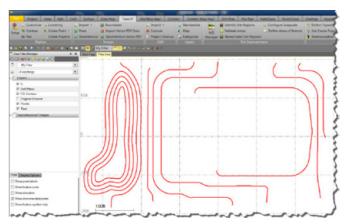
25. Repeat the same Digitizing process that we performed on the Original Ground lines with all of the Finish Design Ground lines.

Note: The Finish Design Ground lines are solid blue. As you trace the line you will see a solid red line show up on top of the blue line on the image.

- 26. After all FD Contours have been created, select
- 27. Go to the View Filter Manager and turn off the Georeferenced Image by unchecking the box.

*Note: The plan view on your screen should look similar to this.* 





- 28. In the View Filter Manager turn the Georeferenced Image back on by checking the box and turn off the FD Contour layer by unchecking the box.
- 29. Select the Digitize Pad icon in the Digitize area under the Takeoff tab.
- 30. Enter Building Pad in the Name cell.
- 31. Select the drop-down arrow in the *Layer* cell and create a new layer with the following settings.

Layer name: FD Building Pad Color: Orange Line style: Solid Line weight: 0.50mm Protect Layer: 🔽

32. Select

in the New Layer window.

Close

33. Leave the Vertical Offset at 0.

OK

34. Enter 467 in the Elevation cell.

*Note: The elevation of 467' is from the title in the building on the plans.* 

35. Digitizing the building pad using the same process as used with the contours.

Note: Business Center - HCE knows that a pad is a closed polygon so after selecting the four corners of the pad it auto-closes the line for you.

36. Once the pad is Digitized select

Surface Data Prep Project . 🦕 Customize 👍 Linestring Boundaries Import \* Import 3 Import Vector PDF Data Section Create Point -Place K Explode Setup Pad Create Polyline 🛛 🕍 Georeference 💓 Georeference Vector PDF Project Cleanup 🍬 🥥 📰 🖪 📶 🖌 My Filter 1. de .... Properties FD Building Pad 100 Layer. FD Building Pad . Vertical offset tion: ¥ 467.000 Office Bldg. FF. 467  $\mathbf{C}$ 61 ng the Filtertype -100 inth: 13.55.4

37. Select <sup>The Linestring</sup> in the Digitize area under the Takeoff tab.

Note: This command is used when bringing in any line that does not have a constant elevation.

- 38. Enter Parking Lot in the Name cell.
- 39. Select the drop-down arrow in the *Layer* cell and create a new layer with the following settings.

Layer name: FD Parking Lot Color: Green Line style: Solid Line weight: 0.50mm Protect Layer: 🗹

OK

40. Select

in the New Layer window

- 41. With the cursor in the Digitize Next Points cell, Left-click where right side driveway begins.
- 42. Left Click on the driveway line next to the 460.97 spot elevation and then enter 460.97' in the Digitize Elevation Cell.

Note: After entering the elevation you can put the curser back in the Next Point by hitting Tab or left clicking in the cell.

43. Digitize the parking lot and driveway with the same process as the Contours and Building Pad.

Note: Make sure to click on each spot elevation that is encountered. Enter the elevation of the spot elevation right after clicking on it.

44. After Digitizing the Parking lot is completed,

select Close

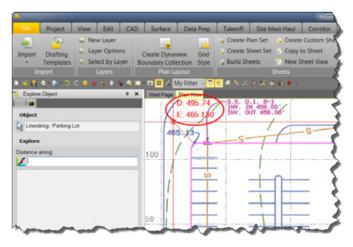
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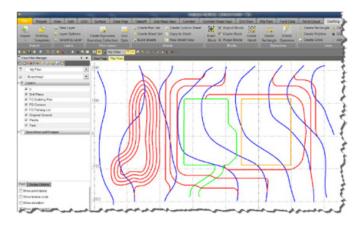
- 45. Select the Explore Object icon from the Quick Access Tool Bar.
- 46. Left-click the Parking Lot line to select it and double-check the elevations are correct by moving the cursor along the newly created linestring.

Note: You will want to confirm all the spot elevations around the Parking Lot to make sure they were entered correctly.

- 47. Select Close once all elevation checks on the Parking Lot are done.
- 48. In the View Filter Manager turn the Georeferenced Image off by unchecking the box and turn on all layers by checking the box next to the Group Layers.

Note: You may have to select the box in front of the Layers Group twice because the first selection may turn off all layers.





- 49. In the View Filter Manager turn the Georeferenced Image back on by checking the box and turn off all layers by unchecking the box next to the Group Layers.
- 50. Select the Digitize Linestring icon in the Digitize area under the Takeoff tab.
- 51. Enter Storm Sewer in the Name cell.
- 52. Select the drop-down arrow in the *Layer* cell and create a new layer with the following settings.

Layer name: Utility – Storm Sewer
Color: Cyan
Line style: Solid
Line weight: 0.50mm
Protect Layer: 🔽

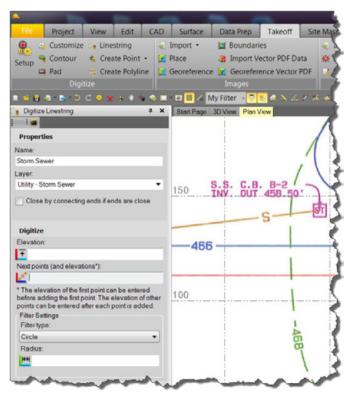
- 53. Select OK in the New Layer Window.
- 54. With the cursor in the Digitize Next Points cell, left-click the start point of the storm sewer in the NE Corner.
- 55. Enter 458.50' in the Elevation cell.

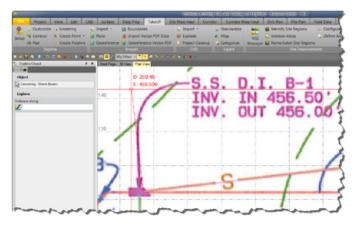
*Note: The 458.50' elevation comes from the out elevation of the Storm Sewer in the NE Corner.* 

56. Left-click the end point of the storm sewer to the West and enter 456.50' for the elevation.

*Note: The 465.50' elevation comes from the IN elevation on the Storm Sewer to the West.* 

- 57. Select New and repeat this process for all of the storm sewer lines.
- 58. After Digitizing the Storm Sewer is completed, select Close
- 59. Select the Explore Objects icon from the Quick Access Tool Bar.
- 60. Select each of the Storm Sewer lines and doublecheck the In and Out elevations are correct by moving the cursor along the linestring.
- 61. Select Close once all elevation checks on the Parking Lot are done.





#### **Categorize Takeoff Layers**

The next step in preparing for takeoff calculations is to assign the layers that your objects reside on to different categories. The layers should be assigned to one of the following categories:

- **Original** All layers that contain Original Ground data should be assigned to this category. These layers will ultimately make up the Original Ground takeoff surface.
- **Design** All layers that contain Finish Design data should be assigned to this category. These layers will make up the Finish Design takeoff surface.
- **Utilities** Assign layers that will be used to calculate utility site improvement quantities but do not contribute to the formation of a takeoff surface to this layer.
- **Other** Assign layers that contain data you do not want to use in forming takeoff surfaces but also do not want to delete to this layer.
- **Unknown** This is the default category that all layers are assigned to and layers with this category are not used to form any takeoff surfaces.
- Unused All layers that are unneeded and that you ultimately intend to delete

For example, all the data on layers that are assigned to the Finish Design category will be utilized to build the Finish Design takeoff surface. Remember that in Business Center - HCE we work with data from an array of sources. Often CAD files will have multiple layers that comprise the Original Ground surface and Finish Design surface. In our case, since we digitized the data in we were able to control what layers the data was assigned to.

1. Select the Categorize Takeoff Layers Select the Categorize icon under Layers on the Takeoff Tab.

Note: That by default all of the layers are listed under the category Unknown.

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- 2. Left-click the box for the Original Ground layer to add a checkmark.
- 3. Select *Original* in the Reassign layer drop-down list and then select Reassign.

Note: The Original Ground layer is no longer under the Unknown category and has been reassigned to the Original category.

- 4. Left-click the boxes for layers FD Building Pad, FD Contour and FD Parking Lot to add checkmarks.
- 5. Select *Design* in the Reassign layer drop-down list and then select Reassign.
- 6. Left-click the box for Utility Storm Sewer to add a checkmark.
- 7. Select *Utilities* in the Reassign layer drop-down list and then select Reassign.
- 8. Left-click the boxes for the remaining layers to add checkmarks.
- 9. Select *Other* in the Reassign layer drop-down list and then select Reassign.

Note: All the layers have now been categorized correctly, and the Original Ground and Finished Design takeoff surfaces were automatically created. Open the Project Explorer and observe the surfaces that were created.

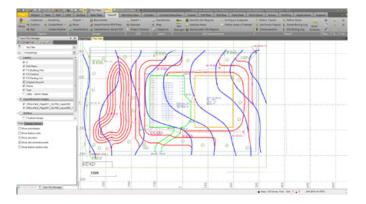
10. Select Close on the Categorize Takeoff Layers.

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11. Select the Build Takeoff Surfaces Surfaces icon in the Takeoff area under the Takeoff Tab.

Note: The Surfaces are now created but still are still not visible in the plan view.



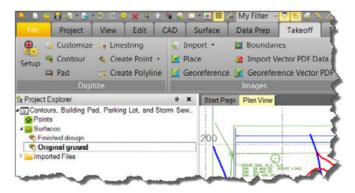
- 12. Open the Project Explorer and Expand the Surfaces.
- 13. Right-click on Finished design and select Properties.

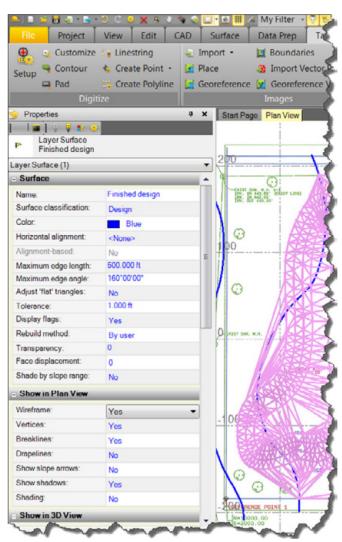
- 14. In the Properties Pane under Show in Plan View change the Wireframe, Vertices, and Breaklines to Yes.
- 15. In the Properties Pane under Show in 3D View change the Wireframe, Vertices, and Breaklines to Yes.

Note: As soon as you change these to Yes , you will see the Surface appear in the Plan View.

- 16. Select Close on the Properties Pane.
- 17. Open the Project Explorer and Expand the Surfaces.
- 18. Right-click on Original ground and select Properties.
- 19. Repeat Steps 14 through 16 for the Original Ground layer.

Note: The Surface Layers can be very distracting being visible but you can turn them off under View Filter Manager by unchecking them.





#### **Material and Site Improvement Manager**

When preparing for takeoff calculations it is necessary to define the materials and site improvements that will be used in determining the earthwork volumes and the quantities of objects to construct. These are defined in Business Center - HCE as:

- Material a naturally occurring or manufactured substance from which a site improvement can be made at a construction site. Examples include soil, rock, sand, flex-base, limestone, cement concrete, asphaltic concrete, PVC pipe, and ductile iron.
- Site Improvement an object that is built out of materials on a construction site. Examples include curbs, sidewalks, parking lots, and building pads.

Now that the Original Ground and Finish Design surfaces have been created we need to assign Site Improvements and Materials to different regions of the site so that we can accurately account for all material quantities in the takeoff report.

Business Center - HCE utilizes an MSI Manager to define all the materials that will be encountered on a construction project both native and manufactured. You will use the materials to also setup site improvements.

Based on our plans the following materials and site improvements are on-site:

#### Materials

- Ashpalt
- Concrete
- Flex-Base
- 12" Storm Sewer Pipe
- Topsoil
- Subsoil
- Rock

#### **Site Improvements**

- Parking Lot and Drive
- Building Pad
- Storm Sewer
- Topsoil Replacement
- 1. Select the Material and Site Improvement

manager MSI Manager icon under Site Improvements on the Takeoff tab.

Note: This will open the Material and Site Improvement Manager in a new window.

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- 2. Select File and then Open External Library.
- 3. Open the Office Park.mxl file.

Note: You may have to navigate to the location on your PC where you saved the file. Once Open, the External Library will have items loaded to it.

- 4. Expand the External Library, then Materials, and then Asphaltic Concrete.
- 5. Left-click on Type III to Highlight it.
- 6. Enter 85 in the Procurement unit cost cell.

Note: This material uses volume as its measurement and the units are Cubic Yard.

- 7. Select Gray in the Color drop-down list.
- 8. Expand the *Pipe* category and left-click the *12" PVC – C900* material to highlight it.

Note: The measurement for pipe is a length. The units are US Survey Foot but can also be modified depending on the scope of the project. Explore the shading options and edit the procurement cost to mirror your region.

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- 9. Expand the Earthen (Mass Earthworks) materials and left-click the *Fine Sandy Clay* material to highlight it.
- 10. Left-click Soil Properties and change the Percent Usable for Fill value to 100%.

Note: This setting allows users to input what percentage of a native material is suitable to be used as fill. You can also edit the shrinkage, hauling bulkage, and hauling compaction values to mirror a sub-soil native to their region.

8
Close

- 11. Right-click the Earthen (Mass Earthworks) category and select New Earthen (Mass Earthworks) Material.
- 12. Enter Topsoil for the Name of the material.
- 13. Select Topsoil in the Material Nature drop-down list.
- 14. Select Topsoil Properties and change this to Usable for Topsoil Replacement.

Note: You can specify whether or not the existing topsoil is suitable to be respread as topsoil after mass earthworks are completed.

- 15. Select Green in the Color drop-down list.
- 16. Under External Library expand the Site Improvements category and then Building Foundations.
- 17. Left-click on Commercial Slab to highlight it.
- 18. Enter 13 in the Installation price cell.

Note: The Bid Unit Price automatically updated.

- 19. Left-click on the cell next to Subgrade in the material column under Site improvement material layers.
- 20. Select Earthen (Select):Flex Base from the dropdown list.
- 21. Left-click on the cell for the Subgrade Thickness under Site improvement material layers and enter 6.

Note: We changed the type and thickness of the Subgrade to match the plans which require 6" of Concrete and 6" of Base.

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22. Expand Pavement and left-click on the Light Duty Parking Areas to highlight it.

*Note: Review your plans to make sure the site improvements meets the specification on the plan.* 

23. Left-click on the Asphaltic Concrete: Type III Thickness (Inch) cell under Site Improvement material layers and enter 2.

Note: If you have more Site Improvements on you plan you will want to check each one to make sure it meets the specifications on the plan.

24. Right-click on Light Duty Parking Areas underneath the Pavement Site Improvements in the External Library, and select Copy from External Library.

Note: When you copy a Site Improvement from an External Library, you will also copy all Materials used in that Site Improvement.

25. Repeat Step 36 for each of the Materials or Site Improvements that are utilized on this project.

*Note:* Only materials and site improvements in the Project Library are available to use in the current project.

26. Select Close on the Material and Site Improvement Manager window.

# Assigning Site Improvements to Regions of the Project

All of the necessary materials and site improvements have been added to the project and we have changed the display and cost parameters to meet our needs. It is now time to assign Site Improvements to different regions of the project so that Business Center - HCE can accurately perform takeoff calculations.

There are two methods for assigning Site Improvements.

- Categorize Layers when categorizing layers, site improvements can be assigned to apply to individual layers.
- Identify Site Regions

We will utilze both methods in this exercise.

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- 1. Select the Categorize Takeoff Layers Categorize icon in the Layers area on the Takeoff tab.
- 2. Left-click the Design Tab in the Categorize Takeoff Layers pane.
- 3. Left-click the box for the FD Parking Lot layer to add a checkmark.
- 4. Select Associate with a Site Improvement
- 5. Select Pavement: Light Duty Parking Areas and select

Note: You will not be able to see the new surface with the subgrades adjusted until you Build Surfaces and then turn on the views on under the Surface Properties by going to Project Explorer. We did this process earlier in the Categories Takeoff Layers section.

- 6. Left-click on the Utilities Tab in the Categorize Takeoff pane.
- 7. Left-click on the box for the Utility Storm Sewer to add a checkmark.
- 8. Select

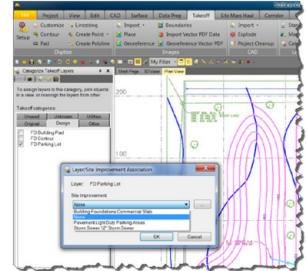
Associate with a Site Improvement

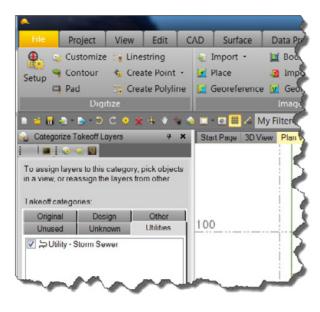
9. Select Storm Sewer: 12" Storm Sewer and select

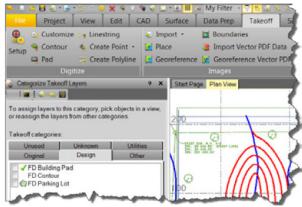
Note: An icon appears between the layer name and the check box once site improvements are applied. The icons indicate the type of site improvement that was applied. In this instance, it is a linear based site improvement.

- 10. Left-click on the Design Tab in the Categorize Takeoff Layers pane.
- 11. Left-click the box for the FD Building Pad layer to add a checkmark.
- 12. Left-click the box for Contains Potential Boundary Lines.

Note: There is a green check mark beside the layer indicating that we can now manually assign site improvements to any boundaries on that layer.







- 13. Select III Identify Site Regions in the Site Improvements area on the Takeoff tab.
- 14. Left-click on Design under Select Takeoff Category to select it.

Note: There are 2 potential boundary line objects.

15. Left-click on the Highlight all potential boundaries box to add a checkmark.

Note: This is selected so that it is easy to determine what boundaries are available to use in the plan view.

- 16. Select <<New Layer>> from the Layer drop-down list.
- 17. Enter Site Improvements in the Name cell and select

Note: This will be the layer that we place the site improvement's seed point on. It is useful to keep all the seed points on one layer.

18. Ensure that Identify Region is selected under the Site region identification.

*Note: If we wanted to remove a site improvement then we would select Remove Identity here.* 

- 19. Select the Building Foundations: Commercial Slab in the Site improvement drop-down list.
- 20. Enter Building Pad in the Name cell under Site improvements.
- 21. With the cursor in the Location cell, left-click within the building pad boundary in the plan view.

Note: If properly applied, the color of the building pad will shade in with the color of the uppermost material of the site improvement. In this example, it is the color that was specified in the MSI for the 3000 PSI Concrete material.

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22. Notice that the Parking Lot site improvement is not shaded.

Note: You can tell that the site improvement was not applied because the parking lot is not shaded.

- 23. Select Close on the Identify Site Regions pane.
- 24. Select Close on the Categorize Takeoff Layers pane.
- 25. Left-click on the boundary of the parking lot to select it.

Note: The parking lot boundary is not a closed line. This means that it is not a valid boundary for an area-based site improvement.

- 26. Right-click in the graphical view and select Edit.
- 27. Left-click on the Auto-close box to add a checkmark and select Close.

Note: The lines ends will connect and in this example it is at the entrance to the drive on the south portion of the project.

- 28. Select Identify Site Regions in the Site Improvements area on the Takeoff tab.
- 29. Left-click on Design under Select Takeoff Category to select it.

Note: The parking lot site improvement has now been applied and is indicated as such with the associated material shading being applied to the plan view.

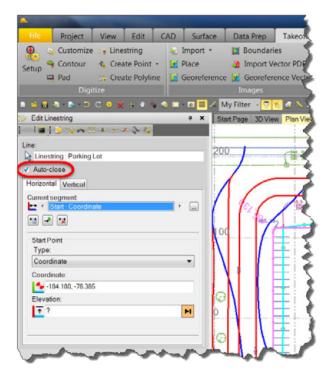
30. Select Close

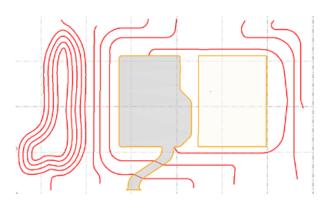
on the Identify Site Regions pane.

# **Topsoil Handling**

The parking lot, building pad, and storm sewer site improvements have all been successfully added. One last site improvement that we must add is the respread of 6" of topsoil in all areas of the site outside the parking lot and the building pad. This is accomplished by using the Identify Site Regions command as well. But first, let us verify that the 6" of topsoil respread site improvement is correctly configured in the MSI Manager. In this exercise the following workflows will be covered:

- Identifying topsoil respread area
- Defining topsoil stripping areas
- Using Excess Topsoil in non-structural fill areas.





1. Select the Material and Site Improvement Manager Manager icon under Site Improvements on

the Takeoff tab.
 Expand the Project Library, then Site

- Improvements, and then Landscaping/Topsoil.
- 3. Left-click on 6" Topsoil Replacement and Sod.
- 4. In the Site improvement material layers section ensure the material is Landscaping: Sod.
- 5. Left-click in the Landscaping: Sod Thickness cell and enter 1.
- 6. Ensure the Topsoil Replacement Requirements is set to Earthen (Mass Earthworks):On-Site Topsoil and that the thickness is 6".
- 7. Select Edge Properties.

*Note:* Business Center - HCE offers two options to handle the edge of topsoil replacement where it meets structural fill.

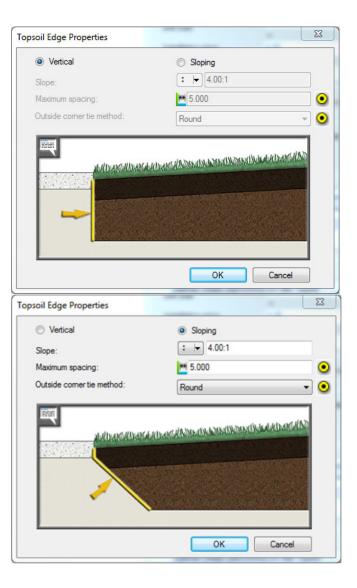
*Vertical* – produces a vertical edge where a structural fill area meets a nonstructural fill area.

*Sloping* – Produces a sloping edge where structural fill meets non-structural fill areas.

Note: This allows you to account for these situations during the takeoff and modeling phase when plans specify these scenarios.

- 8. Left-click on Vertical to select it.
- 9. Select OK on the Topsoil Edge Properties window.
- 10. Select Close on the Material and Site Improvement Manager window.

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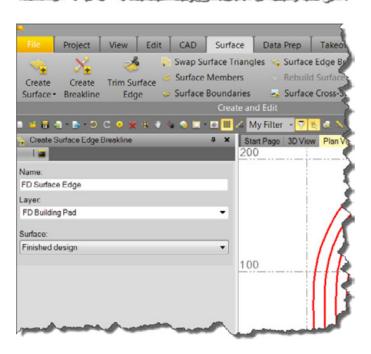
#### 11. Turn on all FD Layers in the View Filter Manager.

Note: There is no boundary around the site. The topsoil respreads site improvement is an areabased site improvement and needs a valid boundary to be applied.

- 12. Select Surface Edge Breakline in the Create and Edit area on the Surface tab.
- 13. Enter FD Surface Edge in the Name cell in the Create Surface Edge Breakline pane.
- 14. Select the FD Building Pad in the Layer dropdown list.

Note: The edge that is being created here is eventually going to be a Potential Site Improvement boundary. It is important to add it to a layer that contains potential boundaries. In this case the FD Contours layer would be problematic because all the contours would be considered boundaries in addition to the surface edge breakline.

- 15. Select the Finish Design in the Surface dropdown list.
- 16. Select OK in the Create Surface Edge Breakline pane.



- 17. Select Identify Site Regions in the Site Improvements area on the Takeoff tab.
- 18. Left-click on Design under Select Takeoff Category to select it.
- 19. Select Site Improvement in the Layer drop-down list.
- 20. Ensure Site region identification set to Identify region.
- 21. Select Landscaping/Topsoil: 6" Topsoil Replacement & Sod in the Site improvement drop-down list under Site Improvements.
- 22. Enter Landscaping/Topsoil: 6" Topsoil Replacement & Sod in the Name cell under Site Improvements.
- 23. With the cursor in the Location cell, left-click inside the detention pond.

Note: The topsoil respread areas have now been identified and indicated with the color green in the plan view as shown here.

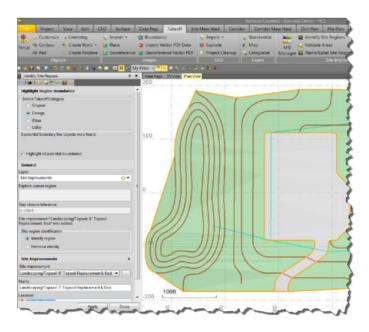
- 24. Select Close on the Identify Site Regions pane.
- 25. Open the Project Explorer and expand the Surfaces.

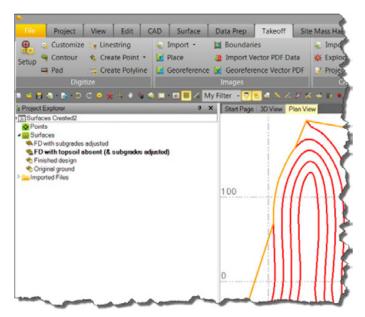
Note: You will not be able to see the new surface with the subgrades adjusted until you Build Surfaces and then turn on the views.



26. Select the Build Takeoff Surfaces Surfaces icon in the Takeoff area on the Takeoff tab.

Note: You will now see the FD with topsoil absent (& subgrades adjusted) surface under Surfaces. It is still not visible in Plan or 3D views until you turn them on in the surface properties. We did this process earlier in the Categories Takeoff Layers section.





27. Select Select Offset Line in the Lines area on the Data Prep tab.

Note: On this example we are stripping the topsoil 10' outside of the design edge. This means that we need to Offset the Boundary.

- 28. Enter TS Stripping Boundary in the Name cell in the Offset Line pane.
- 29. Select Original Ground in the Layer drop-down list.
- 30. With the Curser in the Line to Offset cell, leftclick on the FD Surface Edge line.
- 31. Enter 10 in the Offset distance cell.
- 32. Left-click on the Side to offset and then left-click outside the FD Surface Edge Boundary.

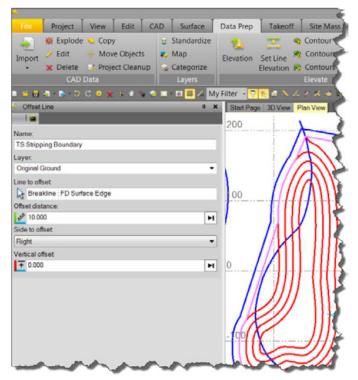


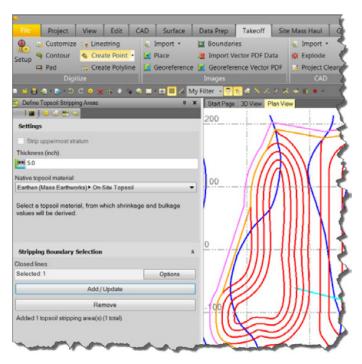
Note: To view the newly created offset line you will need to make sure the Original Ground Layer it turned on in the View Filter Manager.

- 34. Select Close in the Offset Line pane.
- 35. Select the Define Topsoil Stripping Areas
   Define Topsoil icon in the Takeoff area on the Takeoff tab.
- 36. Enter 5 in the Thickness cell.
- 37. Select Earthen (Mass Earthworks) > On-Site Topsoil in the Native topsoil material drop-down list.
- 38. With the curser in the Closed lines box, left-click on the TS Stripping Boundary in the Plan View to select it.
- 39. Select
- Add / Update

Note: You will now see a message saying that 1 topsoil stripping area was added. On complex construction sites multiple areas can be added.

40. Select Close on the Define Topsoil Stripping Areas pane.





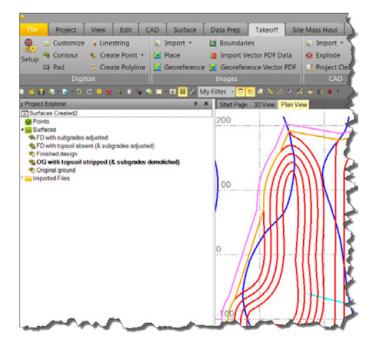
# 41. Open the Project Explorer and expand the Surfaces.

Note: You will not be able to see the new surface with the subgrades adjusted until you Build Surfaces and then turn on the views.



42. Select Surfaces in the Takeoff area on the Takeoff tab.

Note: You will now see the OG with topsoil stripped (& subgrades adjusted) Surface under Surfaces. It is still not visible in Plan or 3D views until you turn them on in the surface properties. We did this process earlier in the Categories Takeoff Layers section.



# **Using Excess Topsoil**

Often times on construction projects there is more topsoil stripped than is specified to be respread. Instead of hauling the excess off site and incurring that expense, it is more efficient to use the excess topsoil in landscaping areas that do not require structural fill.

 Select Select Use Excess Topsoil in the Takeoff area on the Takeoff tab.

Note: The areas that are eligible as locations to use the excess topsoil are shaded. In this example there is only one eligible area.



- 2. With the cursor in the Site Improvement to Reconfigure cell, left-click anywhere in the green shaded area.
- 3. Select Minimum Depth to Level Plane in the Configuration method drop-down list.

Note: The following selections are available in the Configuration method drop-down list:

**Constant thickness** – select this to configure one or more instances of a site improvement to use a constant thickness of excess topsoil earth fill. When you view the finished design related surfaces in the Surface Slicer View, you will see that the total topsoil thickness is the topsoil replacement thickness plus this thickness. You will not see a surface separating the topsoil replacement material layer from the excess topsoil earth fill.

*Minimum depth to level plane* – select this to attempt to make a level plane (flat bottom) in the surface formed by the structural fill, at an elevation based on the lowest point found around the perimeter of the subject landscaping site improvement. This approach may allow you to reuse more excess topsoil, and it will simplify the grading in preparation for the placement of the topsoil.

*Maximum bottom elevation* – select this to specify the elevation at which the program will attempt to form a level planar bottom for the excess topsoil earth fill. As in the above method, this approach may allow you to reuse more excess topsoil, and it will simplify the grading in preparation for the placement of the topsoil.

4. Enter 6 in the Depth (Inch) cell.

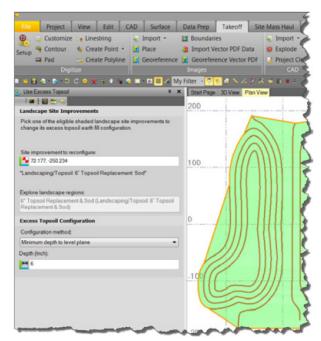
5. Select Apply

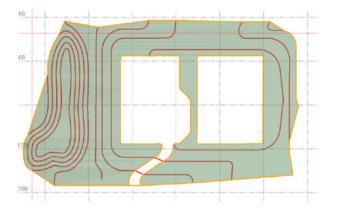
Note: The color of the landscaping area in the plan view has changed to a darker green. This indicates that this area has been designated to use excess topsoil.

- 6. With the cursor in the Site Improvement to Reconfigure cell, left-click anywhere in the darker green shaded area.
- 7. Select None for the Configuration method.
- 8. Select Apply

*Note:* For this example we are not going to use excess topsoil.

9. Select Close on the Use Excess Topsoil.





#### **Overexcavation**

Often times engineers specify that building pads or other areas of a project must be overexcavated and layered replacement of structural fill be replaced. Business Center - HCE has incorporated the Overexcavation command to account for these situations.

Assume that a building pad overexcavation of 5' below finish floor elevation has been specified.

- 1. Select Overexcavation in the Takeoff area on the Takeofftab.
- 2. Enter 5 in the Specified overexcavation cell.

Note: This is the distance below the lowest finish design surface that you need to overexcavate, unless overridden by the Minimum beneath original ground, maximum depth beneath original ground, or Limit to top of stratum.

3. Enter 2 in the Minimum beneath original ground cell.

*Note: This specifies the minimum distance beneath the original ground that needs to be overexcavated.* 

- 4. With the curser in the Closed lines box, left-click on the building pad to select it.
- 5. Select

Add / Update

*Note: You will now see a message saying that 1 overexcavation area was added. On complex construction sites multiple areas can be added.* 

6. Enter 15 in the Maximum depth beneath orginal ground cell.

*Note: This value specifies the deepest distance beneath the original ground surface that can be overexcavated.* 

7. Select Close in the Overexcavation pane.

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# **Defining Areas of Interest**

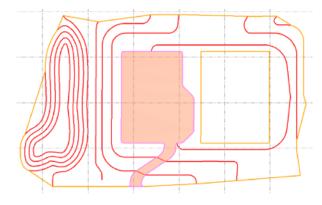
At times during the takeoff and site analysis phase of bidding a project, contractors are only interested in particular portions of the site. Business Center - HCE allows you to define areas of interest to focus in on particular portions of the project.

Let's create an area of interest focusing in on the parking lot and one on the building pad. As if we were an asphalt contractor or concrete contractor, and need to get material quantities.

- 1. Select Gefine Areas of Interest in the Site Improvement area on the Takeoff tab.
- 2. Select Create
- 3. Enter Parking Lot in the Name cell and select
- 4. With the curser in the Closed lines to add or remove cell, left-click the parking lot boundary in the plan view to select it.
- 5. Select Add

Note: You will now see a message saying that 1 line was added to "Parking Lot" and the Parking Lot has changed to a peach color indicating that it is now defined as a area of interest.

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- 6. Select Create
- 7. Enter Building Pad in the Name cell and select

#### 8. Select Individual Site Improvement

- 9. Left-click on Design under Select Takeoff Category to select it.
- 10. Select <<New layer>> in the Layer drop-down list.
- 11. Enter AOI in the Name cell and select
- 12. Left-click on Exterior under Horizontal offset to select it and enter 3 in the Horizontal offset cell.
- 13. With the cursor in the Pick a shaded site improvement cell, left-click in the building pad in the plan view.
- 14. Select Apply

If you have the AOI layer checked in the View Filter Manager, you will now see the boundary created 3' outside the building pad site improvement. This new boundary can now be used to define an area of interest.

- 15. Select Close on the Create Boundary by Site Improvement.
- 16. With the Building Pad Highlighted under Areas of Interest and the Curser in the Closed lines to add or remove cell, left-click on the outer boundary you just created for the building pad to select it.
- 17. Select Add

Note: An Area of Interest has just been created that is defined by a boundary 3' outside the building pad site improvement, and is shaded a peach color.

18. Select

Close

on the Define Areas of Interest.

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# **Validating Areas**

The validating areas command allows users to confirm that the regions identified for site improvements are correct by uniquely shading each region. This is useful in offering a visual aid to users indicating where site improvements have been applied and essentially double-checking our work.

- Select the Validate Site Improvement Areas
   Validate Areas icon in the Site Improvements area on the Takeoff tab.
- 2) Left-click on Design under Takeoff Category to select it.
- 3) Select Site Improvement in the Layer drop-down list.
- 4) Enter 70 in the Fill transparency (%) cell.
- 5) Select Apply

Note: Notice that the areas where site improvements have been applied are now shaded based on the upper most material layer of that site improvement.

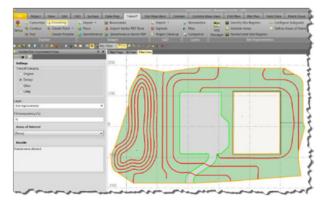
Note: If you do not see the shaded site improvements, make sure you have the Site Improvements layer turned on in the View Filter Manager.

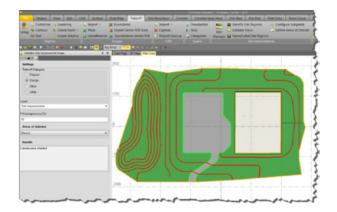
Note: This step is not necessary to perform a takeoff calculation but it is recommended as a way to doublecheck and ensure that all areas have been accounted for on the project.

- 6) Enter 30 in the Fill transparency cell.
- 7) Select Apply
- 8) Select Building Pad in the Areas of Interest.
- 9) Select Apply

Note: The program now only validates the site improvement that is selected in the Area of Interest drop-down list.

- 10) Select [None] in the Areas of Interest.
- 11) Select Apply
- 12) Select Close on the Validate Site Improvement Areas.





# Name/Label Site Regions

Use this command to name and optionally label site regions so you can report on their areas and cut/fill volumes individually in the Takeoff Report. The types of regions you can report on include: area-based site improvements, landscaping/topsoil site improvements, and simple subgrade adjustments.

- 1) Select Name/Label Site Regions in the Site Improvements area on the takeoff tab.
- 2) Ensure the box for Label Site Improvement is checked.
- 3) Select <<New layer>> in the Layer drop-down list.
- Enter Name\_Label Site Regions in the Name cell and select OK
- 5) Select Agency 0.10 in the Text style drop-down list.
- 6) Left-click on Generic area-based site improvements under Applicable Region Identities to select it.
- 7) With the cursor in the site improvement region cell, left-click in the parking lot area in the plan view.
- 8) Enter Parking Lot in the Name cell.
- 9) With the curser in the Text insertion point cell, leftclick in the plan-view where the text should be placed.
- 10) Label the Building Pad by repeating steps 2 through 9.

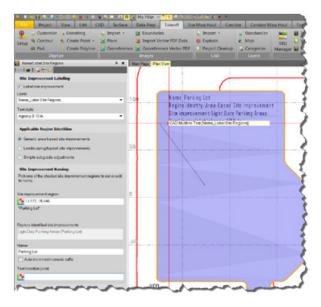
Note: Once the Building Pad is labeled we will move onto labeling the Landscaping/topsoil Site Improvements.

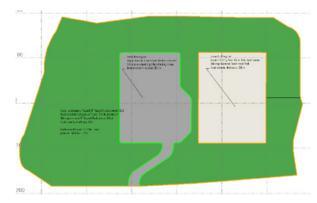
- 11) Left-click on Landscaping/topsoil site improvements under Applicable Region Identity to select it.
- 12) With the curser in the Site improvement region, leftclick inside the Topsoil Replacement Site Improvement in the plan view.
- 13) Enter Topsoil Respread in the Name cell.
- 14) With the curser in the Text insertion point cell, leftclick in the plan-view where the text should be placed.

# **Area/Length/Count Report**

You can elect to generate a Area/Length/Count report to quickly calculate:

- Total number of objects in a selection.
- The length of each open line in a selection.
- The perimeter length of each closed line in a selection.
- The area of each closed polyline in the selection, and the total of those areas.





- 1. In the View Filter Manager, turn on layers FD Building Pad, FD Parking Lot, and Utilities – Storm Sewer.
- 2. Select the Area/Length/Count Report icon in the Reports area on the Takeoff tab.
- 3. Select Options next to the Object cell and then Select All.

*Note:* All the objects on the layers turned on are now selected.

- 4. Select Only Specified Categories in the Categories to include drop-down list.
- 5. Check the boxes for areas and lengths and uncheck the box for Counts by left-clicking on the boxes.
- 6. Left-click on the Load Data into Excel under Output Options to select it.

*Note: If preferred, the data can be saved to a .csv file or dispayed in the report viewer.* 

7. Select Apply

Note: The area/length/count report is launched in Excel. The report is a quick and simple way to get area caluclations for building pads and parking lots. You can also get the length calculations for the storm sewer in this report.

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# **Takeoff Reporting**

Now that all the necessary steps have been performed in the takeoff workflow, it is now time to generate a Takeoff report to calculate the following:

- Mass earthwork material volumes
- Topsoil material volumes and areas
- Existing in-ground site improvement volumes and areas
- Site improvement volumes and areas
- Site improvement quantities

The Takeoff Report automatically reports on the differences between the specialized takeoff-generated surfaces, each of which were formed in the previous exercises. The report uses any data, including costs, that may be available prior to start of construction, to help in preparing for the job bidding process.



#### 1. Select <sup>Surfaces</sup> in the Takeoff area on the Takeoff tab.

*Note: This step is to ensure that all changes and configurations are applied, and the surfaces are current.* 

- 2. Select the Takeoff Report icon in the Reports area on the Takeoff tab.
- 3. Select all four Report Sections by left-clicking on there boxes to add checkmarks.
- 4. Ensure that the Building Pad and Parking Lot are uncheck under the Consider areas of interest.

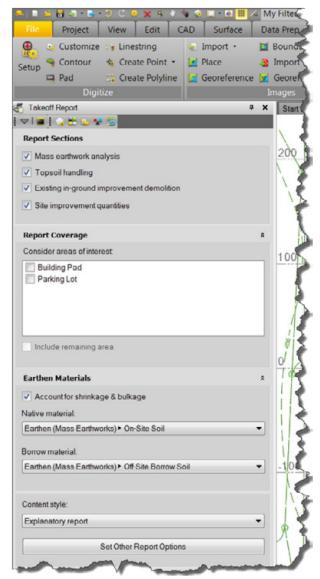
Note: The areas of interest created earlier in the exercise are now available to be selected. If an area of interest was selected then the reporting would be confined to that area(s) only. If the Include Remaining Area box is checked, the rest of the site can be reported on in addition to the selected Areas of Interest.

5. Ensure the Account for shrinkage & bulkage is checked.

Note: If stratum is defined then the Native material is greyed out since all material layers are already defined and handled in the report as they are encountered during excavation.

Note: To account for shrinkage and bulkage, accurate values need to be entered for each material in the MSI Manager.

- 6. Select Earthen (Mass Earthworks) > On-Site Soil in the Native Material drop-down list.
- 7. Select Earthen (Mass Earthworks) > Off-Site Borrow Soil in the Borrow material drop-down list.
- 8. Select Explanatory Report in the Content style dropdown list and select OK.



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Note: The takeoff report appears within Business Center - HCE. You should use the Explanatory Report format to assist in becoming familiar with the terminology used in the report. For each value computed in the report there is a number that coincides with a definition of how that value was derived. Explore the different pages of the report and familiarize yourself with the definitions of the different values given in the report as well.

Note: You can also go back into the MSI Manager and change the shrinkage and bulkage values for the On-Site Soil and see how that changes the Mass Earthworks Analysis values.

CHAPTER
5

# **Site Mass Haul**

#### Welcome

Welcome to the Trimble<sup>®</sup> Business Center – Heavy Construction Edition (HCE) site mass haul student guide. The site mass haul module in Business Center - HCE incorporates tools and commands that enables you to determine the most efficient distribution of earthen materials from cut zones to fill zones on a site. The most efficient use of borrow pits, waste sites, and haul roads to balance an earthworks site.

This guide was developed by Trimble Navigation's Global Services Training and Support staff to support classroom instruction delivered by a Trimble Certified Trainer. The Trimble Certified Trainer will use this guide to lead you through the Site Mass Haul module using real world exercises. Please use this guide in conjunction with the Business Center - HCE help files and other product resources available.

#### **Overview**

The assortment of commands available in the site mass haul module can be divided into four categories.

- Cut/Fill Map
- Analysis
- Earthworks
- Reporting

A cut/fill map needs to be generated showing the cut and fill between an original ground surface and a finish design surface.

An initial site mass haul analysis is computed utilizing the cut/fill map that was generated, to determine an initial distribution of in situ earthen material from cut zones to fill zones. This mass haul analyses help estimate the earthwork costs of transforming your existing surface into the design surface.

Earthworks commands are utilized to create borrow sites, waste sites, and haul roads to account for the inbalance of materials on-site, whether the site requires an import or an export. Procurement, dumping, and transportation costs are then associated with the newly created sites and roads. The mass haul analysis is then refreshed, updating the analysis to more accurately indicate the most efficient method of cutting, filling, importing, and exporting material to build the project to design. It takes into account the costs associated with each site and haul road and generating the most cost-effective method.

You can then generate a a site mass haul report. This report consicely reports the earthen material properties (shrink, swell), and generates a map showing cut and fill zones along with proposed haul roads. It will also show cut zone statistics, fill zone requirements, and haul route statistics. All of this is valuable information that can be utilized when bidding a project.

# **Learning Objectives**

- Create a cut/fill map that reflects the difference between original ground and design surfaces
- Create a site mass haul analysis to see proposed routes between cut and fill zones
- Add earthworks sites and incorporate them into the mass haul analysis
- Add haul roads between the earthwork sites and zones to make the haul routes more realistic
- Understand shrink/swell values and how that impacts the mass haul analysis
- Generate and interpret a site mass haul report

### **Site Mass Haul Definitions**

**Mass Haul Analysis** – an analysis of where and how earthen materials on a job site are cut from certain haul zones and moved to other fill zones.

**Cut/Fill Map** – a map that indicates areas on a surface to cut and fill to achieve a design.

**Waste Sites** – are areas off design where unusable and/or excess material is dumped to reduce the cost of the mass haul or to remove it from the job site if a project is an export.

**Borrow Pits** – are areas off design that provides for additional fill material when there is a deficit of earthen material on-site.

**Haul Roads** – linestrings that define haul roads in Business Center - HCE for use in a mass haul analysis. They are defined between haul zones on a job site or between an earthworks site and the job site for transportation of import or export.

**Native Material** - the earthen material that is most representative of the original gorund surface that exists onsite.

**Borrow Material** – the earthen material to be obtained from earthwork sites or off-site borrow sites should there be a deficit in material on-site.

**Haul Zones** – The more zones that are input the better analysis you will receive. The mass haul analysis balances the zone first and then determines the best place to take excess to or best place to receive an import from to achieve balance in that zone.

Haul Distance – the distance the material is hauled along the haul route to the zone.

**Dispersion Distance** – the average distance to disperse the material from the end of the haul route around the zone.

**Unit Cost Per Volume** – the cost to collect, move, and disperse one unit of volume of material the entire distance from the cut location to the fill location.

Site Cost – the total cost to buy the total amount of material being borrowed from off-site.

**Transportation Cost** – the cost to transport material from the start of the haul route in one zone, to the end of the haul route in another zone.

Dispersion Cost – the cost to disperse material from the end of the haul route around the zone.

**Collection Distance** – the average distance to collect material from around the zone and transport it to the start of the haul route.

**Collection Cost** – the cost to collect material and move it to the start of the haul route.

**Transportation Distance** – the distance material is moved from the start of the haul route to the end of the haul route.

# Files Needed

For the training exercises, each user should save the following files provided by your Certified Trainer onto their PC and note the location.

- Site Mass Haul Training Data.vce
- Solar Farm Training Data.jpg

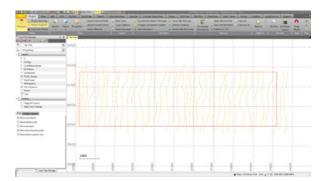
# **Getting Set-up to Perform a Site Mass Haul Analysis**

The Business Center - HCE project file *Site Mass Haul Training Data.vce* and *Solar Farm Training Data.jpg* accompanies this student training guide. The .vce data consists of an original ground surface and a finish design surface, of a solar farm pad. It is assumed that you are familiar with creating surfaces before starting this module.

The Solar Farm Training Data.jpg is a Google Earth<sup>™</sup> mapping service image that is saved as a JPEG directly form Google Earth. This image encompasses the construction project and all of the borrow and waste sites that will be used in the mass haul analysis. Importing Google Earth images as a background image in Business Center - HCE is extremely useful when performing mass haul analysis. It makes creating haul roads and earthworks sites much easier since the borrow pits, waste sites, and haul roads are visible on the image.

After completing this exercise you will be able to import a Google Earth image and georeference it to use when performing a site mass haul analysis.

- 1. Open the Site Mass Haul Training Data.vce file.
- 2. Ensure all layers are turned on in the View Filter Manager.

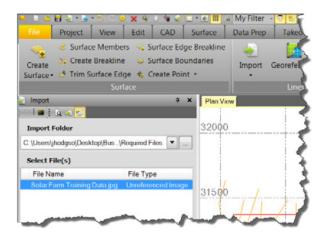




- 3. Select in the Lines and Images area under the Site Mass Haul tab.
- 4. Left-click on the Solar Farm Training Data.jpg to highlight it.

Note: You may have to use the button to select the folder where the Solar Farm Training Data.jpg file is saved on your PC.

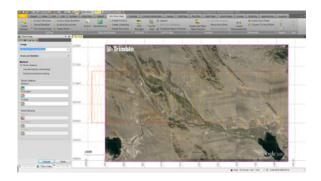
5. Select Import



# 6. Select the Georeference Image icon at the top of the Place Image Pane.

Note: There is not a scale bar or a known distance available on the image to allow the use of the place the image command. There are pixels in the Google Earth image that can be correlated to the corners of the solar farm design. This allows us to use the georeference image command to accurately scale and place the image.

- 7. Select Solar Farm Training Data.jpg in the Image dropdown list.
- 8. Select Add twice in the Georeference Image pane.



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- 9. With the curser in the Pixel cell for point A, left-click the gravel road intersection indicated with the red arrow labeled Point 1.
- 10. With the curser in the Location cell for point A, left-click on the actual point 1 in the plan view.

Note: You will need to turn on the Points layer in the View Filter Manager to see Point 1. It is in the NW corner of the solar farm pad.

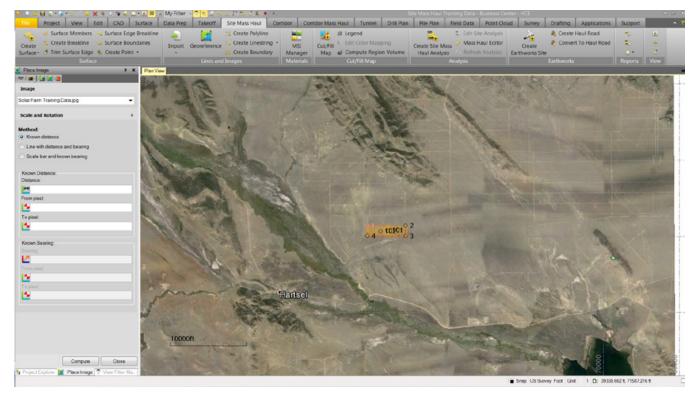
Note: You can use the Snap command to select Point 1.

#### 11. Repeat sets 9 and 10 for Point B in the Georeference Image pane.

*Note: Point B will associate the pixel indicated with the red arrow labeled point 2 with the actual point 2 in the plan view.* 

Select Compute in the Georeference Image pane.
 Select Close in the Georeference Image pane.
 Select Close in the Place Image pane.
 Select Close in the Import pane.

Note: That completes the project set-up that is required to perform a site mass haul analysis. Incorporating the image into this exercise will become very useful in later exercises. You will create linestrings representing the haul roads by simply tracing the gravel roads in the image. The roads will have accurate lengths due to the image being properly scaled.



# **Creating Cut/Fill Maps**

A cut/fill map indicates areas on a surface to cut and fill to achieve a design. Creating a cut/fill map is the first step in performing a site mass haul analysis. The program needs to know this information before it can analyze and determine the most efficient method of moving material around the site.



1. Select the Create Cut/Fill Map Map icon in the Cut/Fill Map area under the Site Mass Haul tab.



- 2. Enter CFMap in the Name cell on the Create Cut/Fill Map pane.
- 3. Select Original Ground in the Initial drop-down list under Surface.
- 4. Select Solar Farm Design in the Final drop-down list under Surface.

*Initial surface* = the starting state of the project site, typically is an original ground surface.

**Final surface** = the finish design the user is concerned with generating a cut/fill map for.

5. Ensure that both Shade map and Label grid are checked under Map Features.

**Shade map** = display the cut and fill areas in graduated colors based on the current color mapping.

**Label grid** = display values showing cut and fill values at specific locations on the difference model that's created (Isopach).

- 6. Select CFMap in the Layer drop-down list.
- 7. Select Agency 0.10 in in the Text style drop-down list.
- 8. Enter 100 in the Grid spacing cell.

*Note: This directs the program to show a cut or fill value at 100' intervals.* 

- 9. Select Ticks in the Grid style drop-down list.
- 10. Select 0.1 in the Decimal precision drop-down list.

Note: Depending on the application you can choose a more precise setting here, but since this is a rough grading cut and fill map we went with 0.1.

11. Ensure that the box for Label Surface Elevations is not checked.

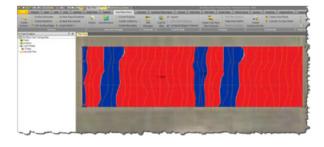
Note: If the Label Surface Elevation box is check, surface elevations will also be shown at each tick location.

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#### 12. Select OK

in the Create Cut/Fill Map pane.

Note: There is a new category created in the Project Explorer labeled Cut/Fill Maps.



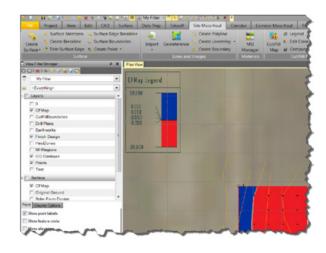
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- 13. Expand the Cut/Fill Maps in the Project Explorer pane.
- 14. Right-click on the CFMap in the Project Explorer and Select Add Legend.
- 15. Enter CFMap Legend in the Title cell.
- 16. Select CFMap in the Layer drop-down list.
- 17. Select CFMap in the Surface or cut/fill map drop-down list.
- 18. With the curser in the Location point cell, left-click on a location for the legend outside of the NW corner of the surface in the plan view.
- 19. Select Agency 0.70in in the Title drop-down list and select Agency 0.50in in the Depth drop-down list under Text styles.

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- 21. Left-click on the legend in the graphical view to select it.
- 22. Right-click in the graphical view and select Properties.
- 23. Left-click on the Display areas cell under Property and select Yes.

Note: The legend will change looks as soon as you select yes. In the new legend the blue areas indicate fill and red areas indicate cut.

Note: The legend indicates that there is a total area of 5,240,720sf that requires between 30' - 0.2' of cut.

Note: The legend also indicates there is a total area of 1,519,738sf that requires between 0.2' and 30' of fill.

24. Select Close in the Properties pane.

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#### **Computing Region Volumes**

Use the Compute Region Volume commands to quickly calculate the cut and fill volumes, areas, centers of mass, and the difference between the volumes of a specific region within your job site.

This command gives you a quick snapshot of earthwork requirements as you work through performing a site mass haul manually. Results help determine how to balance volumes on a site. It provides a quick way to start an area to balance, and then increase or decrease what is included until the cut volume balances the fill.

A haul cost can be determined by measuring the distance from the center of mass of one area to the center of mass of another. The Site Mass Haul Analysis is automated and provides this information as well. Using the compute region volumes command allows you more control by viewing site volumes one region at a time.

- 1. Select Compute Region Volume in the Cut/Fill Map area under the Site Mass Haul tab.
- 2. Select CFMap in the Cut/Fill map dropdown list.
- 3. Select CutFillBoundaries in the Layer dropdown list.
- 4. Leave the Optional existing boundary cell empty.

Note: If using an existing line to represent the region of interest, it would be selected in the optional existing boundary cell. For this exercise new boundaries will be created and that is why we are leaving this cell empty.

5. Left-click on Expand under Boundary edit to select it.

**Expand** = select this to initially create the volume boundary or to enlarge an existing boundary.

*Trim* = select this to reduce the size of an existing volume boundary.

- 6. Enter Region 1 in the Volume boundary name cell.
- 7. Select Circle in the Filter type drop-down list.
- 8. Enter 200 in the Radius cell.
- 9. With the cursor in the Next Points cell, left-click and hold outside the NW corner of the cut/fill map.
- 10. With the left mouse button still pressed, track the perimeter of the region of interest.

*Note: In the picture to the right, you can see the region of interest is about ¼ of the full Cut/Fill map. The boundary line will auto-close to create a polygon and will automatically be tinted.* 

*Note:* The results will automatically be displayed in the Results area of the Compute Regions Volume pane. With all values selected for the report type you will get the following information:

*Cut Volume* = total volume of cut in the region of interest.

Cut Area = total area of cut in the region of interest.

**Center of Mass** = the x,y,z coordinate of the center of mass of the cut.

*Fill Volume* = total volume of fill in the region of interest.

*Fill Area* = total area of fill in the region of interest.

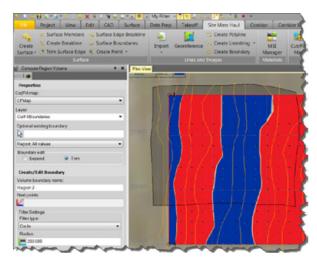
**Center of Mass** = the x,y,z coordinate of the center of mass of the fill.

**Difference** = the volume difference between the cut and fill.

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- 11. Left-click on Trim under Boudary edit to select it.
- 12. With the curser in the Next Points cell, left-click and hold outside Region 1 and drag across the region.
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- 13. Release the left mouse button once outside the region.

Note: Region 1 is now trimmed based on the line that was just tracked across the region and the results in the Results area are updated.



- 14. Left-click on Expand under Boundary edit to select it.
- 15. Enter Region 3 in the Volume boundary name cell.
- 16. Enter 100 in the Radius cell.

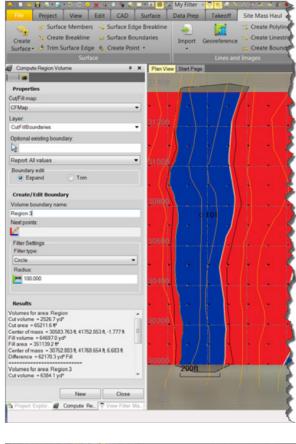
*Note: This will make it easier to draw your box around a smaller area with sharp turns.* 

17. With the cursor in the Next Points cell, left-click and hold outside the NW corner of the 3<sup>rd</sup> Fill zone from the west.

*Note: This fill zone is almost in the center of the Cut/Fill map.* 

*Note:* Your fill volume should equal 64,697cy.

- 18. Highlight all of the text above the double dased line for Region 3 in the Results area in the Compute Region Volumn pane.
- 19. Hit CTRL+C on the keyboard to copy the text.
- 20. Select the Create Text icon in the Text area under the Drafting tab.



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- 21. Select MHRegions in the Layer drop-down list.
- 22. Select Agency 0.30 in the Text style drop-down list.
- 23. Select Middle Center in the Justification drop-down list.
- 24. Enter 40.00 in the Height cell and 90 in theRotation cell.

*Note: These values determine the orientation of the text and the height of the text.* 

25. Enter 2 in the Width factor cell.

*Note: This will allow the newly created text stand out more.* 

26. Ensure the Oblique angle is set to 0.

Note: This determines the slant of the text.

- 27. Select Spline with no arrow in the Leader type dropdown-list.
- 28. Select the icon next to the Text box cell and then hit CTRL+V on the keyboard to paste the results copied earlier.
- 29. Select OK in the Text Editor window.
- 30. With the curser in the Leader point cell, left-click in the upper part of Region 3 in the graphical view.

Note: This is the desired location of the leader arrow.

31. With the curser in the Text insertion point cell, leftclick above Region 3 in the graphical view.

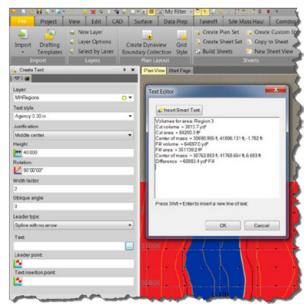
Note: You want to choose a location that places the text outside the surface but clearly legible.

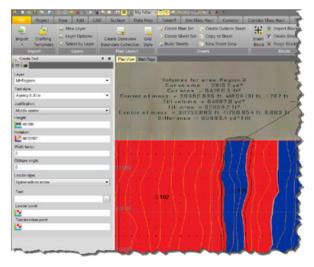
32. Select Close

in the Create Text pane.

Note: You can continue to create different regions and label them for use in the mass haul analysis until comfortable with the process. Also, try trimming and extending the created regions until each region balances between cut and fill.

33. Select Close in the Compute Region Volume pane.





# **Create a Site Mass Haul Analysis**

The Site Mass Haul Analysis command assists in determining the most efficient distribution of on-site material from cut zones to fill zones. The analysis will also assist in estimating earthwork costs to achieve a finish design from an existing ground surface.

You will start by creating a less accurate mass haul analysis with auto-created haul routes. This gives the estimator a general idea of the amount of cut and fill required to balance the site, as well as the amount of import or export required to complete the project.

After the initial analysis is completed, we will then add a network of haul roads and earthwork sites with associated costs. We will then refresh the analysis to determine the optimal road from each cut zone to an associated fill zone, as well as the most economical waste sites and borrow pits to utilize for the project.

The key element in understanding the site mass haul analysis function is the concept of haul zones. You will have to define haul zones, they are not auto-created by performing an analysis. The more haul zones utilized the more precise the analysis will be. When an analysis is performed each haul zone is balanced first. If an excess or deficit exists then the program determines the most economical means to transport excess or import material to satisfy the deficit based on other haul zones balances, borrow and waste pit locations and costs, and transportation costs.

After creating an initial mass haul analysis and then comparing it to subsequent and more detailed mass haul analysis the power of the mass haul analysis will be apparent. We will start by creating an initial site mass haul analysis allowing the software to define the haul routes.



- 1. Select Haul Analysis in the Analysis area under the Site Mass Haul tab.
- 2. Enter MHAnalysis in the Name cell under Mass Haul Analysis in the Create Site Mass Haul Analysis pane.
- 3. Select CFMap in the Cut/Fill map drop-down list.

*Note: This is the cut/fill map that will be used as the basis for the analysis.* 

# 4. Select <sup>Create Polyline</sup> in the Lines and Images area under the Site Mass Haul tab.

Note: We need to define the Haul Zones. They must be a closed polyline in order to be used as a haul zone.

Note: For the initial mass haul analysis, we will create four equal areas to analyze. It is important that haul zones do not overlap, and if they do then the portion of the site inside the overlapping haul zones will be accounted for twice in the mass haul analysis.



- 5. Select the Measure icon from the Quick Access Toolbar.
- 6. With the Curser in the From cell, right-click in the graphical view and select Point Snap.
- 7. Left-click on Point 1 in the Plan view.
- 8. With the Curser in the To cell, right-click in the graphical view and select Point Snap.
- 9. Left-click on Point 2 in the Plan view.

Close

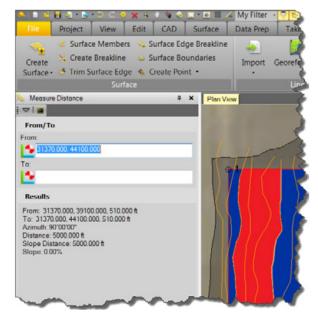
10. Select Measure in the Measure Distance pane.

Note: Your distance between points is 5000'. If we want to divide this up in to 4 separate zones, we need to divide 5000 by 4. This means that the zones will be 1250' wide.

*Note: The Northing Cordinate for Point 1 and 2 is 31370, and will be used in the next steps.* 

11. Select

in the Measure Distance pane.



- 12. Enter Haul Zone 1 in the Name cell.
- 13. Select MHRegions in the Layer drop-down list.
- 14. Enter 0 in the Elevation cell.
- 15. Select Always in the Automatically close by connecting ends drop-down list.
- 16. Left-click on Specify individual points under Method to Add Points to select it
- 17. With the curser in the Next point cell, right-click in the graphical view and select Point Snap.
- 18. Left-click on Point 1 in the Plan view.
- 19. With the curser in the Next point cell, right-click in the graphical view and select Point Snap.
- 20. Left-click on Point 4 in the Plan view.
- 21. Change the Easting Cordinate in the Next point cell to 40350.

*Note: We the Easting coordinate in Point 4 was 39100 and we added 1250 to it because we needed our next point to be 1250 to the right.* 

- 22. Select Add Point in the Create Polyline window.
- 23. Change the Northing Cordinate in the Next point cell to 31370.

*Note: This is the Northing Cordinate from point 1 and 2 that we noted earlier.* 

24. Select Add Point in the Create Polyline window.

25. Select Close

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in the Create Polyline window.

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- 26. Select the Copy Objects Copy icon in the CAD Data area under the Data Prep tab.
- 27. Left-click on the Polyline that you just created to select it.
- 28. Select Apply in the Copy Objects pane.
- 29. With the curser in the From cell, right-click in the graphical view and select Point Snap.
- 30. Left-click on Point 1 in the Plan view.
- 31. With the curser in the To cell, right-click in the graphical view and select End Snap.
- 32. Left-click on the Right Upper corner of the Polyline that you created.

Note: If you get a list of items to choose from, make sure to choose the polyline that you created.

33. Select Apply in the Move Objects pane.

*Note: You should now see two polylines created and we are back at the Copy Objects pane.* 

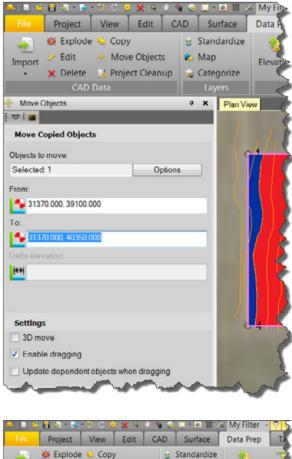
- 34. With the curser in the Objects to copy cell, hold down Ctrl on the Keyboard and left-click on the polylines to select both of them.
- 35. Select Apply in the Copy Objects pane.
- 36. With the curser in the From cell, right-click in the graphical view and select Point Snap.
- 37. Left-click on Point 1 in the Plan view.
- 38. With the curser in the To cell, right-click in the graphical view and select End Snap.
- 39. Left-click on the Right Upper corner of the Polyline that you just moved.

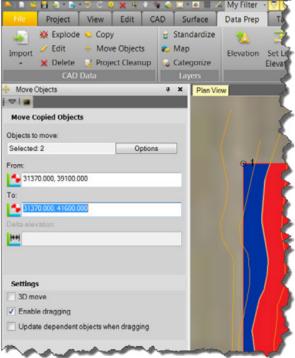
Note: If you get a list of items to choose from, make sure to choose the polyline that you just moved.

40. Select Apply in the Move Objects pane.

Note: You should now see all four polylines and we are back at the Copy Objects pane.

41. Select Close in the Copy Objects pane.

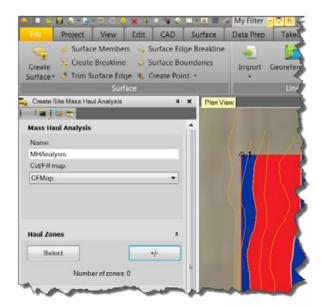




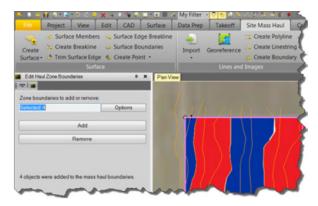
42. Select +/-

under Haul Zones in the Create

Site Mass Haul Analsis pane.



- 43. With the curser in the Zone boundaries to add or remove cell, hold-down the Ctrl key on the keyboard and left-click on the four polylines to select them.
- 44. Select Add in the Edit Haul Zone Boundaries pane.
- 45. Select Close in the Edit Haul Zone Boundaries pane.



#### 46. Select Yes in the Auto-create path drop-down list.

Note: When set to yes Business Center - HCE creates haul roads as necessary from the center of mass of cut zones to the center of mass of fill zones, from cut zones to waste sites, and from borrow sites to fill zones.

Note: Once accurate haul roads are created this will be set to No to force Business Center - HCE to analyze the site using the actual haul roads between earthworks sites and between haul zones on-site.

#### 47. Enter 1 in the Haul cost cell.

Note: This represents the cost to haul 1 cy of loose material one mile on the haul road created.

#### 48. Enter 0.45 in the Dispersion cost cell.

Note: This resents the cost to spread 1 cy of material one mile. Dispersion distance is the distance from the end of the haul route to where the material ultimately rests in the fill zone.

#### 49. Enter 0.65 in the Collection cost cell.

Note: This represents the cost to collect one cy of material from the cut zone and transport it one mile to the beginning of the haul road.

50. Ensure that the box for Account for shrinkage and bulkage is unchecked.

### 51. Enter 0.50 in the Borrow cost cell.

*Note: This is the price to purchase and transport 1 of fill material from an off-site source the entire distance.* 

#### 52. Enter 0.35 in the Waste cost cell.

Note: This is the price to transport and dispose of 1 cy of excess cut material the entire distance to an off-site dump location.

# 53. Select OK in the Create Site Mass Haul Analysis pane.

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## **Interpreting the Initial Mass Haul Analysis Results**

After the mass haul analysis has been completed there will be zones and balance lines created in the plan view and a Mass Haul Analysis is present in the project explorer.

In this section we will investigate the different components of the mass haul analysis and discuss how to interpret these results.

- **1.** Expand Earthworks in the Project Explorer pane and then expand Mass Haul Analysis.
- 2. Right-click on MHAnalysis, and select Properties.

Note: The Parameter's of the analysis are the same as the values that were input when initially running the analysis. Since a native and borrow material were not defined the bulkage and shrinkage factors default to 1.

*Off-Site borrow volume* = the total volume of material needed to borrow from off-site.

*Off-site waste volume* = the total volume of material needed to dump off-site.

*Site borrow volume* = the total volume of material borrowed from earthworks sites.

*Site waste volume* = the total volume of material dumped at earthworks sites.

Note: Since there were not any borrow or waste sites defined in this analysis these volumes are 0.

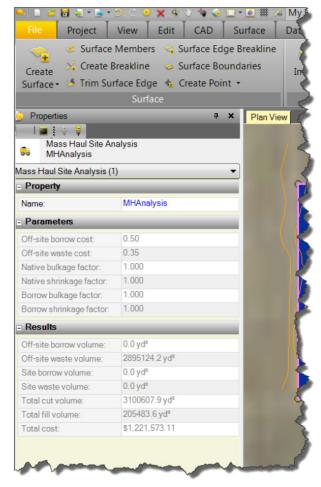
**Total cut volume** = total cut volume of material across all-zones.

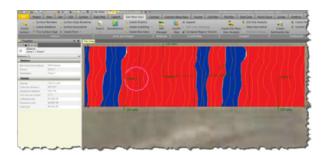
**Total fill volume** = total fill volume of material across all zones.

**Total cost** = the total cost to collect, transport and disperse material in the zones defined – also includes cost to borrow material from off-site or to dump waste material off-site.

# 3. Left-click on the circular balance line called zone 1 to select it.

*Note: The circular balance lines represent material that is cut and filled in the same zone.* 





Note: Since there are not haul roads defined in this project yet the collection and dispersion distances are calculated as the center of mass of the cut to the center of mass of the fill. There is also not a transportation distance given, which is available when a cut is being transported to a different zone to be used as fill.

*Note: The properties of the balance lines are defined below:* 

**Source** = the zone where the cut is coming from.

**Destination** = the zone where the cut is being placed as *fill*.

**Volume** = total volume of material being cut and placed as fill in the current balance line.

**Collection Distance** = Average distance to collect material from around the zone and transport it to the start of the haul route.

**Dispersion Distance** = Average distance to disperse the material from the end of the haul route to around the zone.

**Unit cost per volume** = the cost to collect, move, and disperse one unit volume the entire distance. This is based on the collection and dispersion costs that were input when creating the analysis.

**Collection Cost** = the cost to collect material and move it to the start of the haul route.

**Dispersion Cost** = the cost to disperse material from the end of the haul route to around the zone.

**Total Cost** = the total cost to collect material from the source zone, transport it to the target zone, and disperse it around the target zone.

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Dispersion distance:	568.434			
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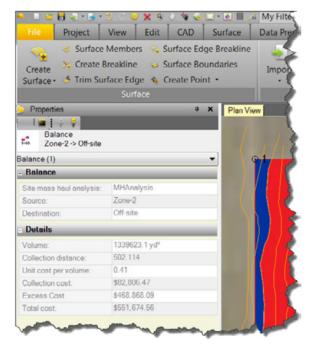
## 4. Left-click on the balance line going from zone 2 to offsite to select it.

Note: Notice there is now an excess cost value given. Since there is more cut than fill in zone 2 and using the excess is not the most economical method of satisfying the deficit in zone 4, the software determines that this material needs to be dumped off-site.

*Excess Cost* = The cost to transport material along the haul route and dump it off-site.

Note: You can continue to explore the different balance lines until it is clear how the material is going to be moved about the job site.

5. Select Close in the Properties pane.



## **Creating Earthworks Sites and Haul Roads**

The next step is to add waste sites, borrow sites, and haul roads. This is so a more accurate analysis can be completed taking into account material excess, deficits, and computing costs based on the distances of each earthworks site from the job site using the network of haul roads created. Since this project has an excess of material borrow sites do not need to be created, only waste sites.



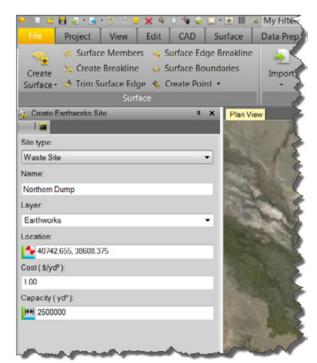
- 1. Select Earthworks Site in the Earthworks area under theSite Mass Haul tab.
- 2. Select Waste Site in the Site type drop-down list.
- 3. Enter Southern Dump in the Name cell.
- 4. Select Earthworks in the Layer drop-down list.
- 5. Enter 16228.352,59774.417 in the Location cell.
- 6. Enter 2.50 in the Cost cell.
- 7. Enter 1,000,000 in the Capacity cell.
- 8. Select Apply in the Create Earthworks Site pane.

Note: A red dump truck icon will now be present in the plan view, but you will have to zoom out to see it.

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- 9. Enter Northern Dump in the Name cell.
- 10. Enter 40742.655,38608.375 in the Location cell.
- 11. Enter 1 in the Cost cell.
- 12. Enter 2,500,000 in the Capacity cell.
- 13. Select Apply in the Create Earthworks Site pane.

*Note: A second red dump truck icon will now be present in the plan view, but you will have to zoom out to see it.* 





- 14. Select Create Haul Road in the Earthworks area under the Site Mass Haul tab.
- 15. Enter Northern Dump Road in the Name cell.
- 16. Select Earthworks in the Layer drop-down list.
- 17. Select OK in the Create Haul Road pane.

#### 18. Enter 0 in the Elevation cell.

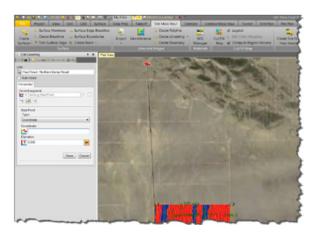
Note: The haul roads do not need an elevation.

- 19. With the curser in the Coordinate cell, left-click on the northern dump truck in the plan view.
- 20. Left-click on Point 1 in the plan view.
- 21. Select Close in the Edit Linestring pane.
- 22. Select Create Haul Road in the Earthworks area under the Site Mass Haul tab.
- 23. Enter Southern Dump Road in the Name cell.
- 24. Select Earthworks in the Layer drop-down list.
- 25. Select OK in the Create Haul Road pane.
- 26. Enter 0 in the Elevation cell.
- 27. With the curser in the Coordinate cell, left-click on the southern dump truck in the plan view.
- 28. Left-click on the road to trace it all the way around to Point 4 in the plan view.

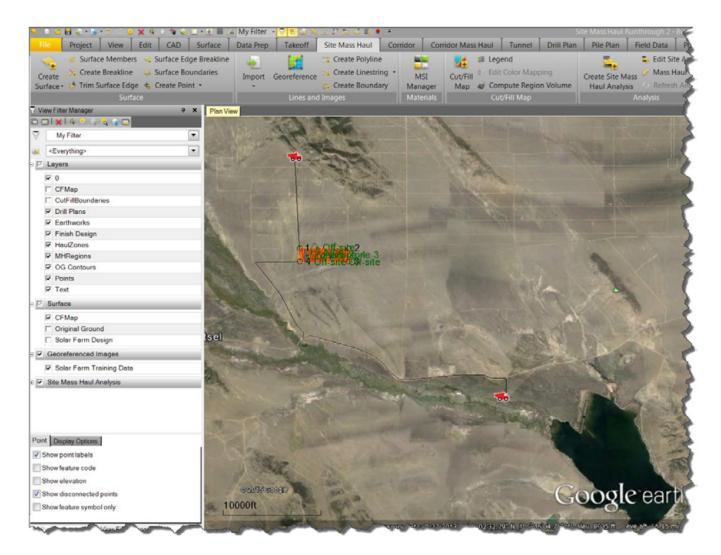
*Note: We are traceing the dirt roads visible in the image from the Northern Dump and Sourthern Dump to the job site.* 

Note: It is important to trace routes that are similar to the ones that will be used during construction so that the analysis is accurate.

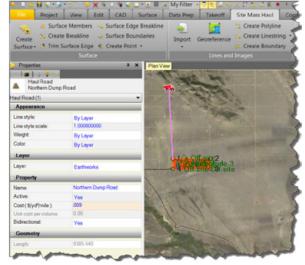
- 29. Select Close in the Edit Linestring pane.
- 30. Select Close in the Create Earthwork Site pane.







- 31. Left-click on one of the Northern Haul Road in the plan view to select it.
- 32. Right-click in the graphical view and select Properties
- 33. Enter .009 in the Cost cell.
- 34. Left-click on the Southern Haul Road to select it.
- 35. Enter .004 in the Cost cell.
- 36. Select Close in the Properties pane.



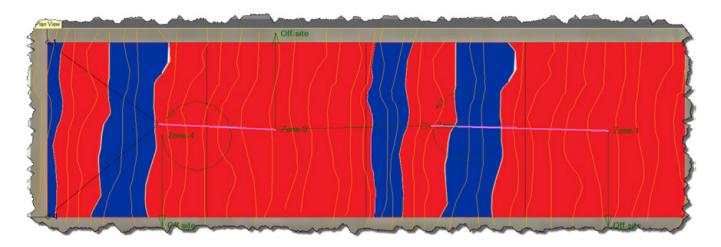
- 37. Select Create Haul Road in the Earthworks area under the Site Mass Haul tab.
- 38. Enter Haul Road in the Name cell.
- 39. Select Earthworks in the Layer drop-down list.
- 40. Select OK in the Create Haul Road pane.
- 41. Enter 0 in the Elevation cell.
- 42. With the curser in the Coordinate cell, left-click on the Point 1 in the plan view.
- 43. Left-click in the Middle Right of the far left zone.

Note: See plan view image below to use as an example.

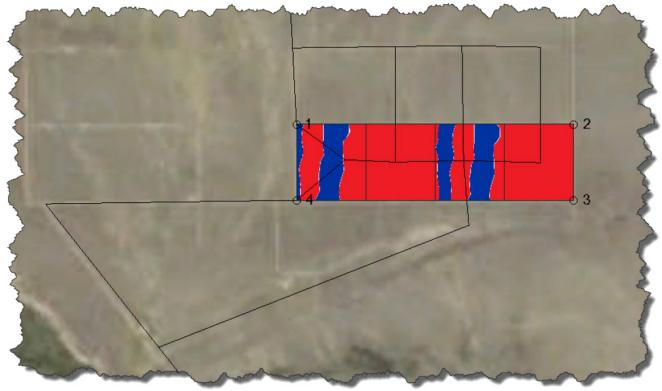
- 44. Select the Create Linestring icon at the top of the Edit Linestring pane.
- 45. Repeat steps 40 through 44 to add individual haul roads as shown in the image.

Note: Good practice is to create the haul roads from the centroid of each zone to the centroid of adjacent zones. It is critical that a separate haul road is created when connecting multiple zones such as below. If a haul road passes through a zone but the start or end point is not located in the zone then the haul road will not be used to transfer material to and from the zone unless there is a connecting haul road that starts or ends in that zone.

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46. Repeat steps 40 through 44 to add individual haul roads as shown in the image below.

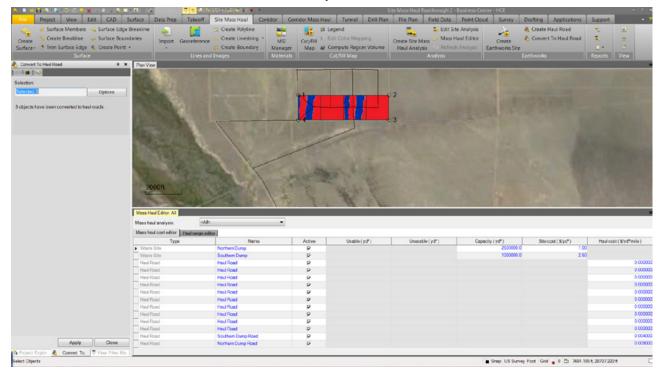


47. Select All Select Mass Haul Editor in the Analysis area under the Site Mass Haul tab.

Note: Not all of the Haul Roads are shown in the Mass Haul Editor.

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- 48. Select 📥 Convert To Haul Road in the Earthworks area under the Site Mass Haul tab.
- 49. With the curser in the Selection cell, hold-down Ctrl on the keyboard and left click on all of the Haul Roads we just completed.
- 50. Select Apply in the Convert To Haul Road pane.
- 51. Select Close in the Convert To Haul Road pane.



- 52. Enter 0.004 in the Haul cost for each of the Haul Roads we just created.
- 53. Ensure all the roads have a checkmark in there Active cell.

Note: In the properties haul roads you can define wether it is bi-directional or a one way road. If changed to one-way then the direction of the line determines the direction of transportation. Leave all roads as bidirectional for this exercise.

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Waste Site	Southern Dump	<b>P</b>			1000000.0	2.50	
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- 54. Right-click on MHAnalysis in the Project Explorer pane and select Edit Site Haul Analysis.
- 55. Select No in the Auto-create path drop-down list.

Note: This means that only the haul roads that we have created will be used in the analysis.

56. Select Apply in the Edit Site Mass Haul Analysis pane.

Note: Notice that the excess material is being sent offsite and not to the waste site that was created.

57. Enter 10 in the Borrow cost cell and enter 10 in the Waste cost cell.

Note: This is so that we will force the analysis to use the waste sites because it is more economical to do so.

- 58. Left-click in the box in front of Account for shrinkage and bulkage to add a checkmark.
- 59. Select Earthen (Mass Earthworks) > On-Site Soil in the Native material drop-down list.
- 60. Select Earthen (Mass Earthworks) > Off-Site Borrow Soil in the Borrow material cell.
- 61. Select Apply in the Edit Site Mass Haul Analysis pane.
- 62. Select the Material and Site Improvements Manager

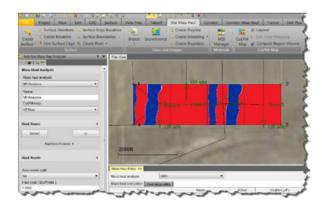
Manager icon in the Materials area under the Site Mass Haul tab.

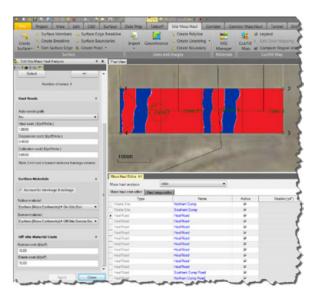
- 63. Expand the Materials and then Earthen (Mass Earthworks).
- 64. Left-click on On-Site Soil to highlight it.

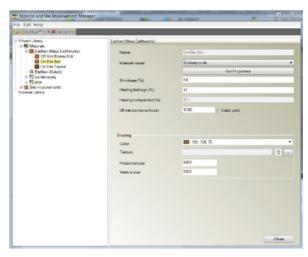
Note: We are assuming that we have a soils report and we know the on-site soil has a 8% shrinkage factor and a 11% hauling bulkage factor.

Note: Since this construction project has a deficit of material there is no borrow, so no borrow material properties need to be entered.

65. Select Close in the Material and Site Improvement Manager window.

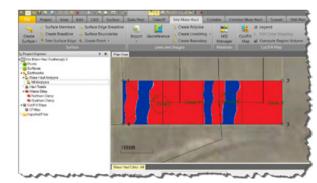






- 66. Select Close in the Edit Site Mass Haul Analysis.
- 67. Right-click on MHAnalysis in the Project Explorer pane and select Refresh Mass Haul Analysis.

Note: You can explore the balance lines and edit the haul road costs to understand how the software takes these changes into affect.

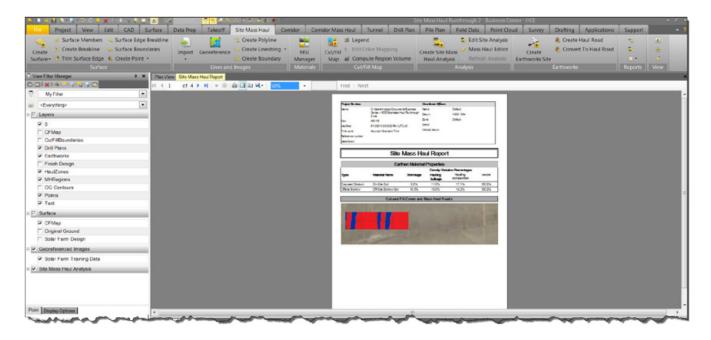


## **Running a Site Mass Haul Report**

After completing the site mass haul analysis a report can be generated that contains all the vital information in a clean and easy to read report.

- 1. Select the Site Mass Haul Report 👫 icon in the Reports area under the Site Mass Haul ribbon tab.
- 2. Select MHAnalysis in the Mass haul analysis cell.
- 3. Select Plan View in the Snapshot cell.
- 4. Select OK in the Site Mass Haul Report pane.

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Notes on the Analysis and Report:

**Moving earth within the same zone** = when earth is moved within the same zone, the cost is calculated by the average distance to the center of mass with the zone multiplied by the defualt unit cost set with the auto-create setting.

*Moving earth from zone to zone* = When moving from one zone to another, the cost includes the cost to gather and the cost to disperse as well as the distance from the center of mass of the first zone to the center of masss of the second zone multiplied by the unit cost.

*Importing material from off-site* = the cost to import material is the given cost per volume plus the cost to disperse in the zone.

*Exporting material off-site* = the cost to export earth is the given cost per volume plus the cost to collect from the zone.

*Note: Explore the different sections of the report to understand how the data is presented. The data reported on is:* 

- Material properties
- Plan view of cut/fill zones and haul roads
- User-input cost summary
- Cut/Fill zone data broken down by which zone material is being cut from and what zone the material is being placed as fill
- Route Statistics

CHAPTER

## **Corridor Mass Haul**

## Welcome

Welcome to the Trimble<sup>®</sup> Business Center – Heavy Construction Edition (HCE) corridor mass haul module. The corridor mass haul module in Business Center - HCE incorporates tools and commands that enables you to determine the most efficient distribution of earthen materials from cut zones to fill zones along a corridor.

This guide was developed by Trimble Navigation's Global Services Training and Support staff to support classroom instruction delivered by a Trimble Certified Trainer. The Trimble Certified Trainer will use this guide to lead you through the Site Mass Haul module using real world exercises. Please use this guide in conjunction with the Business Center - HCE help files and other product resources available.

## **Overview**

Business Center – HCE is a powerful tool that allows you to import surveyed original ground surfaces and analyze a corridor design against it to tell you how the material and how it can be moved most economically. It is also dynamic in the sense that the analysis is updated and changes as the design of the corridor changes.

The haul ranges of different equipment types are entered by the user and these are considered to give you insight into what resources should be used and where along the corridor to move the material in the most economical manner. In addition, the shrink and swell material properties can be accounted for in the analysis.

Engineering considerations such as the existing material strata, haul roads available for use, haulage barriers (rivers), borrow pits, waste sites, and the type and number of machines can all be input into Business Center - HCE.

Cost considerations are then able to be associated with the different resources at your disposal and a mass haul analysis can be computed, and will create a plan that optimizes material movement based on distance and cost parameters.

## **Learning Objectives**

- Run an initial corridor mass haul analysis to determine the most efficient way to redistribute earthen material from cut zones to fill zones along a corridor.
- Define barriers at stations along an alignment beyond which earthen material cannot be moved
- Open a Mass Haul Diagram and be able to graphically analyze the mass haul.
- Create and convert haul roads to be used as routes for vehicles moving materials
- Create borrow pits and waste sites to accommodate material excess and deficits.
- Force specified quantities of usable material to be accepted at one or more points along the corridor.

- Force the removal of specified quantities of material at one or more points along the corridor.
- Modify the network of haul roads to better manage the flow of cut and fill volumes.
- Create haul ranges for multiple machine types that will be used to move material
- After creating a mass haul analysis, automatically apply haul ranges to every balanced section.
- Recalculate the mass haul analysis to understand how changes affect the mass haul analysis.
- Report on the analysis; both on the source and destination of earthwork volumes, and on the properties of the corridor's balance lines.

## **Corridor Mass Haul Commands Defined**

**Georeference Image** – geodetically position raster images in the plan view by correlating specific pixels with known coordinates. This allows you to use arial photographs and scanned job site designs as positionally accurate backgrounds in your Business Center - HCE project.

**Create Corridor Analysis** – computes the most efficient way to redistribute earthen material from cut zones to fill zones along a corridor.

Mass Haul Diagram – use this command to create a diagram showing the accumulated cut and fill volumes along a corridors alignment, balance lines and the direction the material needs to be moved, a graph showing instantaneous cut/fill, and cross haul at each station along a corridor's alignment. The view gives a complete picture of mass haul and earthworks with access to specific mass haul and volume/cost information and analysis.

**Mass Haul Editor** – use this command to quickly edit volumes and costs associated with mass haul import and export locations, earthwork sites, and haul roads.

**MSI Manager** – create and manage libraries of materials used to define the existing strata and corridor materials. Input attributes such as shrink and swell, and a percentage of material that meets specifications to be re-used as fill. The mass haul analysis takes these considerations into account.

**Create Import** – force a specified quantity of useable and unuseable material to be accepted at a particular station along an alignment.

**Create Export** – force the removal of a specified quantity of useable material at a particular station or range of stations along an alignment. Export values specify exact quantities of material that MUST be removed at the specified location.

**Create Barrier** – define stations along an alignment beyond which material cannot be moved. Barriers represent a forced balance point for all hauled material in both directions. Acting as a start and finish points where the earthworks must balance through the use of imports, exports, and earthworks sites.

**Create Earthworks Site** – define the locations, capacities, and associated costs of waste sites and borrow pits to be used in the mass haul analysis.

**Create Haul Road** – create linestrings that define haul roads between zones on project, or between earthworks sites and a corridor construction project.

**Create Haul Range** – specify the maximum distance that earthmoving vehicles (or resources used in tandem such as excavator and haul truck) can economically move material along the corridor. These ranges enable economical estimation to allow the efficient planning of earthwork machine usage.

At Grade Point – this is the manual method to apply haul ranges at selected grade points along the alignment. Balancing manually gives control over the order in which the material is moved along the alignment.

**Auto-Balance** – this command automatically applies haul ranges at all grade points along the alignment; based on the distance and volume parameters of the cut and fill zones, and the haul ranges entered. This method

automatically determines grade points and fits the resources to move the material based on the entered haul ranges.

Clear Balances – remove all balance lines created, wether automatically or manually created.

**Corridor Mass Haul Report** – reports on source and destination earthwork volumes for a corridor mass haul analysis. This report is a textual representation of the Mass Haul Diagram. **Balance Line Report** – reports on the properties of a corridor mass haul's balance line.

## Files Needed

For the training exercises, each user should save the following files provided by your Certified Trainer onto their PC and placed in the Project Management folder.

- Project Planning and Scheduling.vce
- Project Planning and Scheduling.zip or Project Planning and Scheduling folder

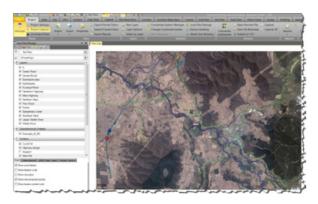
Note: You can find your Project Management folder by opening Business Center – HCE and going to the File tab. Select Options in the File tab and a Options window will open. Left-click on File Locations to select it and note the Project Management folder location. You can use Windows Explorer to navigate to this folder and place the Project Planning and Scheduling.vce and Project Planning and Scheduling folder inside this folder. If you have the .zip file you will need to extract it and then place the folder.

## **Running an Initial Corridor Mass Haul Analyis**

In order to to perform a corridor mass haul analysis you must import an original ground into your Business Center - HCE project file, and either import or create an alignment and corridor design in Business Center - HCE. As these workflows have been covered in previous modules they are already a part of the Project Planning and Scheduling.vce.

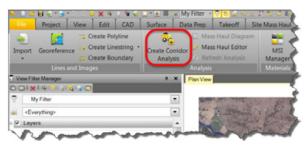
## 1. Open the Project Planning and Scheduling.vce project.

Note: Once opened a georeferenced arial photograph along with a corridor design and cut/fill map will be visible in the plan view. You will also see a network of 2D linework.





2. Select Analysis in the Analysis area under the Corridor Mass Haul tab.



- 3. Enter MH Analysis in the Name cell.
- 4. Select Main Rd from the Corridor drop-down list.

*Note: If multiple corridors are included in a project, only one can be analyzed at a time.* 

5. Enter 25 in the Sampling interval cell.

Note: This defines the distance along the alignment that the Average End Area method of determining volumes will be applied.

6. Select Yes from the Respect earthwork site capacities drop-down list.

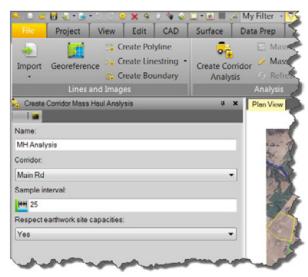
Note: When capacities are associated with borrow pits and waste sites, they are respected when choosing yes.

7. Select OK in the Create Corridor Mass Haul Analaysis pane.

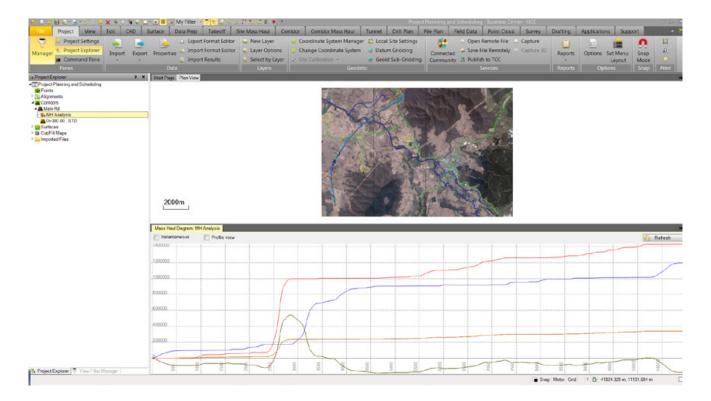
Note: The corridor mass haul analysis is created and its icon appears under the Main Rd. corridor in the Project Explorer.

- 8. Expand the Corridors in the Project Explorer and leftclick on Main Rd to highlight it.
- 9. Select Mass Haul Diagram in the Analysis area under the Corridor Mass Haul tab.

*Note: This will create a graphical representation of cut and fill volumes along the corridor.* 



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How to interpret the diagram:

Vertical axis - values represents volume.

Horizontal axis - values represents stationing along the alignment.

*Note: The mass ordinates are represented by the colored lines in the diagram.* 

**Red line** - is the cumulative cut along the alignment. By definition of it being cumulative the line is ever increasing or flat along stations of fill. It's easy to see graphically that the cut volume increases sharply between 2+450 to 2+850.

*Blue line* - is the cumulative fill along the alignment. By definition of it being cumulative the line is ever increasing or flat along stations of cut.

*Green line* - is the Usable Material. A surplus of usable material exists when the line is above the 0 axis and a deficit exists when the line is below the 0 axis. The amount of surplus or deficit can be determined by referencing the vertical axis at any specific station.

**Orange line** - represents the Unusable Material. This indicates the the amount of unusable cut material being carried, increases very gradually along the corridor. Whatever unusable material cannot be taken to a waste site is hauled to the closest start or finish point.

Note: Warnings are also indicated on the Mass Haul Diagram.

**Warning** - is represented by the red flag icon indicates an imbalance as a result of a surplus or deficit of material occurring at the end of the corridor or at any barrier. Examining the properties for any warning gives details about the actual volume (compacted) of surplus or deficit.

## 10. Hit F11 on the keyboard to open the Properties pane and left-click on a line in the Mass Haul Diagram.

*Note: You can see in the Properties pane information on the selected line.* 

*Note: In the status bar the stationing and volume are indicated at the current location of the cursor.* 

Note: You can move the cursor along each line in the mass haul diagram and review the volumes at different stationing.

- 11. Select Explore Object 🜌 icon in the Quick Access Toolbar.
- 12. With the curser in the Object cell, left-click on the Clay (Useable) ordinate in the mass haul diagram.

Note: You an hover over the lines to see which one is the Clay (Useable) before left-clicking on it.

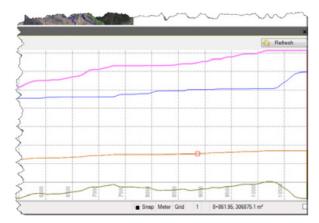
## 13. Enter 7000 in the Sation cell.

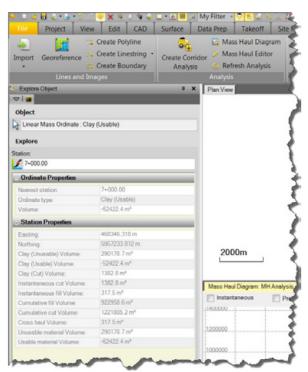
Note: You can either enter a specific station of intrest or select a location along the alignment in the plan view to select a Station.

**Instantaneous Cut Volume** - This is the volume of material to be cut in a particular station range. The station range is defined by the sampling interval that was input when creating the initial mass haul analysis.

*Instantaneous Fill Volume* – This is the volume of material to be filled in a particular station range. The station range is determined by the sampling interval that was input.

*Cross Haul Volume* – the amount of material being moved from a cut down an alignment to a fill.

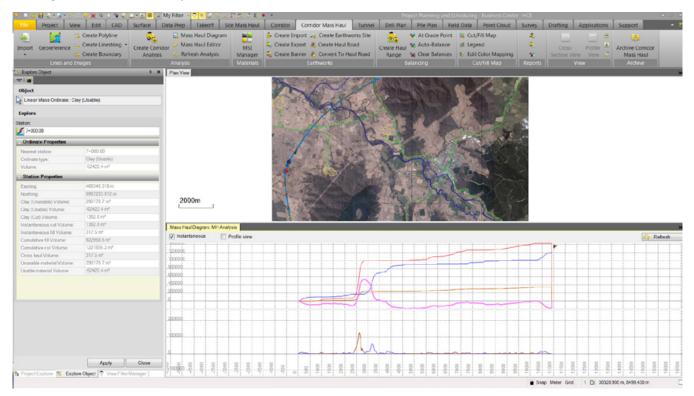




#### 14. Left-click in the box next to Instantaneous in the Mass Haul Diagram.

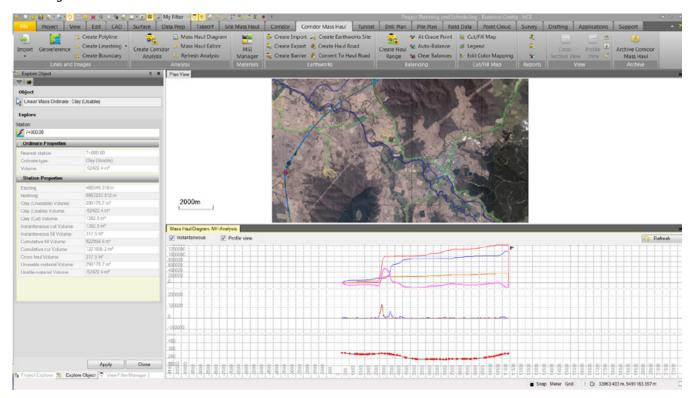
*Note:* You can now see a graph showing the instantaneous cut, fill, and cross haul at each station along a corridor's alignment.

Note: This view shows the instantaneous cut and fill across each sampled section. The sampled sections are determined by the value entered when initally running a mass haul analysis. This view also shows the cross haul distance. Cross haul is defined as the amount of material from a cut zone being moved down an alignment and used in a fill zone in a corridor mass haul.



### 15. Left-click in the box next to Profile view in the Mass Haul Diagram.

*Note:* A profile view shows the vertical alignment at the same horizontal scale as the Corridor Mass Haul Diagram.



Note: The initial mass haul analysis has now been completed and it is simple to see that there is a deficit of usable material on this project. There is a river that is impassable and must be accounted for in the Mass Haul Analysis. There is multiple borrow pits and waste sites that need to be added to the project to ensure the project is being constructed in the most efficient manner. Also there is bore hole data that needs to be entered so that the strata of the existing ground can be defined giving managers a clearer picture of the amount of work this project is going to require. After the Mass Haul Analysis is optimized by inputting all these engineering considerations then haul ranges will be applied to determine what machines should be working at what locations along the corridor.

## **Considering Material Properties and Defining the Original Ground Strata**

Often times a soils report will be available that contains vital material characteristic information such as the shrink and swell values. These values need to be captured in Business Center – HCE, so that the volume calculations can take these factors into account to give accurate values of excesses and deficits on projects.

In addition these reports will often contain core sample data, also known as bore hole data. This data defines the thickness of the different materials that will be encountered during the construction project. This data needs to be captured by Business Center - HCE as well; so that the volumes of usable and unusable cut encountered can be determined accurately, and be placed as fill or as an export accordingly.

In this section it we will learn how to input this data into Business Center - HCE.

1. Close the Mass Haul Diagram.

-

2. Select the Material and Site Improvement Manager

Manager icon in the Material area under the Corridor Mass Haul tab.

- 3. Expand Materials and then Earthen in the Material and Site Improvement Manager window.
- 4. Left-click on Clay to highlight it.
- 5. Enter 7 in the Shrinkage (%) cell.

Note: 7% shrinkage means that 1 CM of in situ cut will equal 0.93 CM of once placed as fill and compacted.

6. Select Soil Properties and enter 80 in the Percent usable for fill in the Soils Properties window.

Note: 80% usable means that for every 100 CM of clay cut, only 80 CM meets specifications to be reused as fill on-site. The other 20 CM must be exported.

- 7. Select OK in the Soil Properties window.
- 8. Left-click on Rock to highlight it.
- 9. Enter 0 in both the Shrinkage (%) cell and the Hauling Bulkage (%) cell.

Note: There currently are not any specific Rock Properties that can be set in the software so the icon is greyed out.

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Project Library	Earthen (Mass Earthworks)	
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Flock Storty Fase Cary	Material wature:	Ordinary colle
Topool I		Sed Properties
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- Externel Library	Having bulkage (%):	10.0
	Having compaction (%)	15.5
	Off-site borrow unit cost	2:00 / Cubic mater
	Calor Texture	120.64.0
	Horizontal size:	1000
	Vertical size	1000

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City	Name	Rock		
Back Senty Fine Clay Topsoil	Material nature	Reck Rock Properties		
III III Earthen (Select)	Shinkago (%)	80		
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	Having compaction (%)	00		
	Off site borrow unit cost	3.50 / Cubic meter		
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- 10. Left-click on Sandy Fine Clay to highlight it.
- 11. Enter 3 in the Shrinkage (%) cell and enter 7 in the Hauling bulkage (%) cell.
- 12. Select Soil Properties and change the percent usable for fill to 90%.
- 13. Select Soil Properties and enter 90 in the Percent usable for fill in the Soils Properties window.
- 14. Select OK in the Soil Properties window.
- 15. Select Close in the Material and Site Improvement Manager window.
- 16. Select Define Strata in the Strata area under the Corridor tab.

Note: This command is how the different layers of strata defined from core samples are entered into the project.

17. Select Original ground in the Original ground dropdown.

*Note: The uppermost material encountered on-site is Topsoil, then Sandy Fine Clay, then Clay, and lastly Rock.* 

*Note: If you need to add more or change their order you can.* 

18. Select OK in the Define Corridor Strata.

Project Library	Eather Mass Eathworks)	
S Matania E Esthen	Name	Sandy Fine Cay
Eli City Eli Rack	Material nature:	Ordinary softs
Topsol B Earthen (Select) B Site improvements	Shrinkage (%)	Sol Properties
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	Hauling compaction (%)	13
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Original ground			
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Earthen Topsoil			
Earthen Sandy Fine Clay			
Earthen Clay			
Earthen Rock			
•			

- 19. Select Screate Boring Log in the Strata area under the Corridor tab.
- 20. Enter BH1 in the Name cell.
- 21. Enter 0+200 in the Station cell.
- 22. Enter -25 in the Offset distance cell.
- 23. Select <<New layer>> in the Layer cell.
- 24. Enter Boring Log Data in the Name cell and select
- 25. Select Boring Log Stratum Settings Corridor Boring Log pane.

Note: A window appears allowing us to enter thicknesses for each layer of stratum. This information all comes from a soils geotechnical report.

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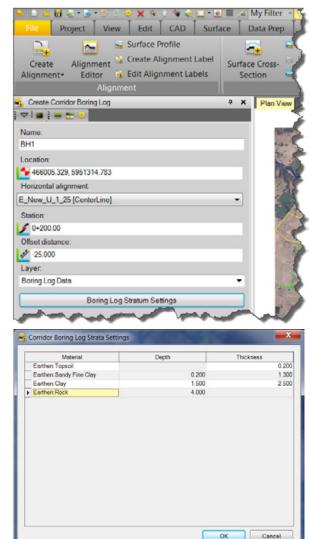
- 26. Enter .2 in the Earthen: Topsoil Thickness cell.
- 27. Enter 1.3 in the Earthen: Sandy Fine Clay Thickness cell.

Note: Notice the depth column is updated by combining all the thicknesses of the current material and those found above it.

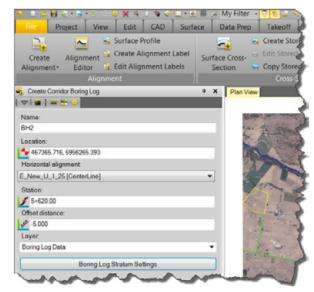
28. Enter 2.5 in the Earthen: Clay Thickness cell.

*Note: The depth of the last material "rock in this case", is automaticallty figured and is projected down from there.* 

- 29. Select OK in the Corridor Boring Log Strata Settings window.
- 30. Select Apply in the Create Corridor Boring Log pane.

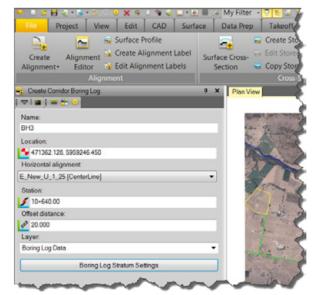


- 31. Enter BH2 in the Name cell.
- 32. Enter 5+620 in the Station cell.
- 33. Enter -5 in the Offset distance cell.
- 34. Select Boring Log Data in the Layer drop-down list.
- 35. Select Boring Log Stratum Settings in the Create Corridor Boring Log pane.
- 36. Enter .3 in the Earthen: Topsoil Thickness cell.
- 37. Enter 3 in the Earthen: Sandy Fine Clay Thickness cell.
- 38. Enter 2 in the Earthen: Clay Thickness cell.
- 39. Select OK in the Corridor Boring Log Strata Settings window.
- 40. Select Apply in the Create Corridor Boring Log pane.



Material	Depth	Thickness
Earthen: Topsoil		0.30
Earthen: Sandy Fine Clay	0.300	3.00
Earthen: Clay	3.300	2.00
Earthen: Rock	5.300	

- 41. Enter BH3 in the Name cell.
- 42. Enter 10+640 in the Station cell.
- 43. Enter 20 in the Offset distance cell.
- 44. Select Boring Log Data in the Layer drop-down list.
- 45. Select Boring Log Stratum Settings in the Create Corridor Boring Log pane.
- 46. Enter .25 in the Earthen: Topsoil Thickness cell.
- 47. Enter 2 in the Earthen: Sandy Fine Clay Thickness cell.
- 48. Enter 3.5 in the Earthen: Clay Thickness cell.
- 49. Select OK in the Corridor Boring Log Strata Settings window.
- 50. Select Apply in the Create Corridor Boring Log pane.



Material	Depth	Thickness
Earthen: Topsoil		0.250
Earthen:Sandy Fine Clay	0.250	2.000
Earthen: Clay	2.250	3.500
Earthen:Rock	5.750	

51. Expand Corridors and Main RD in the Project Explorer pane.

Note: The Mass Haul Analysis icon has changed. This new icon indicates that mass haul objects have been edited that affect the analysis and that it needs to be refreshed.

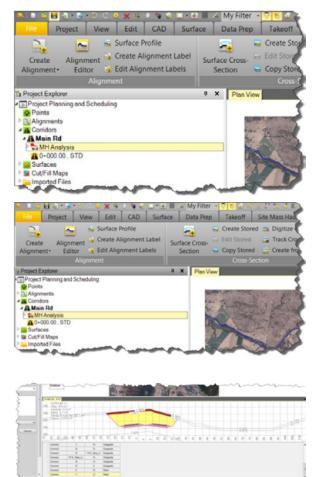
Note: It is good practice to make all the necessary edits to the objects that make up the mass haul analysis and then refresh it. Depending on the complexity of the analysis and sampling distance specified it can take time to complete the analysis.

52. Right-click on the MH Analysis and select Refresh Mass Haul Analysis.

*Note:* The MH Analysis icon in the Project Explorer has now changed its color to orange and there is not a flag.

- 53. Right-click on 0+000.00 STD Corridor Template and select Edit.
- 54. Use the Slider at the bottom of the Corridor Template view to slide down the corridor.

Note: Notice the different layers of strata are now shown beneath the Original Ground surface.

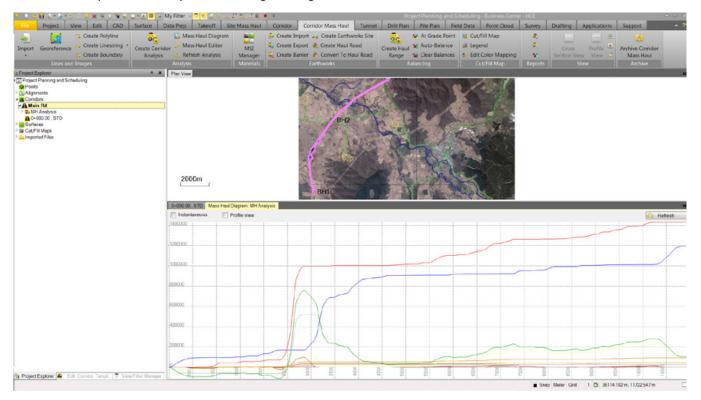


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## 55. Left-click on Main Rd in Project Explorer to highlight it.

## 56. Select Mass Haul Diagram in the Analysis are under the Corridor Mass Haul tab.

Note: There are more ordinate lines in the diagram than before. Each material defined in the stratum is represented by it's own line. This allows managers to track each material type, both the usable and unusable quanties at any station along the alignment.



## **Creating Barriers**

Often times when constructing a linear project the entire length of the project can not be considered as one. It must be broken into multiple segments and each must balance due to rivers, environment restrictions, or bridges that are impassible. Creating a barrier in the mass haul analysis is how these situations are represents a location along the alignment of a corridor construction job site beyond which vehicles performing mass earthwork hauling operations cannot physically pass.

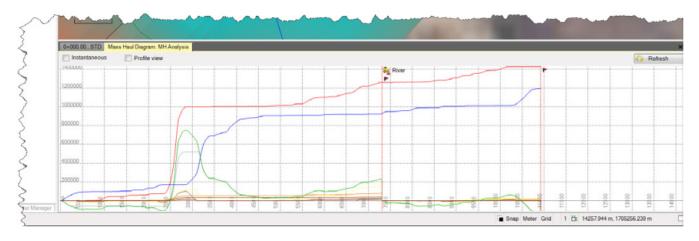
Mass haul barriers represent a forced waste site for all hauled material in both directions, essentially acting as local start and finish points.

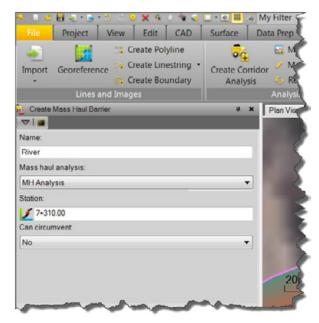
- 1. Select Create Barrier in the Earthworks area under the Corridor Mass Haul tab.
- 2. Enter River in the Name cell in the Create Mass Haul Barrier pane.
- 3. Select MH Analysis in the Mass haul analysis dropdown list.
- 4. With the cursor in the Station cell, left-click in the plan view where the blue line representing the river intersects the corridor.

Note: You will need to zoom in and pan to the location where the river crosse the road. A line will extend from the curser and hook to the corridor, left click when this line is right over the blue river line. It is at station 7+310 approximately.

- 5. Select No in the Can circumvent drop-down list.
- 6. Select Apply in the Create Mass Haul Barrier pane.
- 7. Select Close in the Create Mass Haul Barrier pane.
- 8. Right-click on the MH Analysis in the Project Explorer and select Refresh Mass Haul Analysis.

Note: Notice the river that is now represented in the diagram and the red flag associated with it. This is because there is a surplus of material at the station of the river that has not been dealt with yet. Thus we need to create a waste site and in conjunction an export if desired. Since there is a surplus of unusable material a waste site is mandatory. Unusable material cannot be compensated for with an export because of it's nature of being unusable.





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## **Create Earthworks Sites**

The Create Earthworks command is used in Business Center - HCE to geographically define borrow pits and waste sites that can be used in the mass haul analysis to balance the site.

Borrow sites are quarries that provide additional fill if there happens to be a deficit of material on the job site. Materials from borrow pits can be moved in either direction along the corridor's alignments, depending on where it is required. The borrow material is placed at the point where the haul road connects to the corridor. All material at a corridor mass haul borrow site is considered usable. This means that the percentage usable defined for the borrow material in the Material and Site Improvement Manager is not used.

Waste sites are locations that unusable material and excess usable material can be taken if there is an excess of material on a job site. All of the waste material (accumulated unusable and excess usable) is collected at the point where the haul road connects to the corridor.

The use of borrow and waste sites is optimized based on the cost of material at the earthworks site and the cost of hauling material on the haul roads that connect the earthworks site to the corridor. The cost of using haul roads is based on a unit/distance rate, so the software takes into account the costs associated with longer hauling distances to optimize the use of earthworks sites.

- Select Create Earthworks Site in the Earthworks area under theCorridor Mass Haul tab.
- 2. Select Borrow Pit under the Site type drop-down list.
- 3. Enter Jackson's Quarry in the Name cell.
- 4. Select Earthworks from the Layer drop-down list.
- 5. With the curser in the Location cell, left-click just inside the boundary for Jackson's Quarry in the NW corner of the site near the haul road.

Note: You can hover over the haul roads and boundaries to see there names. Jackson's Quarry is a yellow boundary in the NW corner and is connected by a green haul road.

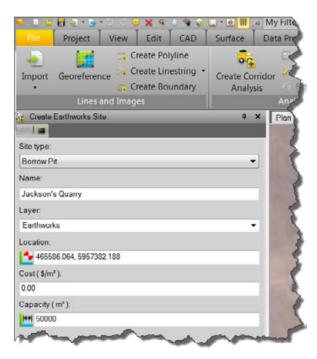
Note: In the computations folder located in the project settings, there is an option for mass haul settings. Open this and note the site connection tolerance. This is the distance that an earthworks site must be to the end of a haul road in order to be utilized in a mass haul analysis.

- 6. Leave the cost per unit of material at \$0.00.
- 7. Enter 50,000 in the Capacity cell.

Note: This is the maximum amount of material available to borrow at this location.

8. Select Apply in the Create Earthworks Site pane.

Note: There is a aqua colored excavator icon that denotes the borrow pit in the plan view.



- 9. Select Borrow Pit under the Site type drop-down list.
- **10.** Enter Northern Quarry in the Name cell.
- **11.** Select Earthworks from the Layer drop-down list.
- **12.** With the curser in the Location cell, left-click just inside the boundary for Northern Quarry in the NE corner of the site near the haul road.

Note: You can hover over the haul roads and boundaries to see there names. Northern Quarry is a yellow boundary in the NE corner and is connected by a green haul road.

- 13. Leave the cost per unit of material at \$0.00.
- 14. Enter 150,000 in the Capacity cell.
- 15. Select Apply in the Create Earthworks Site pane.

*Note: There is a aqua colored excavator icon that denotes the borrow pit in the plan view.* 

- 16. Select Waste Site under the Site type drop-down list.
- 17. Enter Southern Dump in the Name cell.
- 18. Select Earthworks from the Layer drop-down list.
- 19. With the curser in the Location cell, left-click just inside the boundary for Southern Dump in the SW corner of the site near the haul road.

Note: You can hover over the haul roads and boundaries to see there names. Southern Dump is a yellow boundary in the SW corner and is connected by a green haul road.

- 20. Leave the cost per unit of material at \$0.00.
- 21. Enter 400,000 in the Capacity cell.
- 22. Select Apply in the Create Earthworks Site pane.

*Note: There is a red colored dump truck icon that denotes the waste site in the plan view.* 

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- 23. Select Borrow Pit under the Site type drop-down list.
- 24. Enter Johnson's Farm in the Name cell.
- 25. Select Earthworks from the Layer drop-down list.
- 26. With the curser in the Location cell, left-click just inside the boundary for Johnson's Farm in the center of the site near the haul road.

Note: You can hover over the haul roads and boundaries to see there names. Johnson's Farm is a yellow boundary in the center of the site and is connected by a green haul road.

- 27. Leave the cost per unit of material at \$0.00.
- 28. Enter 200,000 in the Capacity cell.
- 29. Select Apply in the Create Earthworks Site pane.

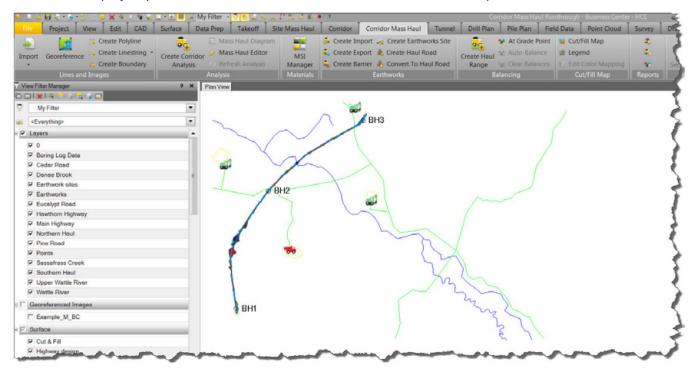
*Note: There is a aqua colored excavator icon that denotes the borrow pit in the plan view.* 

30. Select Close in the Create Earthworks Site pane.

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## **31.** Turn off the Georeferenced Images in the View Filter Manager.

Note: The project plan view should look similar to below with three borrow pits and one waste site.



## **Creating Haul Roads**

As the Business Center - HCE project currently sits none of the earthworks sites created would be used in the mass haul analysis. Without haul roads connecting the waste site or borrow pit to the corridor, the earthworks sites will not be used.

Use the Create Haul Road or Convert to Haul Road command to create linestings that define haul roads between earthwork sites, and a job site or a corridor. You can also use them to circumvent a barrier or provide an alternate haul route in a corridor mass haul analysis. In this project all the green lines denote haul roads, so the Convert to Haul Road command will be utilized.

Haul roads have unique properties such as cost and directionality, this enables them to be used in a mass haul analysis. To view and edit these properties, you can use the properties pane or the mass haul editor.

- 1. Select A Convert To Haul Road in the Earthworks area under the Corridor Mass Haul tab.
- 2. With the cursor in the Selection cell, hold-down the Ctrl key on the keyboard and left-click on all the green lines in the plan view.

*Note: There should be a total of eight lines selected.* 

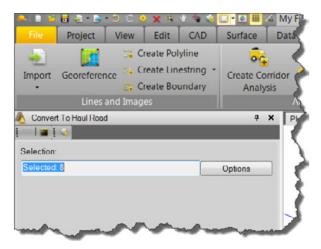
3. Select Apply in the Convert to Haul Road pane.

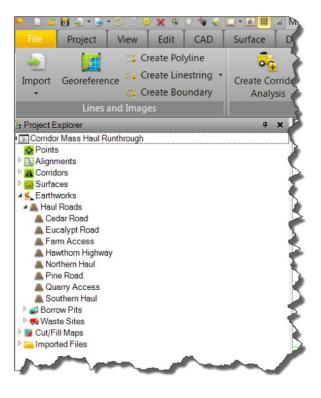
Note: All eight linestrings are now haul roads and can be utilized in mass haul analysis.

- 4. Select Close in the Convert to Haul Road pane.
- 5. Expand the Earthworks and also the Haul Roads in the Project Explorer.

Note: The names of all the linestrings are what the haul roads are now named.

Note: That the network of haul roads crosses the corridor in two locations. These two stations are the entry and exit points for material being borrowed or wasted.



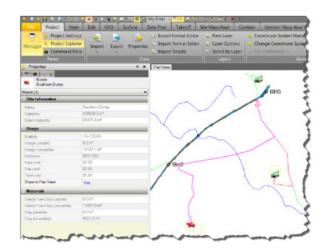


- 6. Expand Corridors and Main Rd in the Project Explorer.
- 7. Right-click on MH Analysis and select Refresh Mass Haul Analysis.

Note: In the plan view there are two of the haul roads have changed to the color red and have arrows at the ends.

8. Left-click on the red line Waste: Southern Dump to select it.

Note: There are two Waste: Southern Dump listed, just choose the second one. There is one for going to each location that crosses the corridor.



9. Right-click in the graphical view and select Properties.

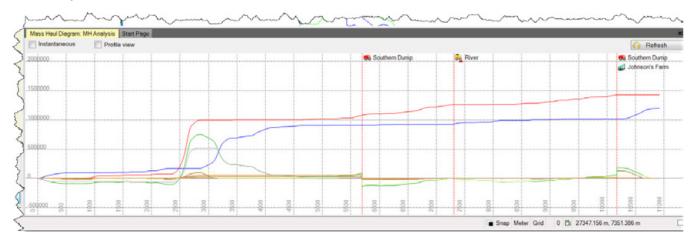
Note: You can gain insight into how much material is being transported to the waste site and the distance it is being transported.

*Note: You can explore the mass haul objects in the plan view by left-clicking on them with the Properties pane open.* 

# 10. Select Mass Haul Diagram in the Analysis area under the Corridor Mass Haul tab, if it is not already open.

Note: Notice the Southern Dump waste site is shown twice in the diagram and the Johnson's Farm quarry is shown once. The location on the diagram is determined by the stationing along the alignment that the material exits or is brought to the site.

Note: That the flags at the river barrier and at the end of the corridor are now gone, because the surplus and deficit of material from the previous analysis is able to be transported through the network of haul roads from borrow sites and to waste sites.



## **Creating Imports and Exports**

Use the Create Mass Haul Import command to force a specific volume of usable and unusable material to be accepted at a particular station along a corridor's alignment. You can also specify usable and unusable volumes to be considered in the corridor mass haul analysis.

Import values specify exact quantities of material that must be supplied at a particular point. The mass haul analysis does not consider the source of the imported material and just accepts that it will be supplied at a specific location along the alignment. This import material can then be distributed along the alignment over a specified distance. All import earthworks must be used and the excess import is hauled to locations until it is used.

One example for forcing an import is as follows. Our organization has another construction project 5 miles away that has an 50,000 CM excess of material. Since this current project has a deficit it makes sense to force an import of that material here as opposed to paying to waste the material from that project and also paying to purchase material for this project.

Use the Create Mass Haul Export command to force the removal of a specified quantity of usable material at a particular station along a corridor's alignment. Export values specify exact quantities of material that must be removed at a particular point. All export earthworks specified at a particular location must be used and a deficit caused by export needs to be compensated for by the system.

Creating an export is how stockpiling material is specified in the mass haul analysis. If the capacity of waste sites was not enough to handle the excess material of a site then an export would have to be created as well to balance the site.

For this next exercise we have a deal with farmer Pyziak to get 35,000 CM of material for free because he is digging a lake. So we need to create an import to account for this material in the mass haul analysis.

- 1. Select select reate Import in the Earthworks area under the Corridor Mass Haul tab.
- 2. Enter Pyziak's Lake Clay in the Name cell.
- 3. Select MH Analysis in the Mass haul analysis dropdown list.
- 4. Enter 6+725 in the Station cell.

*Note: This is the stationing that the import will be dropped at.* 

- 5. Enter 35,000 in the Usable quantity cell.
- 6. Leave the Unusable quantity at 0.
- 7. Select Apply in the Create Mass Haul Import pane.

*Note:* A green dot is placed at the stationing along the alignment where the import was created.



Note: We will now assume that we need to stockpile 20,000 CM of material to be used on a future levy project.

- 8. Select Create Export in the Earthworks area under the Corridor Mass Hual tab.
- 9. Enter Future Levy Stockpile in the Name cell.
- 10. Enter 7+735 in the Station cell.
- 11. Enter 20,000 in the Quantity cell.
- 12. Select Apply in the Create Mass Haul Import pane.

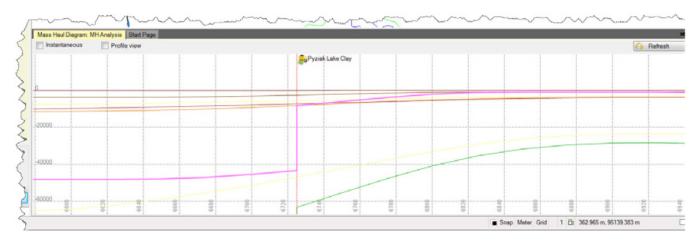
Note: In the plan view there is a red dot indicating an export has been created at this stationing.

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- 13. Expand Corridors and Main Rd in the Project Explorer.
- 14. Right-click on MH Analysis and select Refresh Mass Haul Analysis.
- 15. Select Mass Haul Diagram in the Analysis area under the Corridor Mass Haul tab, if it is not already open.
- 16. Pan and zoom into the Clay (Usable) line near the Pyziak Lake Clay stationing in the diagram.
- 17. Left-click on the Clay (Usable) to select it.

Note: If you are unsure of which line is the Clay (Usable), you can left-click on the line to select it with the Properties pane open to see what it is labeled.

Note: The volume increases by 35,000 CM at this station because of the import. The reason the material is deemed as Clay that is being imported, is because that is the specified borrow material in the corridor properties. If the borrow material was switched to Sandy Fine Clay, then this ordinate would increase by 35,000 CM at this station.

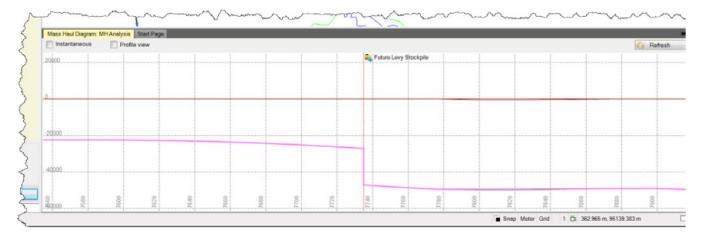


- 18. Pan and zoom into the Sandy Fine Clay (Usable) line near the Future Levy Stockpile stationing in the diagram.
- 19. Left-click on the Sandy Fine Clay (Usable) to select it.

Note: If you are unsure of which line is the Clay (Usable), you can left-click on the line to select it with the Properties pane open to see what it is labeled.

Note: At this stationing the volume decreases by 20,000 CM, going from -28,000 CM to -48,000 CM due to the export created at this station. The material is Sandy Fine Clay because at this location along the alignment, the cut is within this portion of the original ground strata.

*Note:* You might be asking, how can material that does not exist be exported? Remember this question and it will be addressed once we run a balance line report.



## **Creating Haul Ranges for Machines**

Before you can use tools to balance the earthwork materials in the mass haul analysis, the Create Haul Range command needs to be executed to specify the maximum distance that each machine type available for the project can be used to economically move material. Use haul ranges to define the vehicles available for the project and the distance that material can be hauled efficiently in these vehicles before additional costs are incurred (free haul distance). Haul ranges are used when a mass haul analysis is balanced. You can add additional vehicles (haul ranges) to your project to reduce the amount of over haul.

**Free Haul** – The amount of material that can be moved economically in a corridor mass haul balancing process. Ideally 100% of material is in the free haul range.

**Over Haul** – The amount of material that will incur additional costs to move in a corridor mass haul balancing process. If incurred in a mass haul analysis this is an indicator to utilize resources with a greater haul range.

**Cross Haul** – The amount of material cut being moved across an alignment and used as fill in a corridor mass haul.



- 1. Select Range in the Balancing area under the Corridor Mass Haul tab.
- 2. Enter Dozer in the Name cell.
- 3. Enter 70 in the Limit cell.

Note: The maximum distance limit for this dozer is 70M.

4. Select Alignment Only in the Type drop-down list.

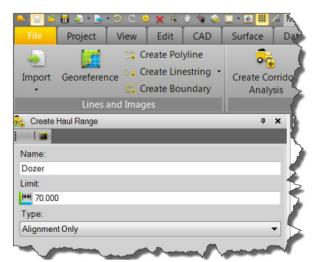
*General* – Use this haul range type if you do not want to limit how the earthmoving equipment (haul range) is used.

**Alignment Only** – this haul range type limits the machine to only being used to move material between cut and fill zones along the alignment. This prevents a machine from using a haul road.

**Alignment to Offsite** – Use this haul range type to balance material that is cut from the alignment and exported offsite.

*Offsite to Alignment* – Use this haul range type to balance against material that is imported from offsite and used as fill in the alignment.

- 5. Select Apply in the Create Haul Range pane.
- 6. Enter Scraper in the Name cell.
- 7. Enter 500 in the Limit cell.
- 8. Select Alignment Only in the Type drop-down list.
- 9. Select Apply in the Create Haul Range pane.



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- **10.** Enter Excavator/Off-Road Truck in the Name cell.
- 11. Enter 4000 in the Limit cell.
- **12.** Select General from the Type Drop-down list.
- 13. Select Apply in the Create Haul Range pane.

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- 14. Enter Excavator/Tractor Trailer in the Name cell.
- 15. Enter 10,000 in the Limit cell.
- 16. Select General from the Type Drop-down list.
- 17. Select Apply in the Create Haul Range pane.
- 18. Select Close in
  - in the Create Haul Range pane.

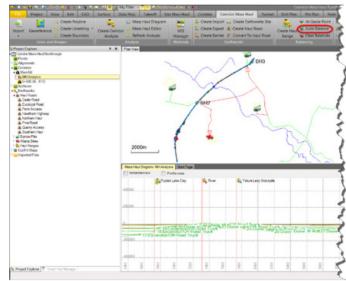
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## **Automatically Balancing Mass Haul Earthworks**

Now that haul ranges are defined for the equipment available on the project, the Auto-Balance Mass Haul command is used to apply the haul ranges to the balanced sections.

- 1. Expand Corridors and Main Rd in the Project Explorer.
- 2. Left-click on MH Analysis to select it.
- 3. Select Auto-Balance in the Balancing area under the Corridor Mass Haul tab.

Note: No input is required for this command, the command determines the vehicles required to move material between balance points. In the Mass haul Diagram, a balance point is the point where the usable material ordinate crosses the zero volume line. At this point along the aligment the amount of cut equals the amount of fill. Haul ranges are used in the balancing process to determine the amount of material that is moved

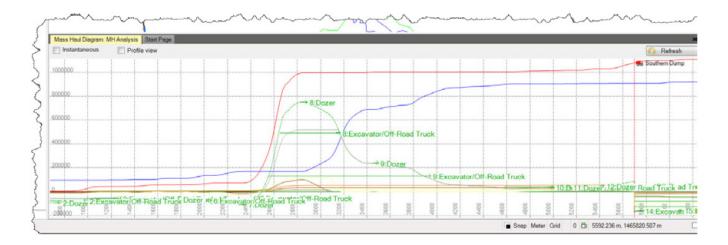


economically "free haul" and the amount of material that will incur additional costs to move "over haul".

Note: The haul range with the smallest limit is used first providing the Haul range type is suitable. For more information on suitable haul range types see Create a Haul Range. When the haul range limit is reached the next smallest suitable haul range is used. The process continues until all material is balanced or the largest Haul range limit has been reached. The remaining material is overhaul.

Note: If overhaul exists, existing earthmoving vehicles can be used to balance the remaining material at a higher cost; different earthmoving vehicles that can economically haul larger distances can be added to the project or additional borrow and waste sites can be added to reduce the distance material needs to be moved along the alignment.

Note: Only haul ranges with types alignment to offsite, offsite to alignment or general can be used to balance against vertical lines caused by import, export, borrow, waste or haul.



- 4. Pan and zoom in the Mass Haul Diagram tell you see 28: Excavator/Off-Road Truck.
- 5. Left-click on Balance Line 28:Excavator/Off-Road Truck to select it.
- 6. Right-click in the graphical view and select Properties.

**Cut Range** – the station range where the scraper is cutting material.

*Fill Range* – the station range where the scraper is filling material. In this balance line the material is moving down alignment, this is also indicated with an arrow on the balance line in the mass haul diagram.

**Distance** – the average distance the material is being hauled from cut to fill is given here.

**Volume Information** – details cut and fill volume totals, and import material used in this zone. It also details that this resource is the most economical way to contribute to the export we placed for the Future Levy Stockpile.

*Materials* – details showing volumes of each material is given here.

7. Select Clear Balances in the Balancing area under the Corridor Mass Haul tab.

Note: This will delete the auto-balance that was just applied, so that we can do a manual balance in the next excersice.

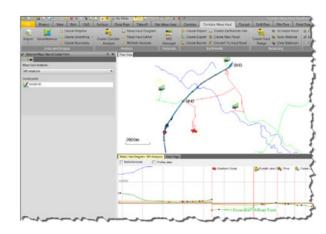
## **Balancing Mass Haul Earthworks at a Station**

Use the Balance Mass Haul at Grade Point command to specify a grade point on an alignment at which you want material balanced and haul ranges applied.

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- 1. Select \* At Grade Point in the Balancing area under the Corridor Mass Haul tab.
- 2. Select MH Analysis in the Mass haul analysis dropdown list.
- 3. With the curser in the Grade point cell, left-click in the mass haul diagram on any of the grade points.

Note: Balances are created at the maximum volume of surplus material or the maximum volume of deficit of material that is closest to the station specified between two balance points. They are denoted by red and blue dots.



Red - Bottom of a fill zone

Blue - Top of a cut zone

Note: If manually entering a station, the nearest grade point will be utilized if the station entered is not a grade point.

- 4. Select Apply in the Balance Mass Haul at Grade Point pane.
- 5. Repeat steps 3 and 4 to add a few Grade Points to see what happens in the Mass Haul Diagram.

Note: Balance the mass haul in the order that you plan to haul material on site. Mass haul volumes are dependent on the order in which you balance each section. If a project planner wants to start at the river and work away from this point, pick the grade point near the river and work towards the begin stationing. You will then notice in the mass haul diagram that the balance line arrows are moving away from the river, thus showing the direction of material haulage.

- 6. Select Clear Balances in the Balancing area under the Corridor Mass Haul tab.
- 7. Select 👫 Auto-Balance in the Balancing area under the Corridor Mass Haul tab.

*Note: We will use the auto balance for the rest of the exercises.* 

## **Applying Costs and Editing Mass Haul Objects**

The mass haul cost for usable material is determined by the area between the usable line and the 0 line in the Mass Haul Diagram multiplied by the per cubic meter per unit distance volume cost (the same is true for unusable material). For details on how corridor mass haul cost calculation are made, see the help topic called Run a Corridor

Mass Haul Report. Although you can set costs as you create each mass haul object, let's examine and set costs for all of the various objects that affect the total cost now.

1. Right-click on MH Analysis in the Project Explorer pane and select Properties.

Note: The Cost(\$/CM/KM) specifies the price of cutting, pushing/hauling,filling,and compacting each unit of earthen materials one distance unit along the corridor.

2. Enter 5 in the Cost(\$/CM/KM) cell.

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## 3. Select <a>Mass Haul Editor</a> in the Analysis area under the Corridor Mass Haul tab.

Note: A pane with all the mass haul objects appears with costing.

**Borrow Pit Costs** = the price of purchasing each unit of borrow material.

*Waste Pit Costs* = the price of dumping each unit of waste material.

**Haul Road Costs** = the price to move each unit of material one distance unit along the haul road. The cost is multiplied by the length of the haul road to calculate the price to move each unit of material to the construction project. The software then chooses which borrow pit or waste site to use. It weighs the price to haul the material plus the price to purchase or waste the material, and opts for the most efficient method.

4. Enter .75 in the Site cost cell for the Southern Dump.

*Note: The cost is cheap because they want to build up a low region so they can build on the site.* 

- 5. Enter 2.5 in the Site cost cell for Johnson's Farm.
- 6. Enter 4.0 in the Site cost cell for the Northern Quarry.
- 7. Enter 3.0 in the Site cost cell for Jackson's Quarry.
- 8. Enter 0.002 in the Haul cost cell for all haul roads.

Note: If for one reason or another a mass haul object is not to be available for use in the analysis anymore simply left-click in the Active box to remove the checkmark.

*Note: If more accurate estimates are available for the quantities available at earthworks sites, simply edit the volume here as well.* 

Mass haul analysis:	MH Analysis	*					
Mass haul cost editor Ha	ul range editor						
Туре	Name	Active	Usable (m <sup>a</sup> )	Unusable (m <sup>a</sup> )	Capacity (m <sup>a</sup> )	Site cost (\$/m <sup>a</sup> )	Haul cost ( \$/m³/km
Import	Pyziak Lake Clay	2	35000.0	0.0			
Export	Future Levy Stockpile	1	20000.0				
Borrow Pit	Johnson's Farm	<b>F</b>			200000.0	2.50	
Borrow Pit	Northern Quarry	1			150000.0	4.00	
Borrow Pit	Jackson's Quarry	P			50000.0	3.00	
Waste Site	Southern Dump	<b>v</b>			400000.0	0.75	
Haul Road	Farm Access	<b>1</b>					0.0
Haul Road	Hewthorn Highway	₩.					0.0
Haul Road	Eucalypt Road	P					0.0
Haul Road	Northern Haul	<b>v</b>					0.0
Haul Road	Quarry Access	1					0.0
Haul Road	Southern Haul	2					0.0

- 9. Expand Corridors and Main Rd in the Project Explorer.
- 10. Right-click on MH Analysis and select Refresh Mass Haul Analysis.

## **Archiving a Corridor Mass Haul Analysis**

Use the Archive Corridor Mass Haul command to manually archive a corridor mass haul analysis. When a mass haul plan is published to VisionLink, the corridor mass haul analysis is automatically archived. Archiving preserves the current corridor mass haul details and restricts the mass haul analysis to viewing only.

- 1. Expand Corridors and Main Rd in the Project Explorer.
- 2. Left-click on MH Analysis to selct it.



3. Select Mass Haul in the Archive area under the Corridor Mass Haul tab.

Note: In the project explorer there will be a MH Analyis [Date/Time] created that is now read-only.

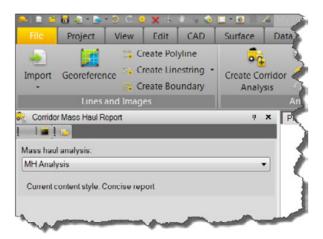


## **Running a Corridor Mass Haul Report**

- 1. Select the Corridor Mass Haul Report icon in the Reports area under the Corridor Mass Haul tab.
- 2. Select MH Analysis in the Mass haul analysis dropdown list.

Note: If you still have MH Analysis highlighted from the step before, you will not see this screen. The Report will automatically come up for the highlighted Mass Haul Analysis.

3. Select OK in the Corridor Mass Haul Report pane.



#### 4. Review the results in the Corridor Mass Haul Report.

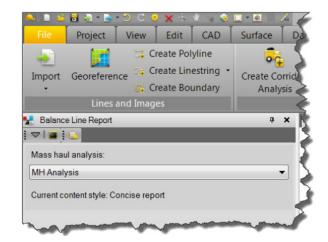
- The source section shows volumes of cut materials at station intervals along the corridor's alignment.
- The destination section shows volumes of material used for fill at station intervals.
- The haul cost is the price of hauling the specified volume of material from the earthworks site to the corridor or vice versa.
- The site cost is the price of material being used from the borrow site or being dumped at the waste site.
- The total cost is the combined price of haul plus site cost.

I Diagram: MH Analysis Start P				Report			
of 54 🕨 🔰 🍬 🎯 😂	10 AU M.• 75%	• Find	Next				
							1
	Item	Quantity (m*)	Haul Cost(\$)	Site Cost(\$)	Total Cost(S)		
	Export	20,000.0					
	Waste Total	353,628.7	2,767.23	265,221.56	267,988.79		
	Waste Usable	259,357.6					
	Waste Unusable	94,271.1					
	Haul Road Use				0.00		
	Plate Pload Ose				0.00		
	Mass Haul				7,407,612.12		
	Total Cost(\$)		4,486.30	617,797.60	8.029.896.01		
	Source						
	Station (m)	Rock (Bank Cut) (m*)	Sandy Fine Clay (Bank Cut) (m*)	Topsoil (Bank Cut) (m*)	Clay (Bank Cut) (m*)	Borrow (m*)	
	0+000.00	0.0	0.0	0.0	0.0	0.0	
	0+025.00	0.0	0.0	0.0	0.0	0.0	
	0+050.00	0.0	0.0	0.0	0.0	0.0	
	0+075.00	0.0	0.0	0.0	0.0	0.0	
	0+100.00	0.0	0.0	0.0	0.0	0.0	
	0+125.00	0.0	0.0	0.0	0.0	0.0	
	0+150.00	0.0	0.0	0.0	0.0	0.0	
	0+175.00	0.0	0.0	0.0	0.0	0.0	
	0+200.00	0.0	0.0	0.0	0.0	0.0	
	0+225.00	0.0	0.0	0.0	0.0	0.0	
	0+250.00	0.0	0.0	0.0	0.0	0.0	
			iii.				-

## **Running a Corridor Balance Line Report**

Run a Balance Line Report to capture the properties and details of a corridor mass haul's balance line. I recommend having the topic in the help section titled Understanding Balancing in a Corridor Mass Haul as a reference until comfortable with the terminology.

- 1. Select the Balance Line Report 🚺 icon in the Report area under the Corridor Mass Haul tab.
- 2. Select MH Analysis in the Mass haul analysis dropdown list.
- 3. Select OK in the Balance Line Report pane.



			Mass Haul Editor: MH A	malysis Corridor Ma	ss Haul Report Bala	ance Line Report							
1	of 15 🕨 🕅	+ 🛞 🔒 🗖	R - 75%	-	Find Next								
	Description:												
		Corridor	: Main Rd Ma	ass Haul: MH	Analysis								
	Balance Summ	nary											
	Range (m)	Total (m <sup>a</sup>	) Cross Haul (m <sup>a</sup> )	No Haul (m <sup>a</sup> )	Balance (m <sup>a</sup> )								
	Dozer-70.000	40	398.7 11,441.2	0.0	28,957.4								
	Excav ator/Off- Road Truck- 4000.000	1,435	.033.7 12,242.7	0.0	1,422,791.0								
	Balance Detail	Is											
	Symbol	Range (m)	Cut Station (m)	Fill Station (m)	Bank Cut (m <sup>a</sup> )	Import (m*)	Fill Required (m <sup>a</sup> )	Export (m <sup>#</sup> )	Total (m <sup>a</sup> )	Cross Haul (m*)	No Haul (m <sup>#</sup> )	Balance (m*)	Avg Distan (m)
	<=1	Dozer-70.000	0+545.31 - 0+525.00	0+525.00 - 0+475.31	1,267.6	0.0	1,134.3	0.0	1,134.3	655.0	0.0	479.2	46.
	<=1	Excav ator/Off- Road Truck- 4000.000	0+600.00 - 0+545.31	0+475.31 - 0+426.56	3,156.5	0.0	2,805.0	0.0	2,805.0	891.1	0.0	1,913.9	122.4
	Total ≺-1		0+600.00 - 0+525.00	0+525.00-0+426.56	4,424.1	0.0	3,939.3	0.0	3,939.3	1,546.1	0.0	2,393.2	107.
	<=2	Dozer-70.000	0+767.10 - 0+725.00	0+725.00 - 0+697.10	258.0	0.0	240.2	0.0	240.2	42.3	0.0	198.0	44./
	<=2	Excavator/Off- Road Truck- 4000.000	1+125.00 - 0+767.10	0+697.10-0+234.16	39,549.9	0.0	33,175.4	0.0	33,175.4	758.2	0.0	32,417.2	641.9
	Total <=2		1+125.00 - 0+725.00	0+725.00 - 0+234.16	39,807.9	0.0	33,415.7	0.0	33,415.7	800.5	0.0	32,615.2	638.
	<=3	Dozer-70.000	1+248.06 - 1+225.00	1+225.00 - 1+178.06	210.0	0.0	196.8	0.0	196.8	106.6	0.0	90.3	41.
	<13	Excav ator/Off- Road Truck- 4000.000	1+300.00 - 1+248.06	1+178.06 - 0+234.05	510.3	0.0	470.5	0.0	470.5	184.8	0.0	285.7	195.7
	Total ≺-3		1-300.00 - 1-225.00	1+225.00 - 0+234.05	720.3	0.0	667.3	0.0	667.3	291.4	0.0	375.9	158.0
	<=4	Dozer-70.000	1+446.17 - 1+400.00	1+400.00 - 1+376.17	2,052.9	0.0	1,800.7	0.0	1,800.7	538.3	0.0	1,262.4	46.1
	<=4	Excavator/Off- Road Truck- 4000.000	1+550.00 - 1+446.17	1+376.17 - 0+209.82	9,647.2	0.0	8,317.6	0.0	8,317.6	97.0	0.0	8,220.7	842.0
						0.0	10,118,4	0.0	10,118,4	635.3	0.0	9,483.1	736.

CHAPTER

## Drilling

## Welcome

Welcome to the Trimble<sup>®</sup> Business Center – Heavy Construction Edition (HCE) Drill Plan module. The Drill Plan module in Business Center - HCE incorporates tools and commands to prepare drill plans for drilling machines that are running Trimble<sup>®</sup> DPS900 Drilling and Piling System ("DPS900").

This guide was developed by Trimble Navigation's Global Services Training and Support staff to support classroom instruction delivered by a Trimble Certified Trainer. The Trimble Certified Trainer will use this guide to lead you through the Drill Plan module using real world exercises. Please use this guide in conjunction with the Business Center- HCE help files and other product resources available.

## **Overview**

Drill planning in Business Center - HCE enables you to create a variety of drill plans to send to DPS900, a Trimble drilling and piling system for road construction and pit mining. The drill plan helps the DPS900 machine operator navigate to holes (nearest, previous, next, or selected), and then guides him in drilling the holes at the planned orientation, inclination, and depth.

The commands available in the Drill Plan module can be divided into three categories: Drill Plans, Data Export, and Drill Plan Reporting.

We will start by ecamining the various automatic methods of creating a drill plan. Then a point file will be imported and a drill plan can be manually created from this data. After the drill plan is created it can be exported to a machine running DPS900. After the drilling has been carried out a drill plan quality file can be imported back into Business Center - HCE and a drill hole quality report can then be generated.

## **Learning Objectives**

- Create an automatic drill plan using a boundary
- Create an automatic drill plan using a corridor
- Create an automatic drill plan using a grid
- Create an automatic drill plan using a reference line
- Add a new drill hole to a drill plan
- Import point data containing drill plan designs
- Create a manual drill plan from imported data
- Export data to DPS900

• Generate a drill hole quality report

## **Drill Plan Definitions**

**Create a Drill Plan Based on a Boundary -** Use the Create Drill Plan command to create a gridded drill plan (drill hole pattern) within a boundary. Split holes are created (facing perpendicularly inward) along the boundary line and blast holes are created within the bounded area. The grid's columns are fixed, but the row spacing can use fixed or dynamic spacing (which adjusts the width between holes to avoid adding extra holes near or outside of the boundary). This drill plan type allows you to drill blast holes to a design surface or to a single benching elevation.

**Create a Drill Plan Based on a Corridor** - Use the Create Drill Plan command to create a gridded drill plan of blast holes along a corridor design. This type of drill plan can be constrained between a start and end station, and by a boundary. Corridor drill plans also support benching, which allows you to create successive ledges by drilling split holes one vertical level at a time. One set of drill holes is created for each bench.

**Create a Drill Plan Based on a Grid** - Use the Create Drill Plan command to create a drill plan based on an origin, design surface, rock surface, and a uniform spacing (rows and columns) of blast holes. This type of drill plan can be constrained by a boundary.

**Create a Drill Plan Based on a Reference Line** - Use the Create Drill Plan command to create a gridded drill plan of blast holes (and optionally split holes) along and offset from a reference line. This type of drill plan can be constrained between a start and end station, and by a boundary.

**Create a Drill Plan Manually** - Use the Create Manual Drill Plan command to create an empty drill plan to which you can add drill holes in preparation for sending the plan to a drilling machine running DPS900. In addition, you can create a Manual drill plan by importing a drill plan in an IREDES file, which you can then modify.

Add a Drill Hole to a Drill Plan - Use the Add Drill Hole to Drill Plan command to add one or more drill holes to an existing drill plan of any type. You can specify coordinates for each drill hole or you can create drill holes at the locations of existing objects, such as points. If you import a drill plan in an IREDES file, you can also add new drill holes to it.

**Export** - Export the drill plan as a Project Link file (.vcl) for use on a drilling machine running DPS900. You may also want to export a separate .vcl file (to be placed in the Design folder) containing reference linework of site features. A calibration (.dc) file may also need to be exported for the calibration of control.

**Run a Drill Hole Quality Report** - Use the Drill Hole Quality Report command to see a summary and details on pairs of drill holes; the holes in a drill plan (planned holes) as compared to their corresponding as-drilled holes. Each as-drilled hole that is reported on is qualified as passing, failing, or requiring action (based on the tolerances in Project Settings). The Drill Hole Quality Report is generated as a Microsoft<sup>®</sup> Excel spreadsheet.

## **Files Needed**

For the training exercises, each user should save the following files provided by your Certified Trainer onto their PC and note the location.

- Drill Plan.csv
- P,N,E,ELV Drill Plan Coordinates.csv
- Manual Drill Plan.vcl
- Manual Drill Plan.quality.xml

## **Creating Automatic Drill Plans**

After completing this section you will be able to:

- Create different types of drill plans in Business Center HCE
- Add individual drill holes to a drill plan

There are four automatic ways to create a drill plan in Business Center - HCE. These are boundary, corridor, grid, and line. The types of plans created will be shown in more detail in the individual sections.

#### **Boundary Plan**

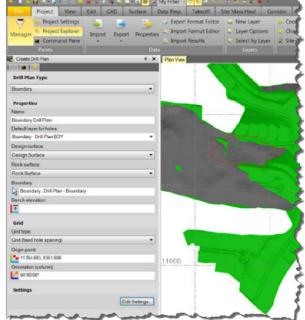
1. **Open the Drill Plan.vce file.** 



- 2. Select Drill Plan in the Drill Plans area under the Drill Plan tab.
- 3. Select Boundary in the Drill Plan Type drop-down list.
- 4. Enter Boundary Drill Plan in the Name cell.
- 5. Select Boundary Drill Plan BDY in the Default layer for holes drop-down list.
- 6. Select Design Surface in the Design surface drop-down list.
- 7. Select Rock Surface in the Rock surface drop-down list.
- 8. With the curser in the Boundary cell, left-click on the Red boundary line in the graphical view to select it.
- 9. Select Grid (fixed hole spacing) in the Grid type dropdown list.
- 10. With the cuser in the Origin point cell, left-click in the center of your boundary in the graphicial view.
- 11. Enter 90 into the Orientation (column) cell.

Note: You can also use the curser in the graphical view to set the Orientation (column) angle.





## 12. Select Edit Settings... in the Create Drill Plan pane.

Note: The edit settings dialog allows you to define the settings for the drill plan. This guide will not go into these settings in detail, as they are specific to each projects' requirements. Full details for all of these settings can also be found in the Business Center - HCE help files.

- 13. Enter 30 in the Hole length (display only) cell.
- 14. Enter 5 in the Minimum hole length cell.
- 15. Enter .5 in the Maximum distance above rock cell.
- 16. Select the Blast Holes tab in the Edit Drill Plan Settings window.

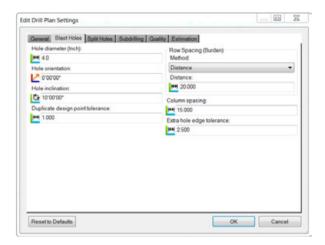
Note: The Blast Holes tab allows you to define the parameters of the blast holes. This includes diameter, orientation, inclination, duplicate tolerance, burden, spacing and edge tolerance.

- 17. Enter 4 in the Hole diameter (Inch) cell.
- 18. Enter 1 in the Duplicate design point tolerance cell.
- 19. Enter 20 in the Distance cell under Row Spacing (Burden).
- 20. Enter 15 in the Column spacing cell.
- 21. Enter 2.5 in the Extra hole edge tolerance cell.
- 22. Select the Split Holes tab in the Edit Drill Plan Settings window.

*Note: The Split Holes tab allows you to define the parameters of the split holes. This includes diameter, inclination, duplicate tolerance and spacing.* 

- 23. Enter 1 in the Duplicate design point tolerance cell.
- 24. Enter 10 in the Maximum hole spacing cell.

and the second s	Subdrilling Quality Estimation
	Hole length (display only):
	30.000
	Minimum hole length:
	<b>5.000</b>
	Maximum distance above rock:
	H++ 0.500



General Blast Holes Split Holes Su	bdniling Quality Estimation	
Hole diameter (Inch):	Maximum hole spacing	
HH 3.0	HH 10.000	
Hole inclination:	100 million (100 m	
10'00'00"		
Duplicate design point tolerance:		
HH 1.000		

25. Select the Subdrilling tab in the Edit Drill Plan Settings window.

Note: The Subdrilling tab allows you to define the Subdrilling parameters. These include settings to define how the subdrilling is calculated, and settings for the blast and split hole constants.

- 26. Left-click in the box in front of Include length percentage to add a checkmark.
- 27. Left-click in the box in front of Include split hole constant to add a checkmark.
- 28. Enter -2 in the Split hole constant: (usually negative) cell.

General Blast Holes Split Holes Subdrilling	Quality Estimation			
Include length percentage:	Include blast hole constant			
Length percentage:	Blasthole constant.			
5.00%	0.000			
Include factor of row spacing (burden):	Include split hole constant			
Factor of row spacing (burden):	Split hole constant (usually negative)			
0.3	HH -2.000			

29. Select the Quality tab in the Edit Drill Plan Settings window.

*Note: The Quality tab allows you to define the tolerances for the diameter and end points of the drill holes.* 

- 30. Select Distance in the Method drop-down list under Blast Hole End Point Tolerance.
- 31. Enter .5 in the 3D distance cell under Blast Hole End Point Tolerance.
- 32. Enter .5 in the 3D distance cell under Split Hole End Point Tolerance.

General Blast Holes Split Holes S Diameter tolerance: (Inch)	Blast Hole End Point Tolerance
144 0.5	Blast Hole End Point Tolerance Method
	Distance
	Factor of burden:
	0.1
	3D distance:
	0.500
	Split Hole End Point Tolerance
	3D distance:
	0.500

33. Select the Estimation tab in the Edit Drill Plan Settings window.

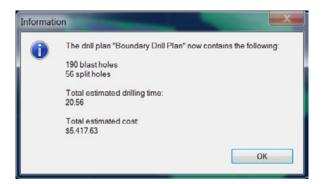
Note: The Estimation tab allows you to define time, cost and cost factor for the drilling job. The cost factor is the amount of down time between the actual drilling.

- 34. Enter 90 in the Blast hole rate: (ft/h) cell under Average Penetration Rate.
- 35. Enter 120 in the Split hole rate: (ft/h) cell under Average Penetration Rate.
- 36. Enter 225 in the Cost per hour (\$) cell under Cost.
- 37. Enter 1.15 in the Cost factor cell under Cost.
- 38. Select OK in the Edit Drill Plan Settings window.
- 39. Select OK

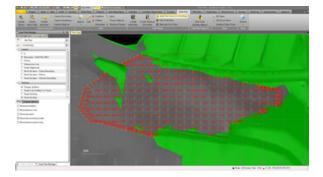
#### in the Create Drill Plan pane.

Note: A box similar to the one shown on the right will appear. Your values may be slightly different depending on where you clicked for the origin point.

second in the second second second second	iling Quality Estimation
Average Penetration Rate	Cost
Blasthole rate: (t/h)	Cost per hour (\$):
HH 90.000	225.00
Split hole rate: (t/h)	Cost factor:
H 120.000	1.150



40. Select OK in the Information window.



# 41. Select 3D View in the View area under the Drill Plan tab.

Note: You could also select the icon in the Quick Access Toolbar to create a 3D View.

Note: The boundary contains both cut and fill areas. In the fill areas no drill plan is created. The split holes are shown in red and the blast holes are shown in blue. You can see that the angles of the holes correspond to those chosen in the settings.

## 42. Turn off the Rock Surface in the View Filter Manager and zoom in on a group of holes.

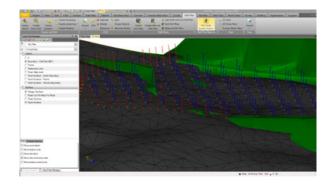
Note: You can see that where the minimum hole depth is met, the split holes end slightly above the design surface.

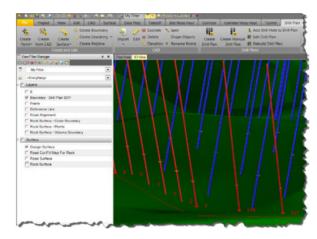
Note: The blast holes end beneath the design surface. This is because of the settings chosen when creating the drill plan.

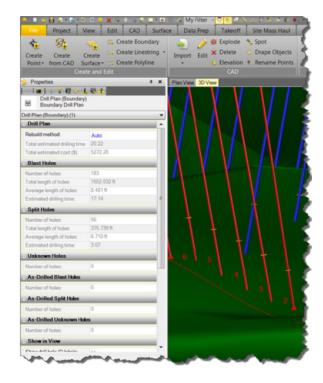
Note: The small orange marks on the drill holes show where the drill hole intersects the rock surface.

- 43. Expand the Drill Plans in the Project Explorer pane.
- 44. Right-click on Boundary Drill Plan in the Project Explorer pane and select Properties.

*Note: You can review the properties for the whoe Drill Plan.* 



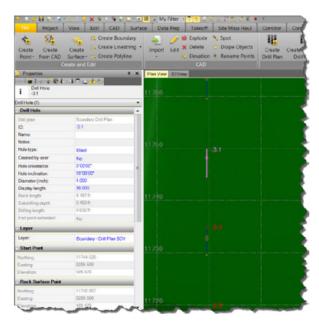




#### 45. Left-click on any hole in the Plan view.

*Note:* You can now see the properties of the selected hole.

Note: Depending on the distance between the rock surface, the design surface, and the minimum hole length setting; the software will extend drill holes so that they meet the minimum length specified. If the hole is extended it will be shown in the properties. If you do not want this to happen set the minimum length to Oin the settings tab.



46. Left-click on Boundary Drill Plan in the Project Explorer pane to select it and select **Edit Drill Plan** in the Drill Plans area under the Drill Plan tab.

*Note: You can also right-click on the Boundary Drill Plan in the Project Explorer pane and select Edit.* 

Note: This reopens the create drill plan dialog from earlier and you can change any settings.

47. Enter 480 in the Bench eleavtion cell in the Edit Drill Plan pane.



	Project	View	Edit	CAD	Surfac	ce Dat	a Prep	Takeoff
Create Point •	Create from CAD	Create Surface	: Cr	eate Bou eate Line eate Poly	string +	e Import	Edit ×	Explode Delete Elevation
		ireate and						CAD
Edit Dr					4 ×	Plan View	3D View	
1 🖬 🕴	•					1		
Drill Pla	in Type					11760		
Boundary	y				×			
Propert	ies							
Name:								
Boundary	y Drill Plan							
	yer for holes:					11750		
	- Drill Plan BC	Y						
Design s								
Design S	urface				-			
Rock sur	face:							
Rock Su	face				•	1		
Boundary						11740		
Boun	dary : Drill Pla	in - Bounda	iy .			11740		
Bench el	evation:							
+ 480								

#### 48. Select

OK

#### in the Edit Drill Plan pane.

Note: A box similar to the one shown on the right will appear. Your values may be slightly different depending on where you clicked for the origin point.

Informatio	on	1	X
	The drill plan "Drill Plan" now cont 111 blast holes 38 split holes Total estimated drilling time: 12:50 Total estimated cost \$3,322.26	ains the followi	ng:

#### 49. In the 3D view, Pan and Zoom around the site.

Note: A bench has been created at the 480.00 elevation.

Note: You can check the properties of the drill holes to see that the Design Point Elevations all now end above 480 which is the bench height.

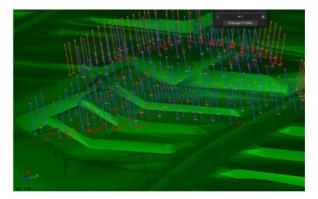
- 50. Select Save Project As under the File tab.
- 51. Name the file and select Save.
- 52. Select Close under the File tab.

#### Grid Plan

1. Open the Drill Plan.vce file.



2. Select Dull Plan in the Drill Plans area under the Drill Plan tab.



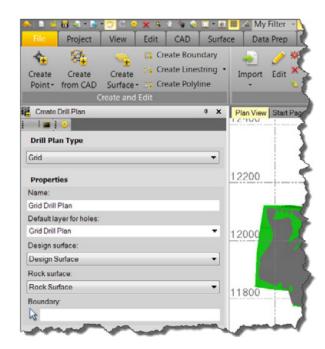
File Project Vie	w Edit CAD Surfac	e Data Prep Takeoff S	te Mass Haul Corridor Corridor Mass H
Point + from CAD Sur	Create Boundary	- Devition •	Drape Objects Create Create Manual Drill Plan Drill Plan
			Dell
raject Explorer	* *	Plan Vare	
Chill Plan Points Alignments Conitions Serfaces			

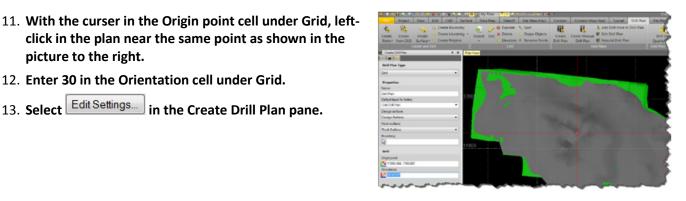
- 3. Select Grid from the Drill Plan Type drop-down list.
- 4. Enter Grid Drill Plan in the Name cell under Properties.
- 5. Select <<New Layer>> from the Default layer for holes drop-down list.
- 6. Enter Grid Drill Plan in the Layer name cell.
- OK 7. Select in the New Layer window.
- 8. Select Design Surface from the Design surface dropdown list.
- 9. Select Rock Surface from the Rock surface drop-down list.

click in the plan near the same point as shown in the

10. Ensure that the Boundary cell is blank.

picture to the right.





14. Enter 40 in the Hole length (display only) cell.

12. Enter 30 in the Orientation cell under Grid.

13. Select Edit Settings... in the Create Drill Plan pane.

- 15. Enter 10 in the Minimum hole length cell.
- 16. Enter .0 in the Maximum distance above rock cell.

Hole length (display only):
H+ 40.000
Minimum hole length:
H++ 10.000
Maximum distance above rock:
I++ 0.000

17. Select the Blast Holes tab in the Edit Drill Plan Settings window.

Note: The Blast Holes tab allows you to define the parameters of the blast holes. This includes diameter, orientation, inclination, duplicate tolerance, burden, spacing, and edge tolerance.

- 18. Enter 30 in the Hole orientation cell.
- 19. Enter 1 in the Duplicate design point tolerance cell.
- 20. Enter 20 in the Distance cell under Row Spacing (Burden).
- 21. Enter 15 in the Column spacing cell.
- 22. Enter 8 in the Rows behind cell.
- 23. Enter 5 in the Holes to the left cell.
- 24. Enter 10 in the Holes to the right cell.
- 25. Select the Subdrilling tab in the Edit Drill Plan Settings window.

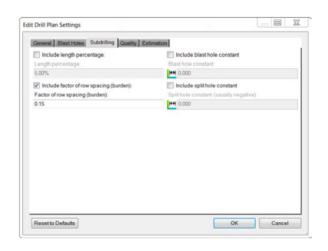
Note: The Subdrilling tab allows you to define the Subdrilling parameters. These include settings to define how the subdrilling is calculated and settings for the blast and split hole constants.

- 26. Left-click in the box in front of Include factor to row spacing (burden) to add a checkmark.
- 27. Enter .15 in the Factor of row spacing (burden) cell.
- 28. Select the Quality tab in the Edit Drill Plan Settings window.

*Note: The Quality tab allows you to define the tolerances for the diameter and end points of the drill holes.* 

- 29. Select Distance in the Method drop-down list under Blast Hole End Point Tolerance.
- 30. Enter 1 in the 3D distance cell under Blast Hole End Point Tolerance.
- 31. Enter 1 in the 3D distance cell under Split Hole End Point Tolerance.

Hole diameter (Inch):	Estimation Row Spacing (Burden)
HH 3.0	Method:
Hole orientation:	Distance
30'00'00"	Distance
Hole inclination:	H+4 20.000
10:00:00*	Column spacing:
Duplicate design point tolerance:	Here 15.000
HH 1.000	Rows ahead
	10
	Rows behind:
	8
	Holes to the left
	5
	Holes to the right
	10



Diameter tolerance: (Inch)	Blast Hole End Point Tolerance
MM 0.5	Method:
	Distance
	Factor of burden:
	0.1
	3D distance:
	1.000
	Split Hole End Point Tolerance
	3D distance:
	1.000

32. Select the Estimation tab in the Edit Drill Plan Settings window.

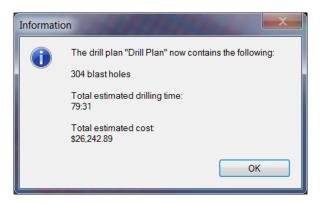
Note: The Estimation tab allows you to define time, cost and cost factor for the drilling job. The cost factor is the amount of down time between the actual drilling.

- 33. Enter 75 in the Blast hole rate: (ft/h) cell under Average Penetration Rate.
- 34. Enter 120 in the Split hole rate: (ft/h) cell under Average Penetration Rate.
- 35. Enter 275 in the Cost per hour (\$) cell under Cost.
- 36. Enter 1.2 in the Cost factor cell under Cost.
- 37. Select OK in the Edit Drill Plan Settings window.
- 38. Select OK

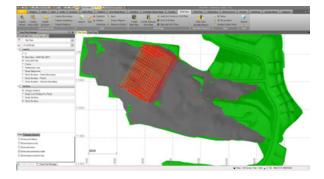
#### in the Create Drill Plan pane.

Note: A box similar to the one shown on the right will appear. Your values may be slightly different depending on where you clicked for the origin point.

General Blast Holes Subdrilling Quality	Canada
Average Penetration Rate	Cost
Blast hole rate: (ħħ)	Cost per hour (\$):
HH 75.000	275.00
Split hole rate: (ft/h)	Cost factor.
HH 120.000	1.200



39. Select OK in the Information window.



40. Select 3D View in the View area under the Drill Plan tab.

Note: You could also select the icon in the Quick Access Toolbar to create a 3D View.

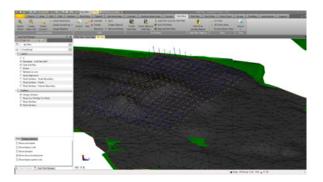
*Note:* You can check the properties of the drill holes like we did earlier in the module.

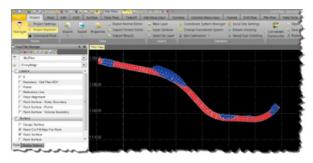
- 41. Select Save Project As under the File tab.
- 42. Name the file and select Save.
- 43. Select Close under the File tab.

#### **Corridor** Plan

- 1. **Open the Drill Plan.vce file.**
- 2. Turn off all Layers and Surfaces in the View Filter Manager except Road Cut Fill Map for Rock surface and Road Surface surface.

Note: You can clearly see were drilling is required from the Road Cut Fill Map For Rock surface.



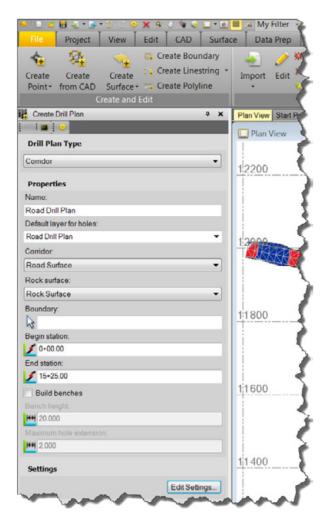




3. Select Drill Plan in the Drill Plans area under the Drill Plan tab.

	Project	View	Edit	CAD	Surface	Det	Pres	1	iteatt	Site Mass Haul	Corridor	Corridor Mass
Create Point-		Create Surface-	.0	reate Bourn reate Lines reate Polyli	ning *	import	/ Lait	* D	plode elete evation		Create DHII Plan	Create Manual Drill Plan
Project E					* x	Plea Ve	- 1					
Post Pa								1				
Maga	narits							1				
Conid Serie												
	il Mapu											

- 4. Select Corridor from the Drill Plan Type drop-down list.
- 5. Enter Road Drill Plan in the Name cell under Properties.
- 6. Select <<New Layer>> from the Default layer for holes drop-down list.
- 7. Enter Road Drill Plan in the Layer name cell.
- 8. Select OK in the New Layer window.
- 9. Select Road Surface from the Corridor drop-down list.
- 10. Select Rock Surface from the Rock surface drop-down list.
- 11. Leave the Begin and End stations on the default settings.
- 12. Ensure that the box in front of Build Benches is unchecked.
- 13. Select Edit Settings... in the Create Drill Plan pane.



- 14. Enter 25 in the Hole length (display only) cell.
- 15. Enter 5 in the Minimum hole length cell.
- 16. Enter .0 in the Maximum distance above rock cell.

General Blast Holes Split Holes S	ubdrilling Quality Estimation
	Hole length (display only):
	25.000
	Minimum hole length:
	HH 5.000
	Maximum distance above rock:
	0.000
	Maximum top bench height (factor)
	1
	OK Cancel

17. Select the Blast Holes tab in the Edit Drill Plan Settings window.

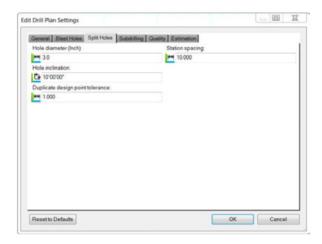
Note: The Blast Holes tab allows you to define the parameters of the blast holes. This includes diameter, orientation, inclination, duplicate tolerance, burden, spacing and edge tolerance.

- 18. Enter 4 in the Hole diameter (Inch) cell.
- 19. Enter 1 in the Duplicate design point tolerance cell.
- 20. Enter 20 in the Distance cell under Row Spacing (Burden).
- 21. Enter 15 in the Maximum hole spacing cell.
- 22. Enter 2.5 in the Extra hole edge tolerance cell.
- 23. Select the Split Holes tab in the Edit Drill Plan Settings window.

*Note: The Split Holes tab allows you to define the parameters of the split holes. This includes diameter, inclination, duplicate tolerance, and spacing.* 

- 24. Enter 1 in the Duplicate design point tolerance cell.
- 25. Enter 10 in the Station spacing cell.

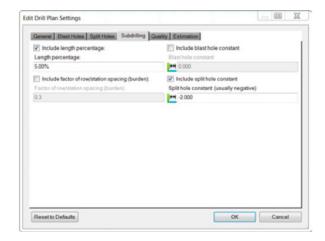
Spacing method. Station spacing and hole spacing				
Row/Station Spacing (Burden)				
Method:				
Distance				
Distance:				
HH 20.000				
Maximum hole spacing				
HH 15.000				
Extra hole edge tolerance:				
HH 2.500				



## 26. Select the Subdrilling tab in the Edit Drill Plan Settings window.

Note: The Subdrilling tab allows you to define the Subdrilling parameters. These include settings to define how the subdrilling is calculated, and settings for the blast and split hole constants.

- 27. Left-click in the box in front of Include length percentate to add a checkmark.
- 28. Enter 5 in the Length percentage cell.
- 29. Left-click in the box in front of Include split hole constant to add a checkmark.
- 30. Enter -2 in the Split hole constant (usually negative) cell.



31. Select the Quality tab in the Edit Drill Plan Settings window.

*Note: The Quality tab allows you to define the tolerances for the diameter and end points of the drill holes.* 

- 32. Select Distance in the Method drop-down list under Blast Hole End Point Tolerance.
- 33. Enter .5 in the 3D distance cell under Blast Hole End Point Tolerance.
- 34. Enter .5 in the 3D distance cell under Split Hole End Point Tolerance.
- 35. Select the Estimation tab in the Edit Drill Plan Settings window.

*Note: The Estimation tab allows you to define time, cost, and cost factor for the drilling job. The cost factor is the amount of down time between the actual drilling.* 

- 36. Enter 90 in the Blast hole rate: (ft/h) cell under Average Penetration Rate.
- 37. Enter 120 in the Split hole rate: (ft/h) cell under Average Penetration Rate.
- 38. Enter 250 in the Cost per hour (\$) cell under Cost.
- 39. Enter 1.2 in the Cost factor cell under Cost.
- 40. Select OK in the Edit Drill Plan Settings window.

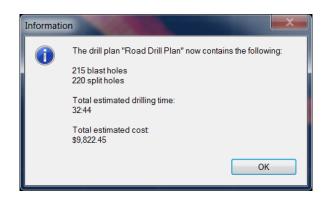
41. Select OK

in the Create Drill Plan pane.

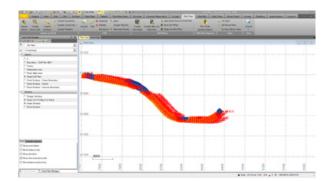
Note: A box similar to the one shown on the right will appear.

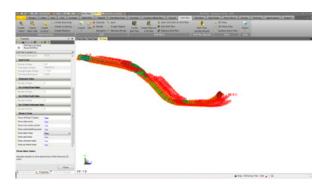
General Blast Holes Split Holes Subdrilling Qu	ony Estmation
Diameter tolerance: (Inch)	Blast Hole End Point Tolerance
HH 0.5	Method
	Distance •
	Factor of burden:
	0.1
	3D distance:
	0.500
	Split Hole End Point Tolerance
	3D distance:
	0.500

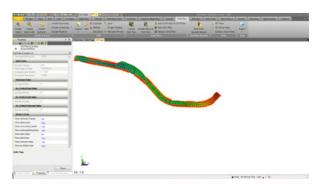
Average Penetration Rate Blast hole rate: (f(h)	Cost Cost per hour (\$):
HH 90.000	250.00
Split hole rate: (t/h)	Cost factor.
120.000	1.200



42. Select OK in the Information window.







43. Select 3D View in the View area under the Drill Plan tab.

Note: You could also select the select the select icon in the Quick Access Toolbar to create a 3D View.

*Note:* You can check the properties of the drill holes like we did earlier in the module.

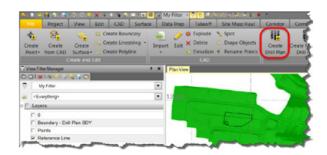
- 44. Expand Drill Plans in the Project Explorer pane.
- 45. Right-click on Road Drill Plan and select Properties.
- 46. Select No in the Show drill hole ID labels under Show in View, in the Properties pane.
- 47. Select No in the Show blast holes under Show in View, in the Properties pane.
- 48. Select Save Project As under the File tab.
- 49. Name the file and select Save.
- 50. Select Close under the File tab.

#### **Reference Line Plan**

- 1. **Open the Drill Plan.vce file.**
- 2. Turn off all Layers and Surfaces in the View Filter Manager except for Reference Line layer and Design Surface.



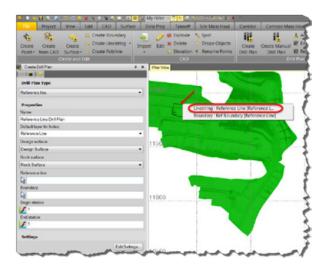
3. Select Drill Plan in the Drill Plans area under the Drill Plan tab.

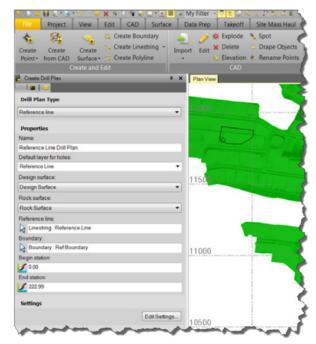


- 4. Select Reference line in the Drill Plan Type drop-down list.
- 5. Enter Reference Line Drill Plan in the Name cell.
- 6. Select Reference Line in the Default layer for holes drop-down list.
- 7. Select Design Surface in the Design surface drop-down list.
- 8. Select Rock Surface in the Rock surface drop-down list.
- 9. With the curser in the Reference line cell, left-click on the Linestring: Reference Line.
- 10. With the curser in the Bounday cell, left-click on the Boundary: Ref Boundary.

Note: If you left-click on the upper part of the Boundary like the step before, you will have to choose the Boundary: Ref Boundary. If you left-click anywhere else on the boundary, it will just be entered into the cell.

- 11. Leave the Begin and End stations on their default settings.
- 12. Select Edit Settings... in the Create Drill Plan pane.





ngth (display only): 300 mole length 30 m distance above rock: 30
00 Im distance above rock:
00 Im distance above rock:
20

- 13. Enter 35 in the Hole length (display only) cell.
- 14. Enter 8 in the Minimum hole length cell.
- 15. Enter 0 in the Maximum distance above rock cell.

16. Select the Blast Holes tab in the Edit Drill Plan Settings window.

Note: The Blast Holes tab allows you to define the parameters of the blast holes. This includes diameter, orientation, inclination, duplicate tolerance, burden, spacing and edge tolerance.

- 17. Enter 4 in the Hole diameter (Inch) cell.
- 18. Enter 0 in the Hole inclination cell.
- 19. Enter 1 in the Duplicate design point tolerance cell.
- 20. Enter 20 in the Distance cell under Row Spacing (Burden).
- 21. Enter 15 in the Spacing along lines cell.
- 22. Enter 0 in the Offset lines to the left cell.
- 23. Enter 150 in the Offset lines to the right cell.
- 24. Enter 1 in the Segment end point tolerance cell.
- 25. Select the Split Holes tab in the Edit Drill Plan Settings window.

Note: The Split Holes tab allows you to define the parameters of the split holes. This includes diameter, inclination, duplicate tolerance, and spacing.

- 26. Left-click on the box next to Build split holes to add a checkmark.
- 27. Ensure that the box next to Use blast hole setting under Hole inclination is unchecked.
- 28. Enter 10 in the Hole inclination cell.
- 29. Enter 1 in the Duplicate design point tolerance cell.
- 30. Enter 10 in the Spacing along lines cell.

General Blast Holes Split Holes Subdrillin	Granty Composition
Hole diameter (Inch):	Offset Spacing (Burden)
4.0	Method
Hole direction:	Distance
Right	<ul> <li>Distance:</li> </ul>
Hole inclination:	HH 20.000
C 00000*	Spacing along lines:
Duplicate design point tolerance:	Here 15.000
1.000	Offset lines to the left
	0
	Offset lines to the right
	150
	Segment end point tolerance:
	1.000

Build split holes     Build blast holes on reference line	
Hole diameter (Inch):	Spacing along lines:
HH 30	H++ 10.000
Hole direction: (same as blasthole setting)	Segment end point tolerance:
Right	✓ Use blast hole setting
Hole inclination:	HH 1.000
C+ 10'00'00"	
Duplicate design point tolerance:	
HH 1.000	

31. Select the Subdrilling tab in the Edit Drill Plan Settings window.

Note: The Subdrilling tab allows you to define the Subdrilling parameters. These include settings to define how the subdrilling is calculated, and settings for the blast and split hole constants.

- 32. Left-click in the box in front of Include split hole constant to add a checkmark.
- 33. Enter 10 in the Length percentage cell.
- 34. Left-click in the box in front of Include split hole constant to add a checkmark.
- 35. Enter -5 in the Split hole constant (usually negative) cell.
- 36. Select the Quality tab in the Edit Drill Plan Settings window.

*Note: The Quality tab allows you to define the tolerances for the diameter and end points of the drill holes.* 

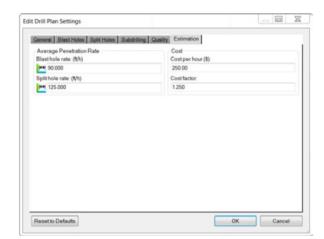
- 37. Select Distance in the Method drop-down list under Blast Hole End Point Tolerance.
- 38. Enter 1 in the 3D distance cell under Blast Hole End Point Tolerance.
- **39. Enter 1 in the 3D distance cell under Split Hole End Point Tolerance.**
- 40. Select the Estimation tab in the Edit Drill Plan Settings window.

*Note: The Estimation tab allows you to define time, cost, and cost factor for the drilling job. The cost factor is the amount of down time between the actual drilling.* 

- 41. Enter 90 in the Blast hole rate: (ft/h) cell under Average Penetration Rate.
- 42. Enter 125 in the Split hole rate: (ft/h) cell under Average Penetration Rate.
- 43. Enter 250 in the Cost per hour (\$) cell under Cost.
- 44. Enter 1.25 in the Cost factor cell under Cost.
- 45. Select OK in the Edit Drill Plan Settings window.

Contraction of the second	Quality Estimation
Include length percentage: Length percentage:	Include blast hole constant Blast hole constant
10.00% Include factor of offset spacing (burden): Factor of offset spacing (burden) 0.3	Implies         0.000           Include split hole constant         Split hole constant (usually negative)           Implies         5.000
	_

General Blast Holes Split Holes S Diameter tolerance: (Inch)	
In 0.5	Blast Hole End Point Tolerance Method:
	Distance
	Factor of burden.
	0.1
	3D distance:
	1.000
	Split Hole End Point Tolerance
	3D distance:
	1.000



- 46. Select OK
  - in the Create Drill Plan pane.

*Note:* A box similar to the one shown on the right will appear.

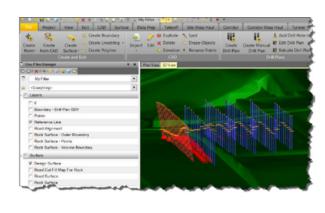
Informati	ion	23
	The drill plan "Reference Line Drill Plan" now contains the fi	ollowing
•	67 blast holes 23 split holes	
	Total estimated drilling time: 18:20	
	Total estimated cost \$5,731.54	
		ОК

47. Select 3D View in the View area under the Drill Plan tab.

Note: You could also select the icon in the Quick Access Toolbar to create a 3D View.

Note: You can see how the split holes were created along the reference line, with the blast holes then extending to the boundary.

48. Select Add Drill Hole to Drill Plan in the Drill Plans area under the Drill Plan tab.



4	22	-	📮 Create Bou		- A		Explode			- 884	11 (	L Add Dell Hole to Drill Pla
Create	Create	Create	. Orate Lee	ating - 1	mport 6	et *	Delete		Drape Objects	Create	Create Manual	E EDE DIS PAR
Point+	from CAD	Surface-	Create Poly	ine .			Devation	٠	Rename Points	Drill Man	Delt Plan	Rebuild Dell Plan

- 49. Select Reference Line Drill Plan in the Drill plan dropdown list.
- 50. Select Blast in the Hole type drop-down list.
- 51. Enter New Holes in the Name cell.
- 52. Leave the Display length, Hole diameter (Inch), Orientation, and Inclination at their default values.

Note: The length hole diameter, orientation, and inclination for the drill holes are automatically populated by the defaults specified in the settings.

53. Left-click on Select objects under Method to Add Holes to select it.

Note: This option bases drill holes on existing points. The drill hole's end points will be based on the point's coordinates.

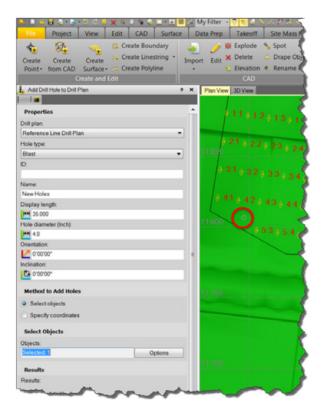
54. With the curser in the Objects cell, left-click on the point in the bottom left corner of the boundary in the Plan View.

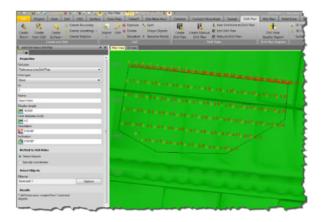
*Note: Each object you pick must have an elevation for the drill hole to be created properly.* 

55. Select Add in the Add Drill Hole to Drill Plan pane.

Note: The new drill hole named 1 will be visible. If it is not, right click on the drill plan in the Project Exporer and select Rebuild Drill Plan.

- 56. Select Save Project As under the File tab.
- 57. Name the file and select Save.
- 58. Select Close under the File tab.





### Import, create, export, and comparison

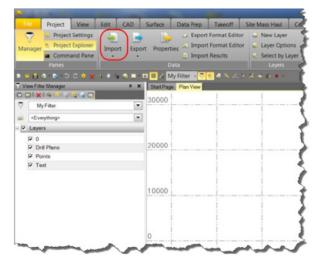
After completing this section, you will be able to:

- Import a text file containing design hole information
- Create a manual drill plan
- Export a drill plan to DPS900
- Import the as-drilled data from DPS900
- Generate a drill hole quality report

This workflow will demonstrate how to import, create, export and compare drill plan data. The import/export/comparison tools can also be used with any of the automatic drill plans created in the first section.

#### Importing text data

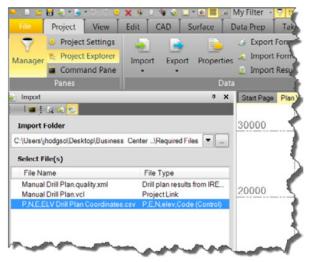
- 1. Open Business Center HCE and start a new project.
- 2. Select the template for US Survey Foot.
- 3. Select the Import icon in the Data area under the Project Tab.



- 4. Left-click on P,N,E,ELV Drill Plan Coordinates.csv in the Import pane to highlight it.
- 5. Select Import in the Import pane.

*Note: You could also drag and drop the file into the graphical view to import the file.* 

*Note: The Import Format Editor box will appear because this is standard text data.* 



6. Left-click on P,N,E, elev, Code (Unknown) to highlight it.

*Note: The preview area will show how the data will be read.* 

7. Select Next> in the Import Format Editor window.

Select definition.							
Select a definition from the list You can also manage the list							
Definition Name	Enabled	Extension	Store Point As	Show Editor	-	New	
New Import	R.	216	Pueros	F			
P.E.N.elev,Code (Control	₩.	CSV	Points	p		Copy	
P.E.N.elev,Code (Unkno	P.	CSV	Points R		100	Fiename	
P,L,L,h,Code (Globel)	P .	CSV	Points	p		Fiename	
P.L.L.h.Code (Locel)	P	C97	Points	R		Delete	
P.N.E.elev,Code (Control	P .	COV	Points	F			
P.N.E. elev, Code (Unkno	P	C91	Puerte	P			
Print Cleard		***	Priete	5			
Civily show onebied definitions				Fiestore All			
Tester			Nexts I bread	I Fast	10	Cracel	
Test 44 C subseniugs hard Deckrop (P. A. E. I	ELV Drill Plan Coordinate		Next> Impor	Fast		Cancel Ined File	1
C UsersgelwitDestop/F.X.E.I spot Passier		6.67Y			1	load File	
Collectings function from the Electron Provider Provider Provider Provider Provider Provide Pr	Nothing	Easting	Elevation			load File	
Collectings function from the Electron Provider Provider Provider Provider Provider Provide Pr		6.67Y			1	load File	
C Dentigeller/Desktop/P.A.E.I report Preview Point M	Nothing 381.006	E cov Easting £1 063	Elevation 100 000		1	load File	
C Ubergysher Desktop/F Jr. E. rpot Powier Powiel 00 01	Nothing 381 006 378 178	Easting 61 263 63 291	Elevation 120 000 100 000		1	load File	
C UsersgehartDecktop/P.J.(E.) post Peak M 900 0.1 0.2	Nothing 381 006 378 179 375 348	Easting 61.063 63.091 96.720	Elevation 100 000 100 000		1	load File	
C (Decenge Net Decktop) P.A.E.1 pat Power Power 00 01 02 0-1	Nothing 361.006 378.170 325.348 363.834	Easting 6:007 Easting 6:063 6:3391 6:720 58:235	Elevation 100 000 100 000 100 000 100 000		1	load File	
C (Joerngelwitzerkreit) A.C.1 spat Preview Poal M 00 01 02 0-1 0-2	Nothing 381:008 378:178 305:348 383:834 383:834 306:663	Easting 6:007 Easting 6:063 6:3391 6:720 58:235	Elevation 100 000 100 000 100 000 100 000		1	load File	
C (Joseph Jack Contrapt P A), E ( part Preside Prival M 00 01 02 0-3 0-2 0-2 b Verse	Nothing 301.006 338.178 305.348 303.834 306.663	Easting 6:007 Easting 6:063 6:3391 6:720 58:235	Elevation 100 000 100 000 100 000 100 000		1	load File	
C. Liberingsheir Deskrap P. A.E. I geget Pensiee Poart M 0.1 0.2 0.3 0.3 0.3 0.3 0.3 0.3 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4	Nothing 301.006 378.178 305.548 303.834 306.663 7.000, 1.000,	Easting 6:007 Easting 6:063 6:3391 6:720 58:235	Elevation 100 000 100 000 100 000 100 000		1	load File	
C (Uneregrade Poster) (C (Uneregrade Poster) Post M 0 0 0 0 0 0 0 0 0 0 0 0 0	Nothing 381,006 378,178 375,548 383,834 365,663 1,000, 1,000, 1,000,	Easting 6:007 Easting 6:063 6:3391 6:720 58:235	Elevation 100 000 100 000 100 000 100 000		1	load File	

- 8. Left-click on Deliminated next to Type to select it.
- 9. Select Next> in the Import Format Editor window.

	r - P,N,E,einv,Code (Unknown)						Ħ
Description and Search							
Enter a description to	r this definition and select form	ot of the fields					
Description (optional)	PINE elev.Code (Unknown)						
Type	@ Delented OF and Witth O Search for Text (advanced O Regular Expression (advan						
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- 10. Left-click on the box next to Import as grid only points, which can be moved or elevated, but do not transform with coordinate system changes to add a checkmark.
- 11. Select Import in the Import Format Editor window.

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12. Select Yes in the Save Changes wi	ndow. Save Changes
Note: This will allow the definition change.	Definition has changed. Save changes after import? Yes No Cancel
13. Select OK in the Project Definition Note: There should now be a grid of points vis graphics window.	The false origin values in the projection definition will be
<ol> <li>Select Close in the Import pane.</li> <li>Left-click on a point to select it.</li> <li>Right-click in the graphical view and select Provide Note: Notice that the elevation is 100.00.</li> </ol>	False northing: 381.006 ft False easting: 61.063 ft

## Creating a manual drill plan



1. Select Drill Plan in the Drill Plans area under the Drill Plan tab.

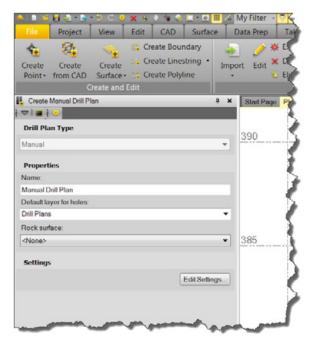
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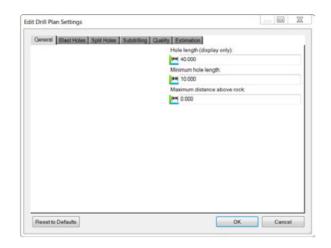
- 2. Enter Manual Drill Plan in the Name cell.
- 3. Select Drill Plans in the Defaul Layer for holes dropdown list.
- 4. Select <None> in the Rock surface drop-down list.

Note: For this example we will assume that this design is 40ft below the previous bench.

5. Select Edit Settings... in the Create Manual Drill Plan pane.



- 6. Enter 40 in the Hole length (display only) cell.
- 7. Enter 10 in the Minimum hole length cell.
- 8. Enter 0 in the Maximum distance above rock cell.



# 9. Select the Blast Holes tab in the Edit Drill Plan Settings window.

Note: The Blast Holes tab allows you to define the parameters of the blast holes. This includes diameter, orientation, inclination, duplicate tolerance, burden, spacing and edge tolerance.

10. Enter 4 in the Hole diameter (Inch) cell.

General Blast Holes Split Holes Subdrilling Quality Estimation	n	
Hole diameter (Inch):		
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Hole inclination:		
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11. Select the Split Holes tab in the Edit Drill Plan Settings window.

Note: The Split Holes tab allows you to define the parameters of the split holes. This includes diameter, inclination, duplicate tolerance, and spacing.

12. Enter 1 in the Duplicate design point tolerance cell.

	Holes Subdrilling Quality Es	timation	
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Hole orientation:			
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Hole inclination:			
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Duplicate design point toler	ance:		
H++ 1.000			

13. Select the Subdrilling tab in the Edit Drill Plan Settings window.

Note: The Subdrilling tab allows you to define the Subdrilling parameters. These include settings to define how the subdrilling is calculated, and settings for the blast and split hole constants.

- 14. Left-click in the box in front of Include blast hole constant to add a checkmark.
- 15. Enter 2 in the Blast hole constant cell.
- 16. Left-click in the box in front of Include split hole constant to add a checkmark.
- 17. Enter -1 in the Split hole constant (usually negative) cell.
- 18. Select the Quality tab in the Edit Drill Plan Settings window.

*Note: The Quality tab allows you to define the tolerances for the diameter and end points of the drill holes.* 

- 19. Enter 1 in the 3D distance cell under Blast Hole End Point Tolerance.
- 20. Enter 1 in the 3D distance cell under Split Hole End Point Tolerance.

Contractory and a second second	9 Quality Estimation
Include length percentage: Length percentage 5.00%	Include blast hole constant Blast hole constant
	Include split hole constant         Split hole constant (usually negative)         HH         -5.000

	ubdnilling Quality Estimation
Diameter tolerance: (Inch)	Blast Hole End Point Tolerance
HH 0.5	3D distance:
	1.000
	Split Hole End Point Tolerance
	3D distance:
	H++ 1.000

21. Select the Estimation tab in the Edit Drill Plan Settings window.

*Note: The Estimation tab allows you to define time, cost, and cost factor for the drilling job. The cost factor is the amount of down time between the actual drilling.* 

- 22. Enter 75 in the Blast hole rate: (ft/h) cell under Average Penetration Rate.
- 23. Enter 100 in the Split hole rate: (ft/h) cell under Average Penetration Rate.
- 24. Enter 275 in the Cost per hour (\$) cell under Cost.
- 25. Enter 1.2 in the Cost factor cell under Cost.
- 26. Select OK in the Edit Drill Plan Settings window.
- 27. Select OK in the Create Manual Drill Plan pane.
- 28. Enter Drill Hole in the Name cell.
- 29. Left-click on Select Objects under Method to Add Holes to select it.
- 30. With the curser in the Objects cell, select all the points in the plan view.

*Note:* You can select all the points by drawing a box around them.

31. Select Add in the Add Drill Hole to Drill Plan pane.

Note: The manual drill plans are created in two stages. The first stage is creating the empty "placeholder" for the drill plan, and then the opjects are added to the drill plan.

*Note: Notice that the hole settings entered in the previous section have been carried though to this dialog.* 

32. Select Close in the Add Drill Hole to Drill Plan pane.

General Blast Holes Split Holes Subd	ing Quality Estimation
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33. Select 3D View in the View area under the Drill Plan tab.

Note: You could also select the icon in the Quick Access Toolbar to create a 3D View.

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- 34. In the 3D view rotate the view until the drill holes look like this.
- 35. Select the top row of holes.

Note: You can do this by dragging a box around them.

36. Right-click in the graphical view and select properties.

*Note: You will notice that the drill hole properties are not visible.* 

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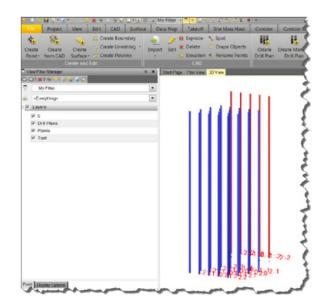
- 37. Left-click the drop down next to All (10) and select Drill Hole.
- 38. Select Split in the Hole type drop-down list.
- **39. Select Close in the Properties pane.**

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#### 40. Pan and zoom in the 3D view.

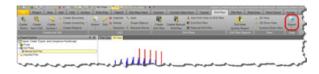
*Note: See how the row of split holes now end 7ft above the blast holes.* 

Note: The reason they appear to extend upwards more is that there is no rock surface to intersect with and the display length has been set to 40ft.



### Exporting a drill plan to DPS900

1. Expand Drill Plans in the Project Explore pane and leftclick on Manaual Drill Plan to highlight it.





2. Select in the Data area under the Drill Plan tab.

- 3. Left-click on the Construction tab in the Export pane.
- 4. Left-click on DPS Drill Plan Exporter to highlight it.
- 5. Select Manual Drill Plan in the Drill Plan drop-down list.
- 6. Ensure the box to Export all planned holes is checked.
- 7. Enter Manual Drill Plan in the File Name cell.

Note: Selecting the icon lets you choose which folder to save to.

- 8. Select Export in the Export pane.
- 9. Select Save Project As under the File tab.
- 10. Name the file and select Save.
- 11. Select Close under the File tab.

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Carrying out a quality report

- 1. Open Business Center HCE and start a new project.
- 2. Select the template for US Survey Foot.
- 3. Select the Import icon in the Data area under the Project Tab.

Note: You can also select the Import icon from the Quick Access Toolbar.

4. Left-click on the Manual Drill Plan.vcl file to highlight it and select Import.

Note: You may have to use the button to select the folder where the Manual Drill Plan.vcl file is saved on your PC.

*Note: This is the drill plan that was exported in the previous exercise.* 

5. Left-click on the Manual Drill Plan.quality.xml file to

highlight it and select

Note: You may have to use the button to select the folder where the Manual Drill Plan.quality.xml file is saved on your PC.

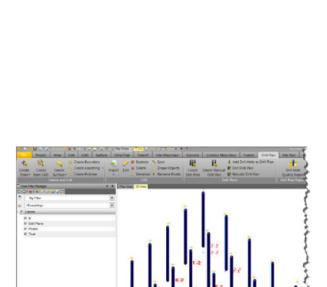
*Note: This is the as drilled data, which is created in by the DPS900.* 

- 6. Select Close in the Import pane.
- 7. Select 3D View in the View area under the Drill Plan tab.

Note: You could also select the icon in the Quick Access Toolbar to create a 3D View.

Note: The design data is shown in dark blue and the as drilled is shown in light blue by default. To change these colors go to the Project Tab and click on Project Settings. The drill plan color settings can be found under Computations and Drill Plan.

Note: This is also where the default settings for each drill plan can be changed.



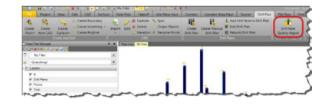
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9

Create



- 8. Select Quality Report in the Drill Plan Reports area under the Drill Plan tab.
- 9. Select Manaul Drill Plan in the Drill plan drop-down list.
- 10. Select All holes in the As-drilled holes to include dropdown list.



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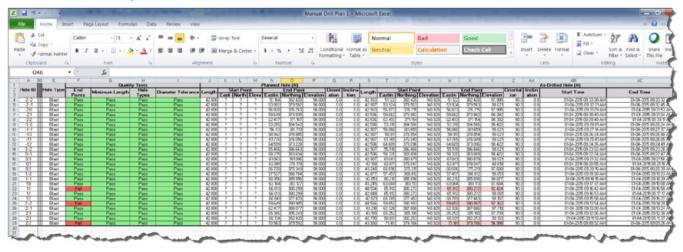
11. Select OK in the Drill Hole Quality Report pane.

Note: This will generate a Microsoft Excel report.

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Number of holes drilled	25	_
fotal drilling length	1126.100	ft
Average length of as-drilled	45.044	ft
Average penetration rate	6734.153	ft/h

#### 12. Left-click on the Hole Data tab.

Note: This will show the information for the individual holes. It also includes the Pass/Fail based on the drill plans quality settings, the planned hole information, the as drilled hole information, the delta values between the two, and the error vector.



CHAPTER

## Piling

## Welcome

Welcome to the Trimble<sup>®</sup> Business Center – Heavy Construction Edition (HCE) Pile Plan module. The Pile Plan module in Business Center - HCE incorporates tools and commands to prepare pile plans for piling machines that are running Trimble<sup>®</sup> DPS900 Drilling and Piling System ("DPS900").

This guide was developed by Trimble Navigation's Global Services Training and Support staff to support classroom instruction delivered by a Trimble Certified Trainer. The Trimble Certified Trainer will use this guide to lead you through the Pile Plan module using real world exercises. Please use this guide in conjunction with the Business Center- HCE help files and other product resources available.

## Overview

Pile planning in Business Center - HCE enables you to create a variety of pile plans to send to DPS900, a Trimble drilling and piling system for road construction and pit mining. The pile plan helps the DPS900 machine operator navigate to piles (nearest, previous, next, or selected), and then guides him in piling the holes at the planned orientation, inclination, and depth.

The commands available in the Pile Plan module can be divided into three categories: Pile Plans, Data Export, and Pile Reporting.

You will start by defining a pile type, and a pile plan will be created from imported point data. The pile plan will then be edited and exported to a machine running DPS900. After the piling has been carried out a pile plan quality file can be imported back into Business Center – HCE, and a piling quality report can then be generated.

## **Learning Objectives**

- Create a pile type
- Create a pile plan
- Create a single pile to add to the pile plan
- Create piles from imported points to add to the pile plan
- Edit the names of created piles
- Export the data to DPS900
- Generate a piling quality report

## **Pile Plan Definitions**

**Manage Pile Types** - Use the Manage Pile Types command to create, edit, and delete various types of piles. These types can then be applied to specific piles when you create pile plans.

**Create a Pile Plan** - Use the Create Pile Plan command to create an empty pile plan to which you can add piles in preparation for sending the plan to a piling machine running DPS900. The pile plan shows the DPS operator what type of pile to load, and where and how to embed it.

**Create a Pile** - After you have created pile types and a pile plan, use the Create Pile command to create individual piles for the plan.

**Create Piles at Points** - Use the Create Piles at Points command to quickly create piles at the locations of imported points.

Rename Piles - Use the Change Pile ID command to change the names of individual piles based on text labels.

**Export Pile Plan Files** - Use the DPS Pile Plan exporter (.vcl) to create a pile plan file for use on piling machines running DPS900.

**Import Pile Plan Results Files** - Import pile plan results files (.xml) to bring as-built pile data in from a piling machine running DPS900 in the field. Then you can run a Blow Count Report and/or a Piling Quality Report.

**Run a Blow Count Report** - Use the Blow Count Report command to report on the number of hammer blows (blow count) that were required to embed each as-built pile (in a pile plan) to its required embedment. Knowing the blow count for each embedded pile is crucial for assuring the quality of the as-built piles.

**Run a Piling Quality Report** - Use the Piling Quality Report command to see a summary and details on pairs of piles. The holes in a pile plan are compared to their corresponding as-built piles. Each as-built pile that is reported is qualified as passing, failing, or requiring action (based on the tolerances in Project Settings). The Piling Quality Report is generated as a Microsoft<sup>®</sup> Excel spreadsheet.

**Rebuild a Pile Plan** - Use the Rebuild Pile Plan command to update a pile plan after it has been changed in the field (e.g., you have deleted piles, such as a spliced pile) or if you imported as-built pile results prior to importing a pile plan.

## **Files Needed**

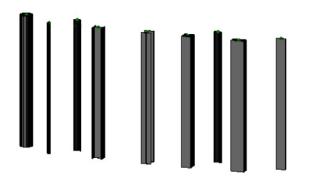
For the training exercises, each user should save the following files provided by your Certified Trainer onto their PC and note the location.

- Pile Plan.csv
- As Built Piles.zip or As Built Piles "folder"

## **Creating a Pile Type**

This project is an example of a solar farm piling job and the types of piles you can create are based on parameters for these cross-sectional shapes:

- Cylinder
- Sheet
- H
- 1
- Square
- Rectangle
- Custom (solid)
- Custom (hollow/open)



- 1. Open Business Center HCE and start a new project.
- 2. Select the template for US Survey Foot.



- 3. Select Pile Types in the Piling Plans area under the Pile Plan tab.
- New in the Manage Pile Types pane. 4. Select

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- 5. Enter H Pile in the Name cell.
- 6. Enter 13.450' in the Pile length cell.
- 7. Enter Steel in the Material name cell.
- 8. Select Elevation from the Piling method drop-down list.

Note: The available piling types are:

*Friction* - Select this if the pile type is to be embedded where there is no rock strata to stop the pile from deeper embedment. 'Friction piles' are counted in the Blow Count Report.

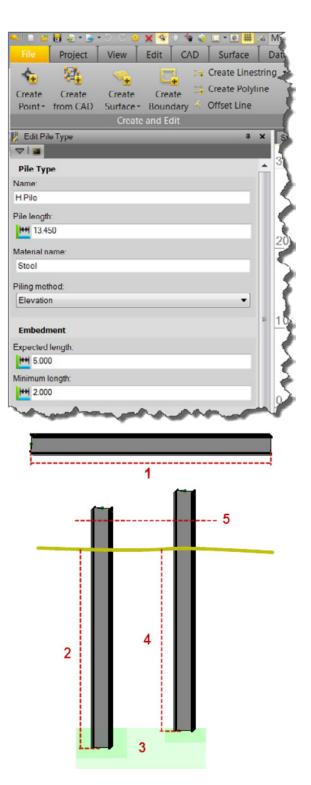
**End-point** - Select this if the pile type is to be embedded where there is rock strata that will stop the pile from deeper embedment.

**Elevation** - Select this if the pile type is to be embedded until it reaches a certain depth (such as in solar farm where panels are to be attached to the top of the piles at a consistent elevation). Only 'elevation piles' use the 3D positional tolerance specified in Project Settings > Computations > Piling and reported in the Piling Quality Report.

- 9. Enter 5' in the Expected length cell under Embedment.
- 10. Enter 2' in the Minimum length cell under Embedment.

Note: The diagram on the right shows what measurements Business Center is looking for in the edit pile type dialog, where:

- 1. Pile length
- 2. Expected embedment length
- 3. Valid embedment
- 4. Minimum embedment length
- 5. Cut-off length



#### 11. Select H from the Cross-section type drop-down list.

Note: The shape section allows you to define the cross sectional parameters of the pile type. More details on how these are defined for more complex pile types can be found in the Business Center – HCE help files.

- 12. Enter 5.8 in the Width (Inch) cell under Shape.
- 13. Enter 3.8 in the Height (Inch) cell under Shape.
- 14. Leave the Target blows cell and Interval distance cell at defaults under Blow Count Requirements.

*Note: In this exercise we are using elevation piles and the Blow Count Requirements information is not used.* 

- 15. Enter 600 in the Pile penetration rate (ft/h) cell under Estimation Factors.
- 16. Enter 25 in the Charge out rate (\$/ft) cell under Estimation Factors.
- 17. Enter 75 in the Machine cost (\$/h) cell under Estimation Factors.
- 18. Enter 5 in the Fuel cost (\$/h) cell under Estimation Factors.
- 19. Enter 30 in the Operator cost (\$/h) cell under Estimation Factors.
- 20. Enter .02 in the Navigation time per pile (h) cell under Estimation Factors.
- 21. Enter 1.2 in the Efficiency factor cell under Estimation Factors.

Note: The Estimation Factors parameters are used to set up estimating for the site. Here you can set the rates, times, and costs for the piling job. There is also an efficiency factor, which is used to account for machine downtime.

Note: The estimation factors shown here give a rough indication of costs to demonstrate how Business Center – HCE calculates estimations and are not necessarily representative of real world values.

- 22. Select OK in the Edit Pile Type pane.
- 23. Select Close
- in the Manage Pile Types pane.

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## **Creating a Pile Plan**

In this exercise, we will create an empty pile plan to contain our piles, which we will create in the second part of this exercise.

Create

- 1. Select Pile Plan in the Piling Plans area under the Pile Plan tab.
- 2. Enter Pile Plan in the Plan name cell.
- 3. Select <<New Layer>> in the Layer drop-down list.
- 4. Enter Pile Plan in the Layer name cell in the New Layer window.
- 5. Select OK in the New Layer window.
- 6. Leave the Inclimation tolerance cell, 2D positional tolerance cell, and the 3D positional tolerance cell at defaults under Quality Tolerances.
- 7. Select OK in the Create Pile Plan pane.

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## **Creating piles from points**

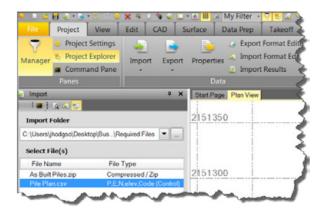
Now we will add piles to the pile plan



- 1. Select in the Data area under the Project tab.
- 2. Left-click on the Pile Plan.csv file to highlight it select.

Note: You may have to use the button to select the folder where the Office Park.pdf file is saved on your PC.

3. Select Import in the Import pane.



- 4. Left-click on the P,N,E,elev, code (unknown) to select it under Definition Name in the Import Format Editor window.
- 5. Select Import in the Import Format Editor window.

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- 6. Enter 0 in both the False northing cell and the False easting cells in the Project Definition window.
- 7. Select OK in the Projection Definition window.
- 8. Select Close in the Import pane.

Projection Definition
The false origin values in the projection definition will be automatically updated using grid point '9437'.
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- Select A Points in the Piling Plans area under the Pile Plan tab.
- 10. Select Pile Plan in the Pile plan cell.

*Note: If you want to add a manufacturer ID or comment, these can be added.* 

#### 11. Enter 90 in the Axial rotation (spin) cell.

Note: This specifies the angle to which the pile should be turned on its vertical axis. Positive rotation is clockwise and 0 is due east. For the pile's inclination, specify an Orientation angle and an Inclination angle.

12. Ensure that there is not a checkmark in the box in front of the Use Pre-bore Definition.



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#### 13. Select all the imported points.

Note: This can be done by either doing a window select or by clicking on the options and choosing select all.

- 14. Select H Pile from the Pile type drop-down list.
- 15. Select Do not create a pile under Duplicate Point Names.
- 16. Select Do not create a pile under Missing Cut-off Elevation.
- 17. Select Apply in the Create Piles at Points pane.

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#### 18. Select Close

in the Create Piles at Points pane.

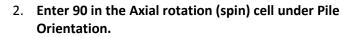
Note: The upper left pile has not been created. This is because that point had no elevation and was skipped due to the settings we chose in the create piles from points dialog. In the next exercise we will add this pile manually.

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## **Creating individual piles**



1. Select **Pile** in the Piling Plans area under the Pile Plan tab.



Note: You will notice that the first part of the dialog looks the same as for the Create Piles at Points command.

3. Enter 9437 in the Pile ID cell.

Note: In this example, we do not have CAD text to use to automatically label the Pile ID, so we had to type 9437 into the Pile ID cell.

- 4. With the curser in the Origin cell under Location, leftclick on the point without a pile in the upper left corner of the pile plan.
- 5. Enter 202.610 in the Cut-off elevation cell under Location.
- 6. Select Apply in the Create Pile pane.

Note: These values came from the original .csv which was altered to demonstrate the manual pile creation tool. The elevation and pile ID would normally need to be found from plans.

7. Select Close in the Create Pile pane.

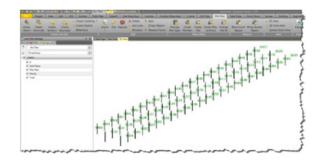
## **Exporting to DPS900**

At this stage in the tutorial you have created a pile type, created a pile plan placeholder, imported points, created piles at these points, and manually created the missing pile.

1. Select Select Select in the View area under the Pile Plan tab.

Note: You could also select the **select** icon in the Quick Access Toolbar to create a 3D View.

Note: You can zoom, pan, and rotate to view the created piles.



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- 2. Select \_\_\_\_\_ in the Data area under the Pile Plan tab.
- 3. Select the Construction tab under File Format.
- 4. Left-click on DPS Pile Plan exporter to highlight it.
- 5. Select Pile Plan in the Pile plan drop-down list.
- 6. Ensure that there is a Checkmark in the box for Export all planned piles.

Note: If you only wanted to export some of the piles, you would uncheck this box and select the piles manually in the graphics window.

- 7. Enter Pile Plan in the File Name cell.
- 8. Select in the Export pane.

Note: This will bring up a Save As window.

Select the location you would like to save the file and select Save.

*Note: You can save it to your folder with the training data for the Piling Chapter.* 

- 10. Select Export in the Export pane, to export the pile plan to DPS900.
- 11. Select File and select Save Project As.
- 12. Name your file and select save.
- 13. Select File and select Close.

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## **Compare As Built**

For this exercise, we will import the as built piling data from DPS900 to compare it to our pile plan.

- 1. Open Business Center HCE and start a new project.
- 2. Select the template for US Survey Foot.
  - -
- 3. Select in the Data area under the Project tab.
- 4. Highlight the Pile Plan.vcl file created in the previous exercise and select Import.

Note: You may have to use the button to select the folder where the Office Park.pdf file is saved on your PC

Note: You can also import the file by dragging and dropping it into the graphics window.

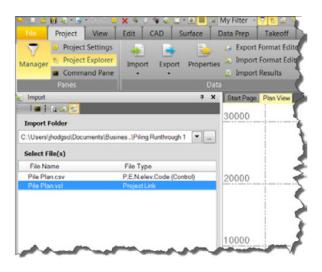
- 5. Select Import in the Import pane.
- 6. Select Close in the Import pane.
- 7. Using Windows Explorer open the folder called As Built Piles.

*Note: This is one of the provided files. If it was provided in a .zip format you will have to extract the file first.* 

*Note: In this folder is the as built information for each of the 72 piles stored as .xml files.* 

- 8. Use the Windows hotkey Ctrl+A to select all the .xml files.
- 9. Drag and drop the select files into the Business Center - HCE graphical view.

Note: The import bar will flash for each file that is imported. Once the import is complete, the as built piling data will be overlaid onto the pile plan.

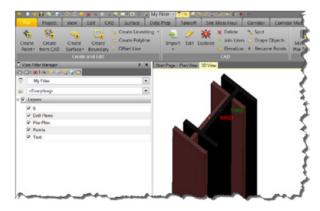


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10. Select **3D** View in the View area under the Pile Plan tab.

Note: You could also select the icon in the Quick Access Toolbar to create a 3D View.

11. Zoom and Pan into some of the piles to visually inspect them.





- 12. Select Report in the Report area under the Pile Plan tab.
- 13. Leave the Reference baseline cell blank.
- 14. Ensure that both Restrict to selected piles and Override project settings do not have checkmarks in their boxes.
- 15. Select OK

in the Piling Quality Report pane.

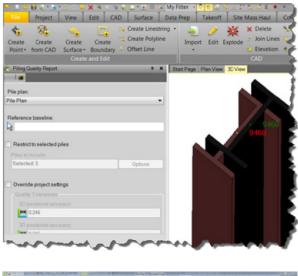
Note: This will generate a Microsoft Excel based report and will launch Excel where it will be possible to view the report.

Note: The report has tabs for Summary, Estimation Properties, Pile Types, and Quality Metrics.

#### 16. Select the Quality Metrics tab in Excel.

Note: The Pass and Fails are color coded to easily see.

Note: In this tutorial we have used elevation piling data, so we cannot run a Blow Count Report. However, in a project with .xml data from a friction piling job the procedure for running the Blow Count Report is the same as for the Piling quality Report. More information on the Blow Count Report can be found in the Business Center help files.



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