

[CLASS ID]

Realizing the Value of Your Civil Infrastructure Models Using Property Set Styles

Bill Neuhauser, P.E.

McKnight & Asc. Inc. (Nome, AK and Detroit Lakes, MN)

Learning Objectives

- What are Property Sets
- What are Automatic and Manual Property Sets
- What are Schedules and how do we use them with Property Sets
- How do we export a Schedule to Excel

Description

With the introduction of Property Set Styles into Civil 3D software, users can benefit quickly with enhanced object specification, dynamic object labeling, and rich data export into the world of BIM (Building Information Modeling) using Navisworks Manage software and InfraWorks software. From concept proposal to detailed design to construction management, Autodesk products have made it easier than ever for engineers and designers do their job of delivering projects using improved CAD and BIM workflows. This session will look at the specific workflows that will encourage any AutoCAD Civil 3D user to adopt property sets into daily design and construction management workflows. The session will look at key workflows for data extraction, project visualization, preconstruction analysis, progress tracking, and ultimately, as-built data collection (asset management).

Speaker

Bill Neuhauser, PE, is a civil engineer for McKnight & Asc. Inc. out of Nome, Alaska and Detroit Lakes, Minnesota. Prior to this, he worked for USCAD and Managed Design, Inc. out of Edina, MN for 14 years as a Civil Application engineer. Before this, taught civil techs at a college, and prior to that worked for a few North Dakota and Minnesota civil consulting firms for about 10 years as an Civil engineer, CADD guy, CADD manager, and supervisor (better known as a jack-of-all-trades). He was also one of the first AutoCAD® Civil 3D® ICE certified experts. Past and current software's DCA, Softdesk®, LDT, C3D and now Infracworks. Also, a partner in a drone services company as their engineer/UAV Pilot.

Speakers

- William Neuhauser, P.E. McKnight & Asc. Inc.

Property Sets, Schedules and Quantities.

One of our biggest tasks as civil engineers and technicians is quantities. Up until now anything that is not in C.Y. is pretty much a very tedious and time-consuming manual add up in Civil 3D. What we Civil 3D users have not known about is some well-hidden commands when brought together can help with this process. Property Sets and Schedules have been in the Architecture/Mechanical realm for years and up until now not really discussed and organized to help the Civil community. So just what are they and how can they help us? We'll go thru how to create property sets.

Just what are Property sets?

[Taken directly from the Autodesk Knowledge page]

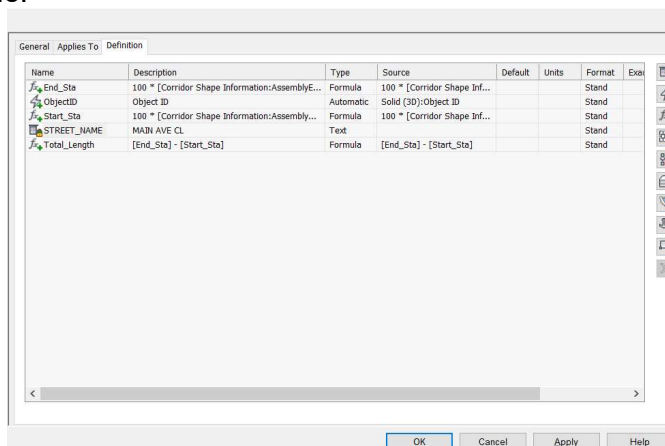
<https://knowledge.autodesk.com/support/autocad-architecture/learn-explore/caas/CloudHelp/cloudhelp/2018/ENU/AutoCAD-Architecture/files/GUID-3034E3CE-1745-4703-B2BE-43986515DC29-htm.html>

The data reported in a schedule table is collected from property sets that you attach to the objects or object styles you are scheduling. The properties contained in a property set are determined by the property set definition, which also specifies the object type, style, and definition to which the property set can be applied.

Note: If you are using both AutoCAD Architecture and AutoCAD MEP, locks may appear on some property set definitions and property definitions when you open legacy engineering drawings. Data that is programmatically set cannot be modified and is protected and identified by locks:

- selections on the Applies To tab and names for property set definitions
- anything that affects the value of underlying data and names for property definitions

A property set definition is a group of related properties of the objects and object styles to be reported in the schedule. Once attached to an object or its style, a property set becomes the container for the property data associated with the object. Values for properties are obtained directly from the object or are entered manually for the object or the style.



Automatic and Manual Properties

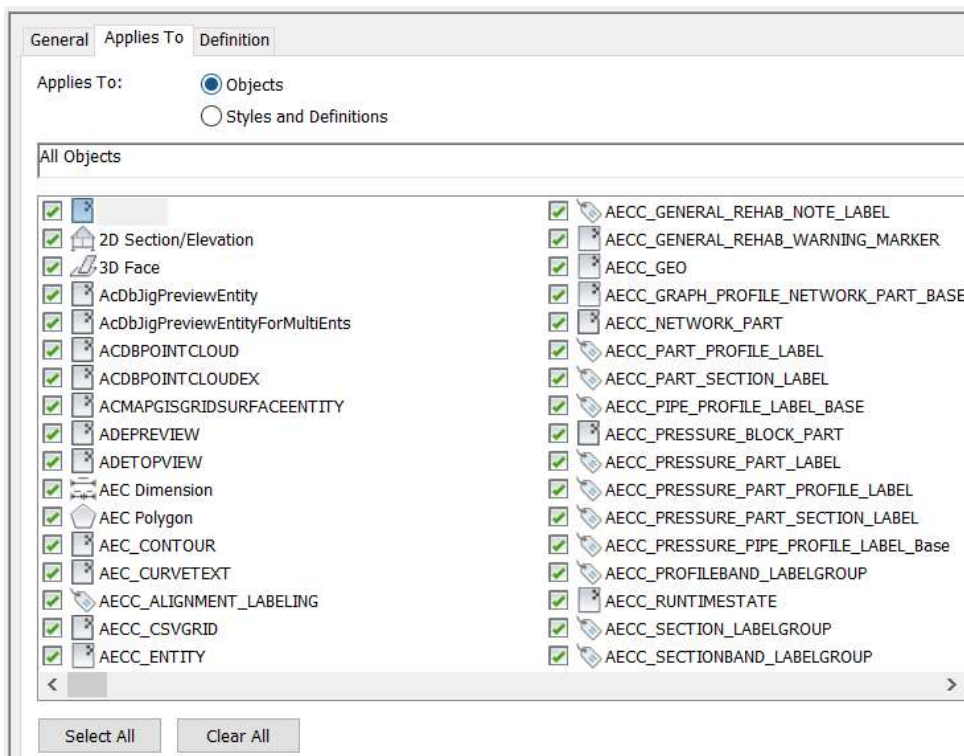
Properties for AEC object types fall into two categories:

- Automatic properties are built into objects and styles when you create the object. Examples are width, length, height, and data retrieved from other sources, such as the project or the object's material.
- Manual properties are those that you enter explicitly, such as fire rating, manufacturer, or finish.

Automatic properties are available to include in your property set definitions. You create and enter values for manual properties.

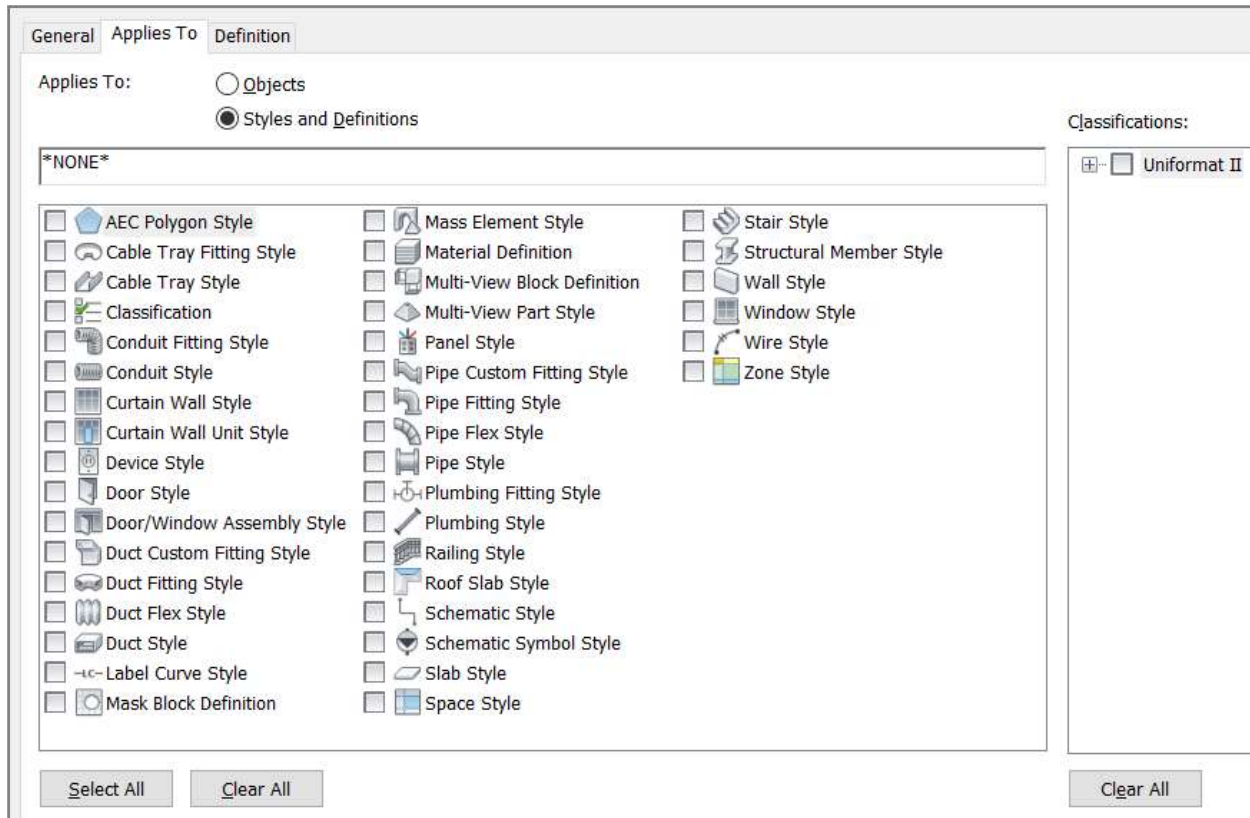
Applying Property Set Definitions to Objects and Styles

You can create a property set definition for either objects or styles and definitions (like multi-view block definitions). Manual properties that are likely to be different for each instance of an object belong in an object-based property set definition that is applied by object.



Property set definition that applies to door objects

Manual properties that will be the same for all instances of a style belong in a style-based property set definition that is applied to a style (such as a wall style) or a definition (such as a multi-view block definition).



Property set definition that applies to multi-view block definition

Automatic properties are dynamically retrieved from the object. Most automatic properties should be put in a style-based property set definition, even if values may vary for each instance of the object. For example, the properties “Door Width” and “Door Height” are extracted automatically from door objects. Placing these properties in a style-based property set definition provides a value for each door object of that style and is more efficient than putting them in an object-based property set definition that you then attach to each door.

Note: A mismatch of data can occur if, after you create a schedule table with property set data added, you change from an object-based property set definition to a style-based definition. To correct this, remove the property sets and update the schedule table.

Fields in Property Set Data

You can enter AutoCAD fields in a manual property field pointing to a drawing using a hyperlink in a manual property, and create a schedule table that contains that property, you can jump from the table cell with the field property in it to the drawing to which it is linked attached to an object or style. Fields enhance the documentation capabilities within a drawing file because the values they display update whenever the associated property changes. Fields can also be associated with hyperlinks. For example, if you insert a Lists in Property Set Data.

List items are created in a list definition and are attached to a manual property definition. With a predefined list of valid items, you can select an item from the list for a manual property either in

the property set definition or on the Extended Data tab of the Properties palette. This reduces the redundancy of entering values that are commonly used.

Predefined Content for Schedules

There are predefined styles and properties for schedule table tools, schedule tag tools, and property set definitions provided with the software. The tools are located on the Scheduling tool palette in the Document tool palette set, and the property set definitions are in Style Manager under Documentation Objects. (Only in ADT and MDT)

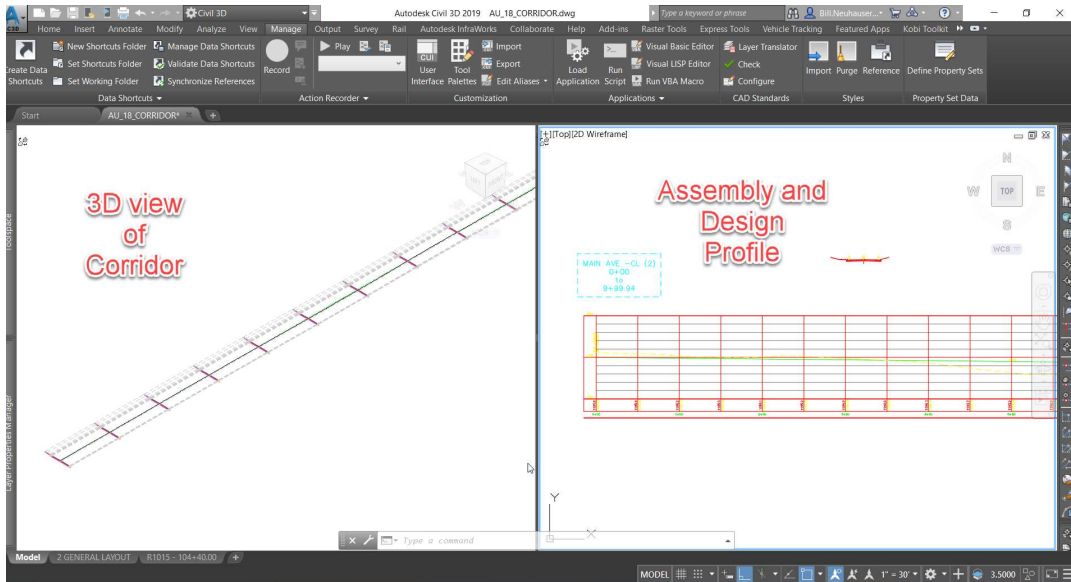
<http://blog.civil3dreminders.com/2016/03/freaking-context-values.html>

SCHEDULES

Schedules are tables you can insert in drawings to list information about selected objects in your building model. Objects are made up of properties that contain data. Schedule tags provide an efficient tool of collecting the property data attached to the objects for display in a schedule table. You can create schedules with varying levels of detail by defining and attaching sets of properties to object styles or to individual objects and then extracting and displaying the data in a schedule table.

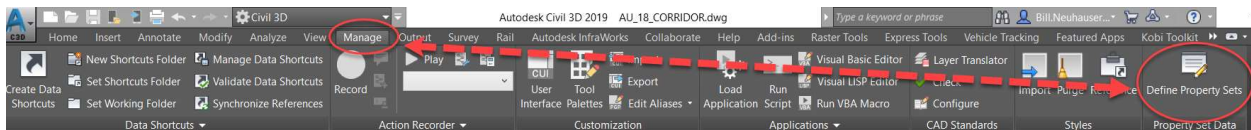
3D SOLIDS=2		SHT	STREET	LAYER	ALIGN	BEG STA	END	CODE	P
MAIN AVE	1			Q3-3D -Base	MAIN AVE - CL (3)	0+00.00	5+00.00	Base	1
MAIN AVE	1				MAIN AVE - CL (3)	0+00.00	5+00.00		1
MAIN AVE	1			Q3-3D -Curb	MAIN AVE - CL (3)	0+00.00	5+00.00	Curb	1
MAIN AVE	1				MAIN AVE - CL (3)	0+00.00	5+00.00		1
MAIN AVE	1			Q3-3D -Pave1	MAIN AVE - CL (3)	0+00.00	5+00.00	Pave1	1
MAIN AVE	1				MAIN AVE - CL (3)	0+00.00	5+00.00		1
MAIN AVE	1			Q3-3D -Pave2	MAIN AVE - CL (3)	0+00.00	5+00.00	Pave2	1
MAIN AVE	1				MAIN AVE - CL (3)	0+00.00	5+00.00		1
MAIN AVE	1			Q3-3D -Sidewalk	MAIN AVE - CL (3)	0+00.00	5+00.00	Sidewalk	1
MAIN AVE	1				MAIN AVE - CL (3)	0+00.00	5+00.00		1
MAIN AVE	1				MAIN AVE - CL (3)	0+00.00	5+00.00		1
MAIN AVE	1				MAIN AVE - CL (3)	0+00.00	5+00.00		1
MAIN AVE	1				MAIN AVE - CL (3)	0+00.00	5+00.00		1
MAIN AVE	1			Q3-3D -SubBase	MAIN AVE - CL (3)	0+00.00	5+00.00	SubBase	1
MAIN AVE	1				MAIN AVE - CL (3)	0+00.00	5+00.00		1
MAIN AVE	1				MAIN AVE - CL (3)	0+00.00	5+00.00		1
MAIN AVE	1				MAIN AVE - CL (3)	0+00.00	5+00.00		1
	1			Q3-3D -Top_Daylight_Daylight_Cut_Datum				Topsoil	1
	1			Q3-3D -Top_Ditch_Datum				Topsoil	1
	1			Q3-3D -Top_Slope_Link_Datum				Topsoil	1
MAIN AVE	2			Q3-3D -Base	MAIN AVE - CL (3)	5+00.00	10+37.83	Base	1
MAIN AVE	2				MAIN AVE - CL (3)	5+00.00	10+37.83		1
MAIN AVE	2			Q3-3D -Curb	MAIN AVE - CL (3)	5+00.00	10+37.83	Curb	1
MAIN AVE	2				MAIN AVE - CL (3)	5+00.00	10+37.83		1

You can produce basic schedule tables using the default tools provided with the software. Before you perform more complex tasks such as creating your own schedule tables, classifications, or working with formulas in your project, it is important to understand how property data, property sets, and property set definitions interact.

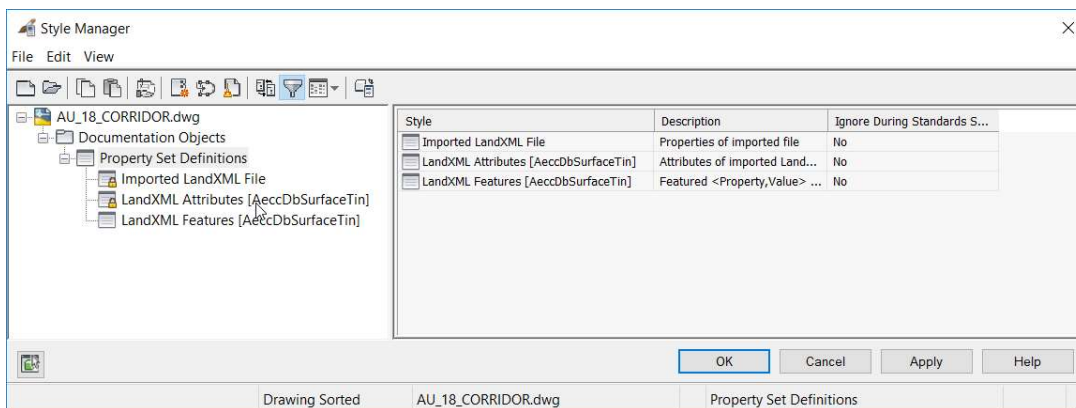


Now that we have covered the technical jargon lets create a few Property Sets. In the above drawing we will start with a basic corridor and a few lines, polylines and hatch patterns, this to mimic a simple plan layout. Our goal here is to extract into a table the quantities we would require for an engineer’s estimate. We are going to focus on how we would extract out items like L.F. of curb removal, S.Y of asphalt removal and S.F. of sidewalk placement. Some very common project bid items that we all have spent hours and hours adding up.

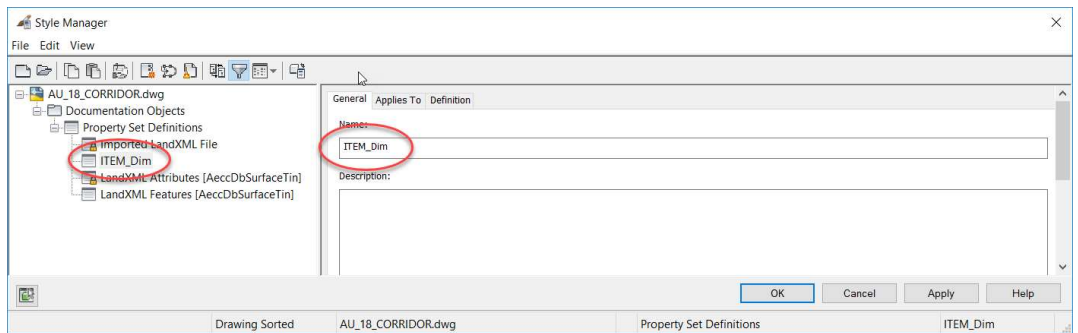
Sample Project data set.



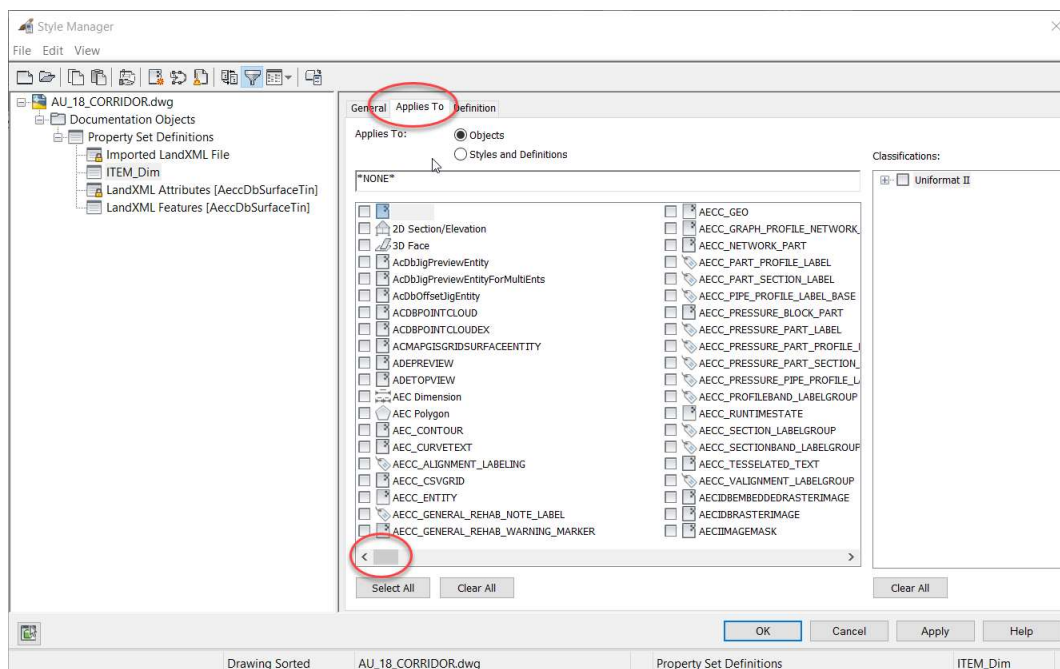
- 1.) We will first start by creating a few Property Sets. While in Civil 3D will go to the “Managed” ribbon and then on the far-right side we’ll choose the “Define Property Sets” button.



This is where we will create our new “Property Sets” (PS). Right click on the Property Set Definition and choose “New”. Highlight “New” and call it “Item_Dim” as shown here.



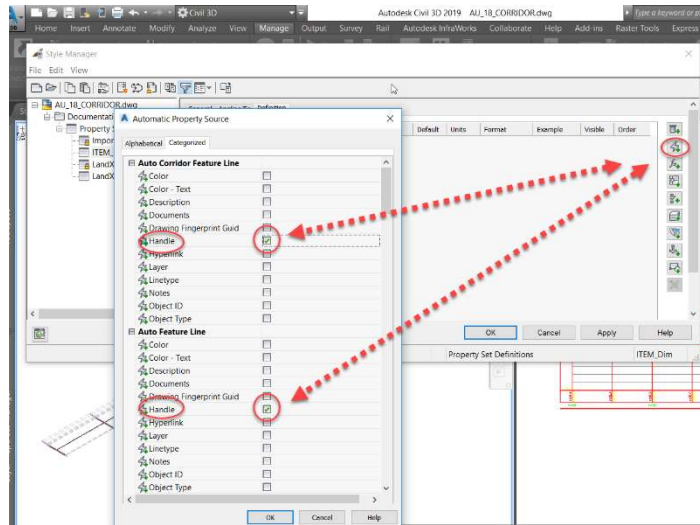
- 2.) Now toggle the “Applies To” tab. This is where we choose what AutoCAD/Civil 3D object(s) we are going to apply this PS to.



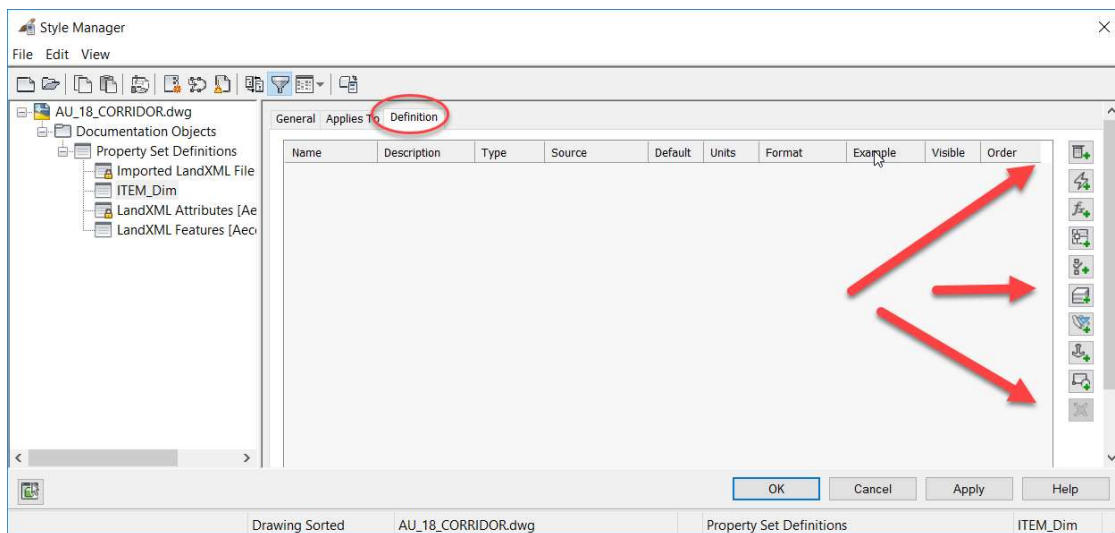
3.) You can now drag the bottom drag bar to the right and see the hundreds of different objects. We can choose the Select All or we can go through the list and choose only what we really need. This in the long run will help speed up the process when you get to real world projects. This may take some trial and error to get just the right objects selected but will pay off later when you are in production. Keep in mind all these property sets, and schedules can and will be saved into your company template, so most of this time spent now will not have to be replicated in the future. Below is a list of objects we might choose during this process. Please

add to this list as you see fit.
Toggle all those you wish to maybe extract out their dimension info for later use.

- Auto Corridor Feature Line
- Auto Feature Line
- Feature Line
- Hatch
- Polyline
- Polyline (2D)
- Polyline (3D)
- Solid (2D)
- Solid (3D)
- Survey Figure

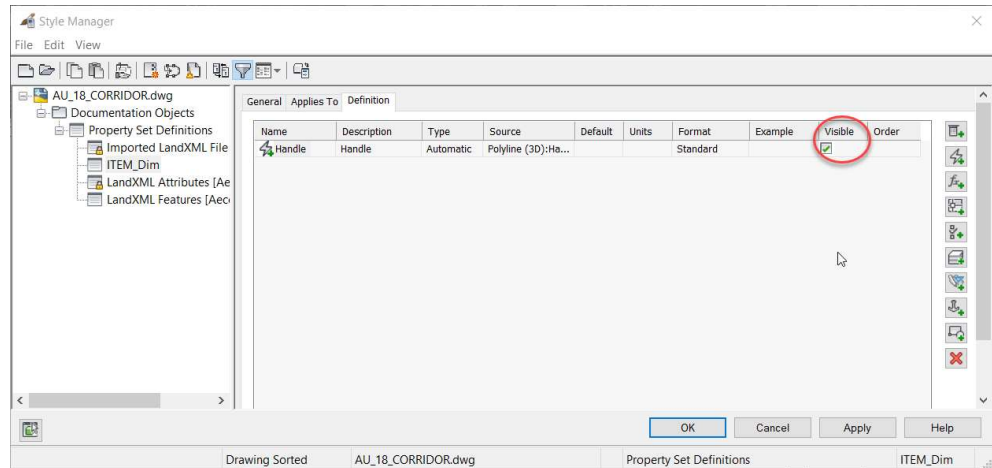


4.) Next choose the Definition tab, this is where will do most of our work now. On the right edge you can see the action icons. These are used to assign data to you objects via manual, automatic or Formula. Manual would be like assigning the sheet number the object resides on or the spec and code number from your local DOT. Automatic would be like the name of the subassembly Shape or the Volume of the 3D corridor solid. While formula might be where you take this volume and the actual depth of the 3D solid and have it calculated the surface area.

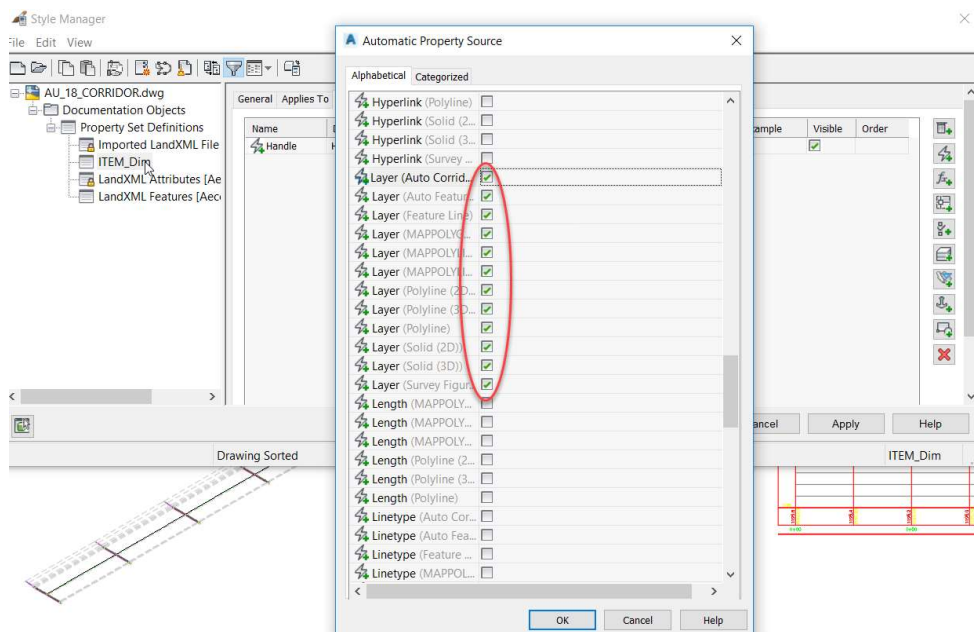


5.) The first thing we need to do for our property sets is to have each PS assign the “Handle” for the objects. This will help the software keep track of each object to make sure they aren’t lost and are each unique. Click on the right “Add Automatic Property Definition” icon and then toggle the box next to one of the “Handle” options. You’ll notice the software will automatically toggle all the “Handle” options once you pick one of them. Click “ok”

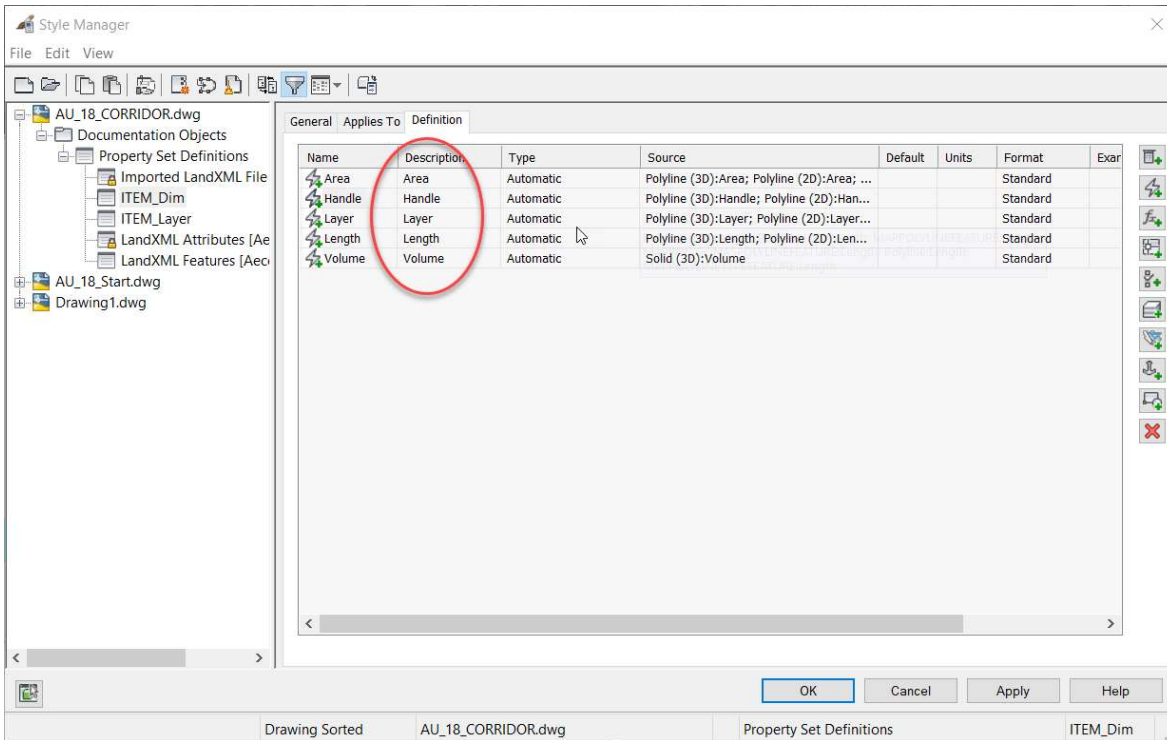
Your first entry should now look like this. The visible option is up to you if you want to later actually see the handle in the properties of the object. You later see like other Automatic PS this will not be editable.



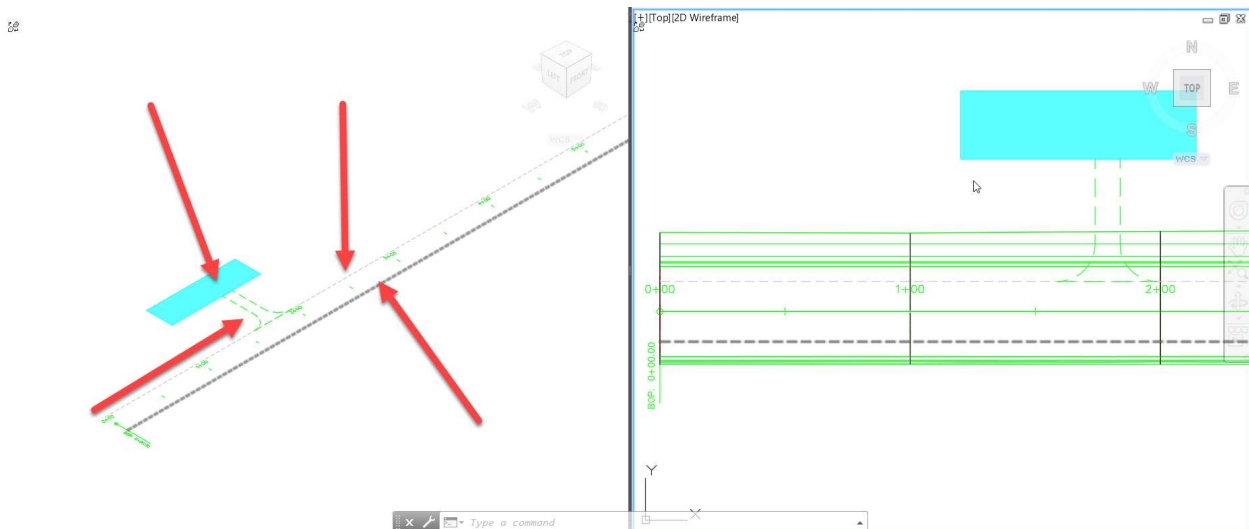
6.) Let’s add another Automatic PS. This time change the tab to alphabetical as shown below. This can sometimes make it easier to find the PS you wish to add. Drag down this list until you see “Layer” and “Length”. What is nice here is that this will show you all the objects and just what “Automatic data” we can extract from the list of objects we chose in step 3. Toggle the Layer, then click ok.



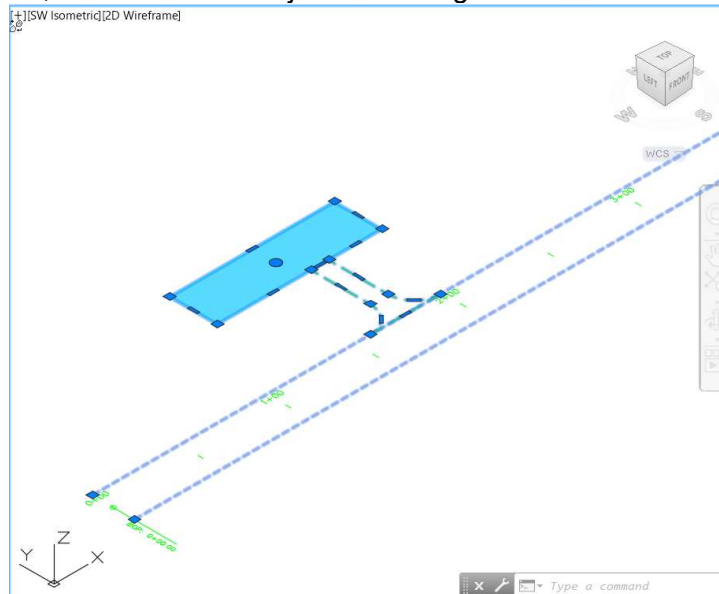
7.) Now repeat for Area, Length, and Volume. Then click ok and go back to your Model Space.



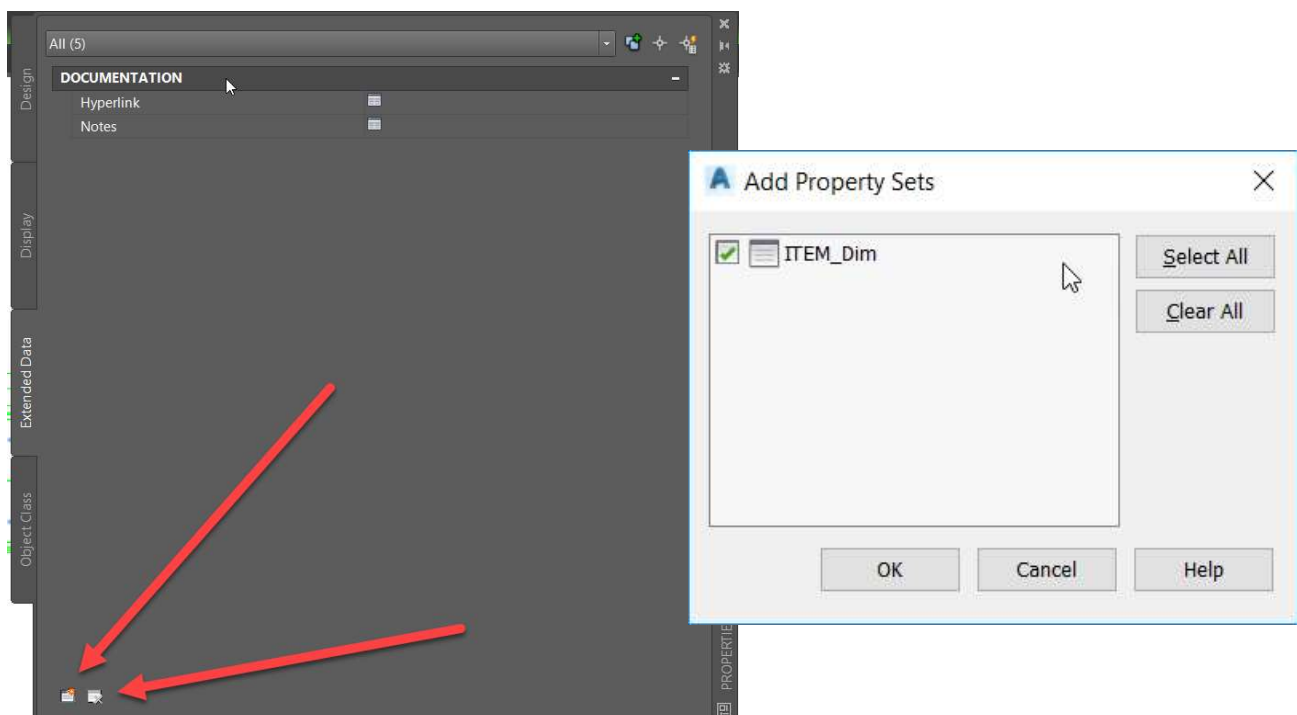
8.) Now I'm going to zoom/pan down to the 3D vport to see the existing objects in this dwg. Here we have polylines for the edge of the road, driveway and even some hatch for the parking area. Each of these items are also on their own layer. We are now going to apply these PS to these objects in the left vport.



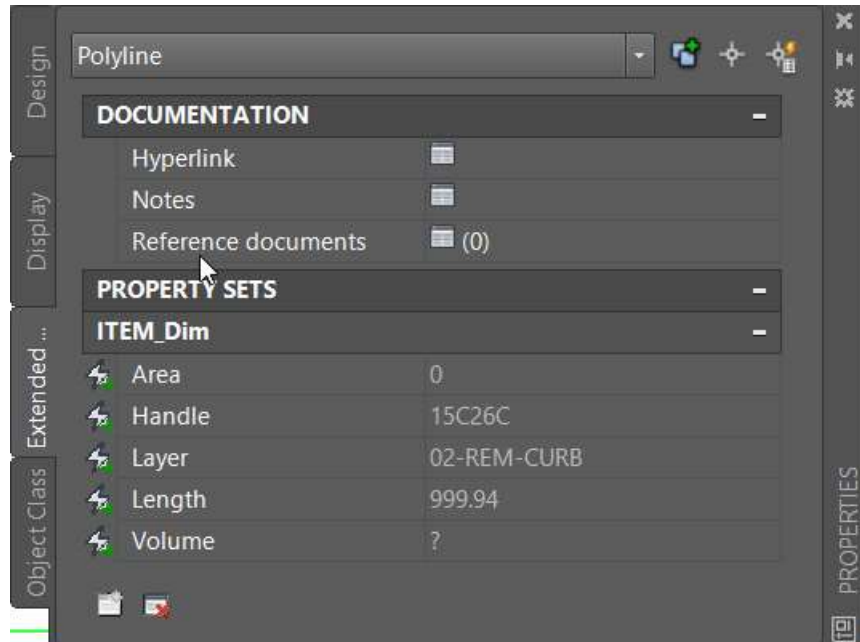
9.) To apply these new PS, grip and highlight all the objects as shown below. Keep in mind even though we also have the station labels gripped, since they are not part of the list of objects to assign within the PS, these selected objects will be ignored.



10.) Right click now and choose “Properties”, then change the tab to “Extended Data”. Somewhat hidden on the bottom left corner are two icons. The left icon is to “Apply” Property Sets, while the right icon is to “Remove” Property Sets. Choose the left icon and you should now see the below right box. Take the defaults and click ok.



Now the PS data will show up. Depending on the object some of the values as you can see will have "?". In this case we all know there is no Volume to a polyline. But as you see there is Length.

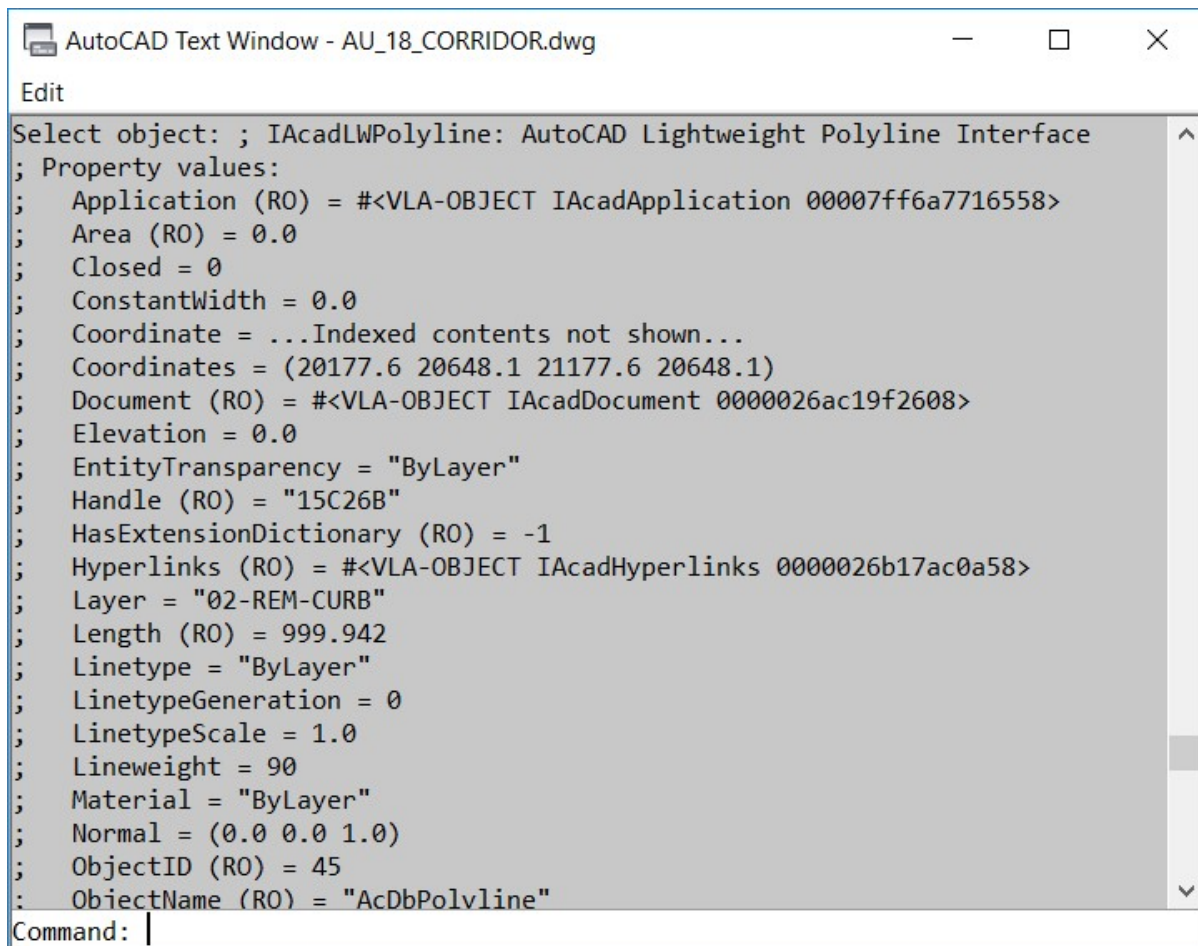


11.) Now one of the hard parts is figuring out just what we can pull automatically from an object and what we might have to instead either manually apply or create a formula. There is a LISP program on the web called DUMP.LSP you can either do a google search for it or you can cut and past the below into a ascii txt file and save it as DUMP.LSP

```
(defun c:DUMP nil (LM:dump (car (entsel))))
(defun c:DUMPN nil (LM:dump (car (nentsel))))

(defun LM:DUMP ( obj)
  (cond
    ( (or (= 'ename (type obj))
          (and (laitp obj) (= 'ename (type (setq obj (cdr (assoc -1 obj)))))))
      )
    (vlax-dump-object (vlax-ename->vla-object obj) t)
    )
    ( (= 'vla-object (type obj))
      (vlax-dump-object obj t)
    )
  )
  )
  (princ)
)
(vl-load-com) (princ)
```

What this DUMP.LSP achieves is that when executed inside Civil 3D or any other AutoCAD vertical you will get a list of what you might be able to extract from the object and placed in the PS. So, for like Hatch, things like “Area”, “Layer” and “Length” are values we find necessary later when we are doing quantities. Mostly because this is stuff we will be able to show and add up in our Schedules and even transfer out to Excel.



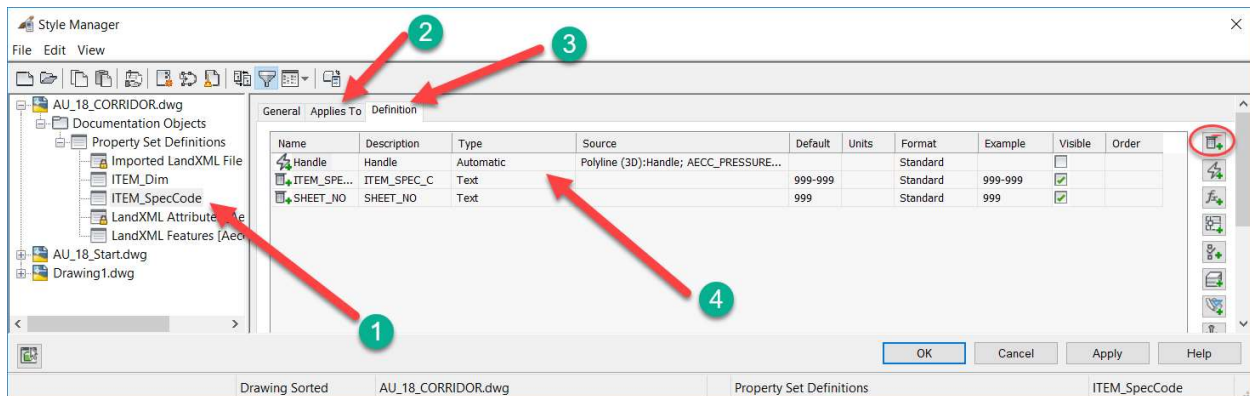
```

AutoCAD Text Window - AU_18_CORRIDOR.dwg
Edit
Select object: ; IAcadLWPolyline: AutoCAD Lightweight Polyline Interface
; Property values:
; Application (RO) = #<VLA-OBJECT IAcadApplication 00007ff6a7716558>
; Area (RO) = 0.0
; Closed = 0
; ConstantWidth = 0.0
; Coordinate = ...Indexed contents not shown...
; Coordinates = (20177.6 20648.1 21177.6 20648.1)
; Document (RO) = #<VLA-OBJECT IAcadDocument 0000026ac19f2608>
; Elevation = 0.0
; EntityTransparency = "ByLayer"
; Handle (RO) = "15C26B"
; HasExtensionDictionary (RO) = -1
; Hyperlinks (RO) = #<VLA-OBJECT IAcadHyperlinks 0000026b17ac0a58>
; Layer = "02-REM-CURB"
; Length (RO) = 999.942
; Linetype = "ByLayer"
; LinetypeGeneration = 0
; LinetypeScale = 1.0
; Lineweight = 90
; Material = "ByLayer"
; Normal = (0.0 0.0 1.0)
; ObjectID (RO) = 45
: ObjectName (RO) = "AcDbPolyline"
Command: |
  
```

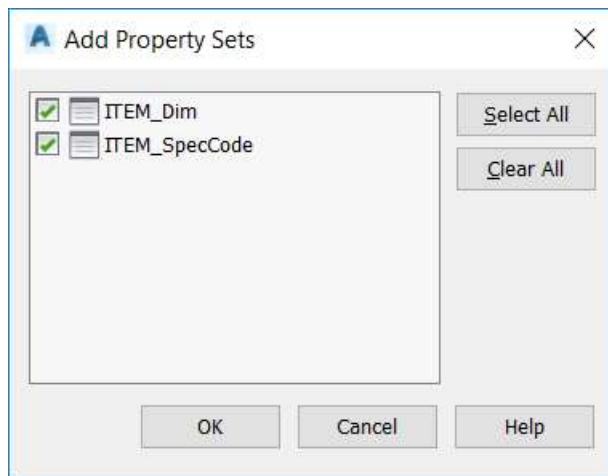
12.) Now we have talked about “Automatic Property Sets”, let’s venture into both Manual and Formulas Property Sets. Manual PS can be items like street names, sheet numbers, DOT spec and codes, owners, order of install etc. For our example I’m going to create a new PS that adds in Sheet number and Item SpecCode (999). These will come in handy later when we start to create out schedules.

13.) Repeat the above steps 3,4,5, and 6. But this time use the Manual icon (upper right) when adding each definition. Don't forget to add the "Handle" definition first. So, first step is to create a new PS and call it Item_SpecCode, then assign the object types as shown below 2.

Then go to 3 and add the three definitions as shown below. Both Item_Spec and Sheet_No are manual. I have added in the Default column a value that will probably never be used in a project therefore it will make it easier to find a PS that is needed to be changed to their proper value later when in production. So 999-99 and 999 for sheet number.



Now you can see that we have a total of two custom PS that we have created so far. You'll see that when we go to apply these to objects we'll have the option to not apply one or the other on the fly. So essentially giving the user the power to not include an object in his totals later if necessary.



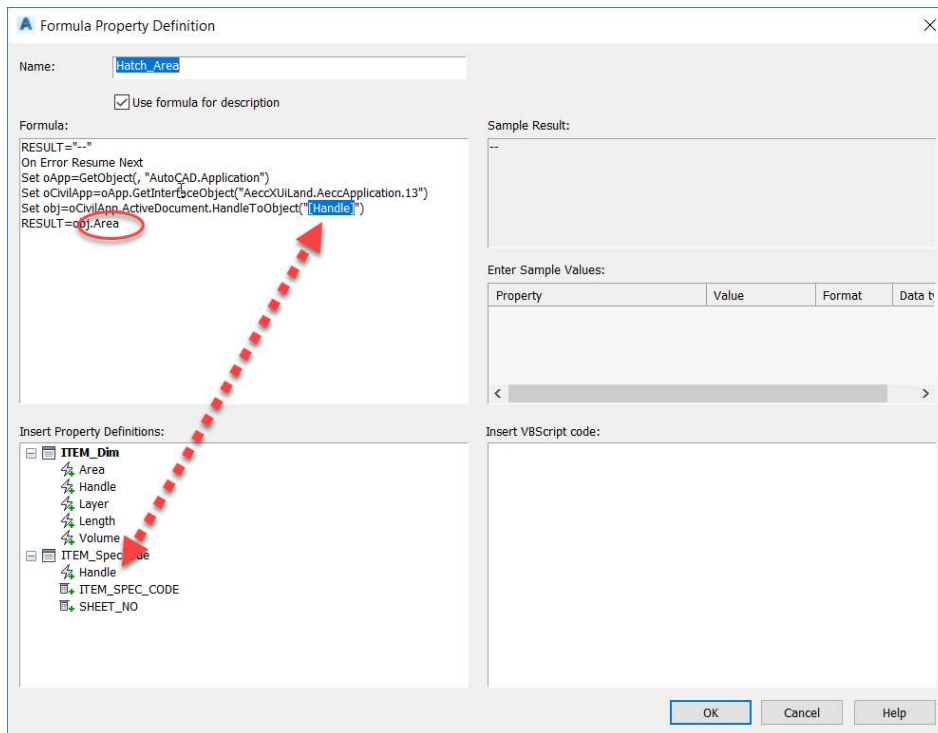
14.) One thing you might notice after testing these on a few different types of objects. In our case we are not getting the area of the Hatch. I've found there are some properties that require a Formula to extract the value we are looking for. This is where the above Dump.LSP and the below code come into play. First, you'll take below code and cut and paste it into our formula, then you'll need to change the Area of the last line "RESULT=obj.Area" with whatever we found in the DUMP screen instead. I.e.. Length, Area, volume or whatever you choose to extract.

Next, we will highlight the [Handle] text and then double click on the lowest Handle text in the "Insert Property Definitions" area. This will make the formula link with your object.

```

RESULT="--"
On Error Resume Next
Set oApp=GetObject(, "AutoCAD.Application")
Set oCivilApp=oApp.GetInterfaceObject("AeccXUiLand.AeccApplication.13")
Set obj=oCivilApp.ActiveDocument.HandleToObject("[Handle]")
RESULT=obj.Area

```




This should now look something like below.
 Tip: Make sure there are no hidden spaces behind Area .

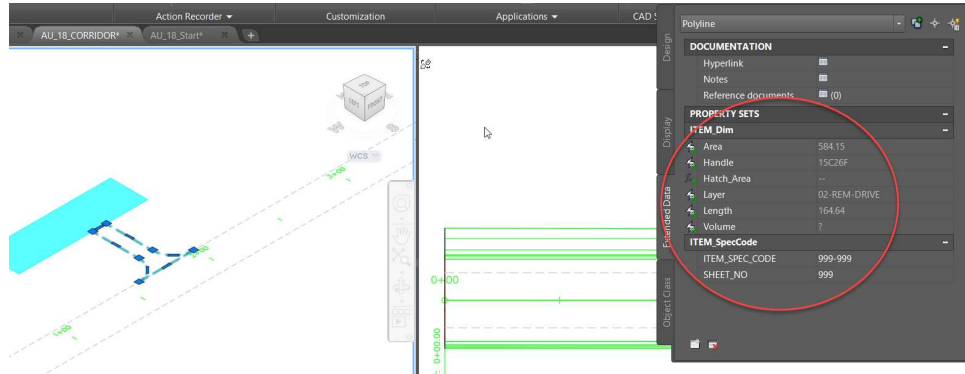
```

RESULT="--"
On Error Resume Next
Set oApp=GetObject(, "AutoCAD.Application")
Set oCivilApp=oApp.GetInterfaceObject("AeccXUiLand.AeccApplication.13") -
Set obj=oCivilApp.ActiveDocument.HandleToObject("[ITEM_SpecCode:Handle]") -
RESULT=obj.Area

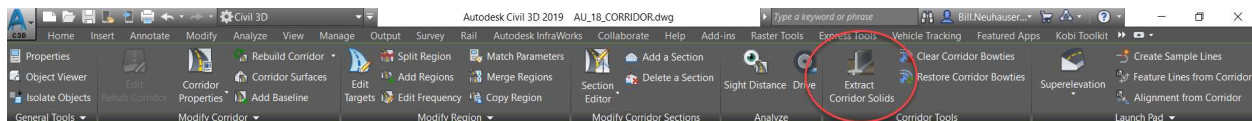
```



You'll now notice if you go to the Extended Data tab on the property pallet you'll now see all these assigned Property Sets.



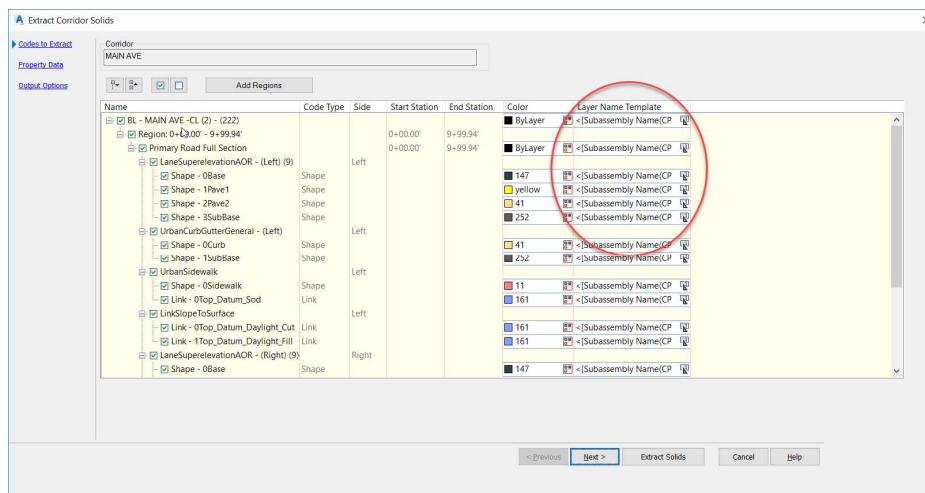
15.) Next, we'll extract our corridor 3D solids and create Property Sets that pertain to them. If we now just grip the Corridor up on the Ribbon you will see The "Extract Corridor Solids". Pick this.



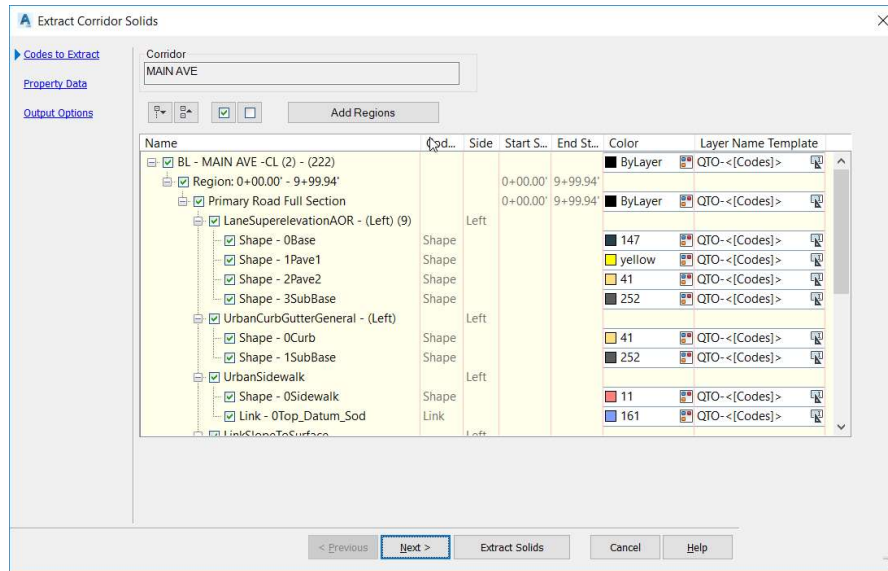
16.) Now on the Command Line you see the below. Choose "All regions"



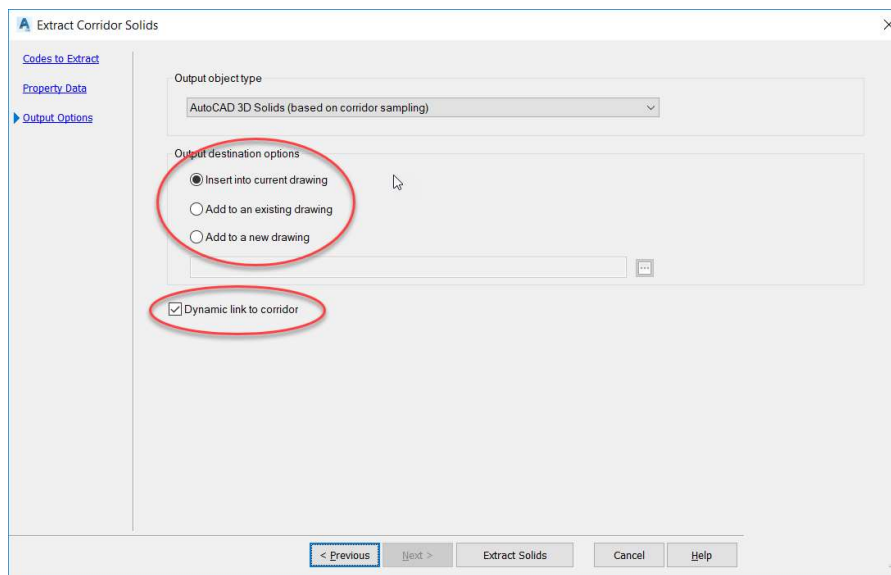
17.) When you do this for the first time in you dwg you might see that the Layer Name Template is set to something like you see here. I'm going to jump out of here and quickly change this in the Command Settings. (Not going to show the step here assuming you know what I'm referring to and can do this yourself).



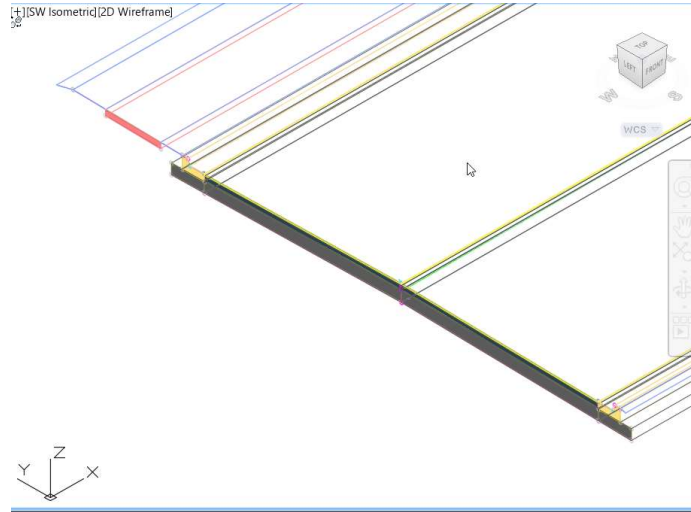
18.) I've changed this to QTO->[Codes]> where codes in this case turns out to be the name of the corresponding Shape within the subassembly. We will find this very important later when we get to Schedules.



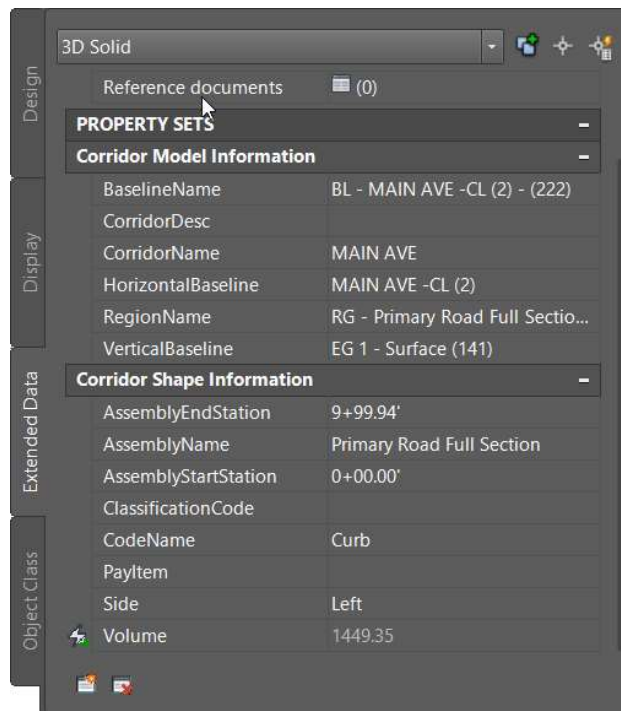
19.) Now click the Next button on the bottom twice, don't click Extract Solids just yet. You have two important options to decide on here. Really only one, keep the lower Dynamic Link to Corridor toggle on as you see it here. The middle option Output destination option is the one you might play with and test on your own. For what we are doing we will Insert into current drawing. But in production, it might be better to export these solids into a new dwg where you would do your QTO in. This is your option and would probably be a case by case decision. Now click on Extract Solids.



20.) This is now when having at least one viewport in a 3D perspective as I do here helps. Also applying a special Code Set to the corridor now will help see the ends of each shape with solid hatching.

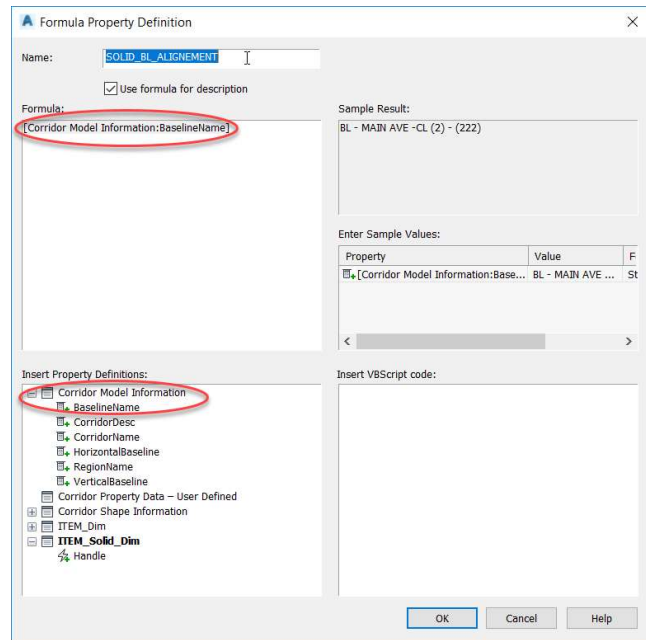


21. Now if you grip one of these solids, you'll notice that there is some property data already assigned to each solid by Civil 3D. Notice the CodeName, Volume and both start and end stations. Even if we run the DUMP.LSP on one of these solids you'll see that nowhere listed is the length of the solid nor the depth. These are two values we will need to create a Formula for. The station values will be used to calculate the lengths, while we will need to manually assign to each solid its depth.

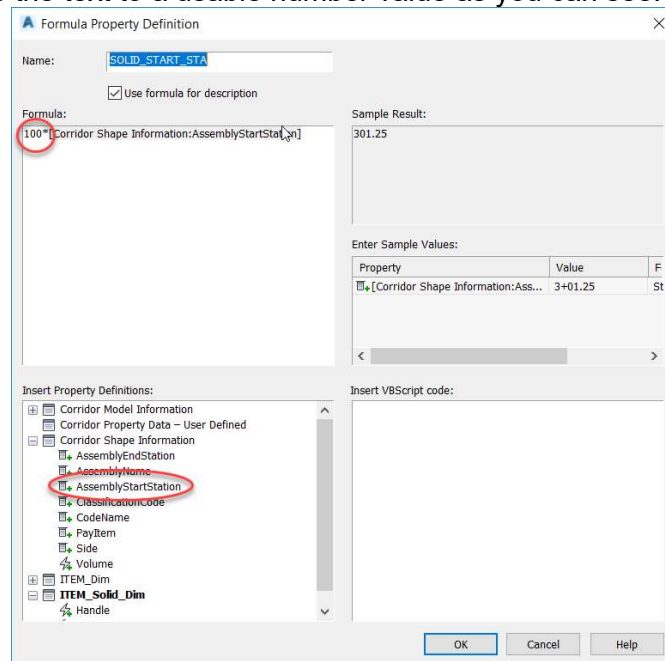


22.) We are going to go back into the “Define Property Sets” and create a new PS called “ITEM_Solid_Dim”. In this PS this time we will only select “2D and 3D Solids” for the “Applies to”.

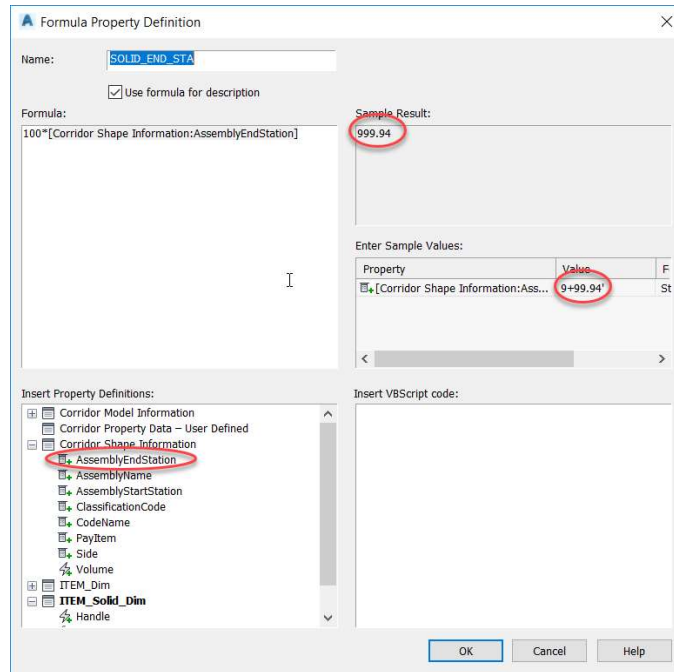
23.) Below we have created a PS but this one is grabbing the Baseline Alignment name. This will again be used later in our Schedules.



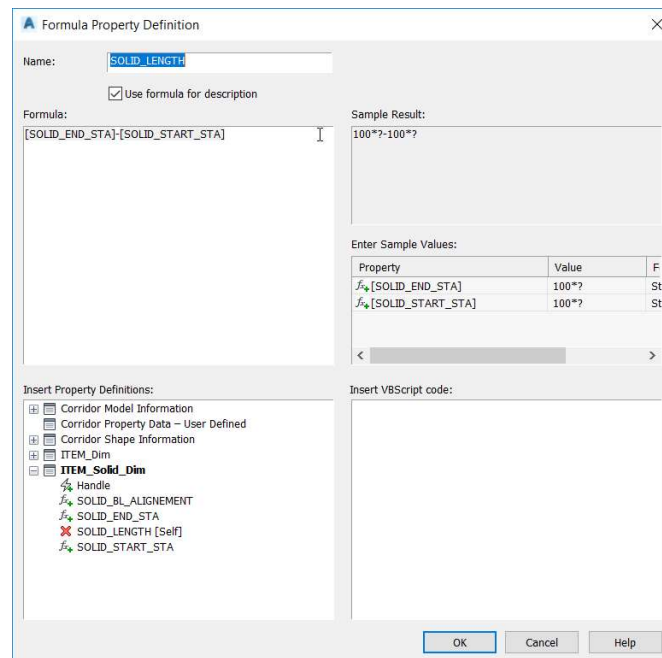
24.) The PS is taking the Solid Starting station that is in text for and by multiplying the station value by 100 converts the text to a usable number value as you can see.



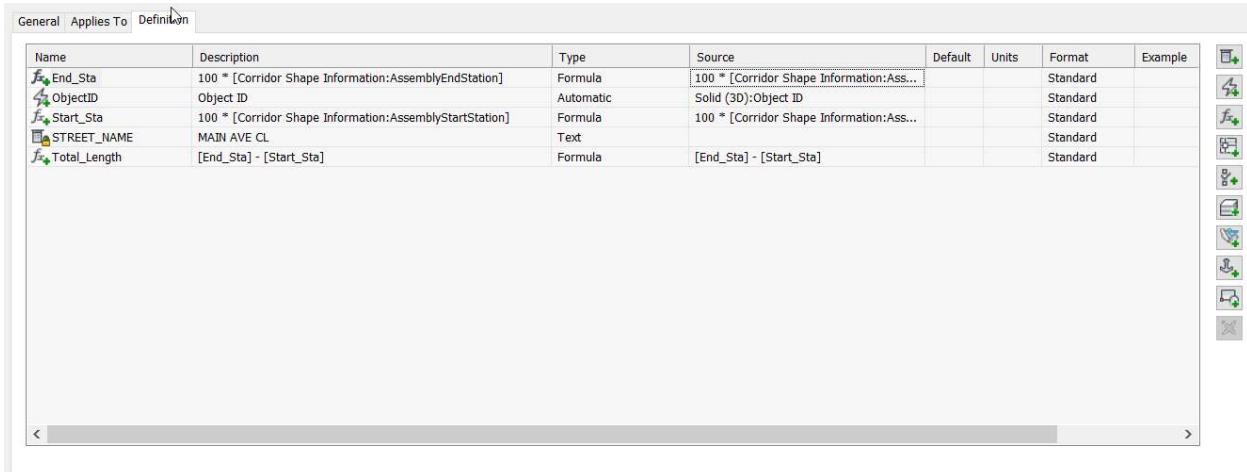
25.) Repeat the above process, but now calculate the end station of the solid.



26.) Now with both the end station and start stations converted to a usable number, we will now create the below formula to figure out the total length of the Solid.

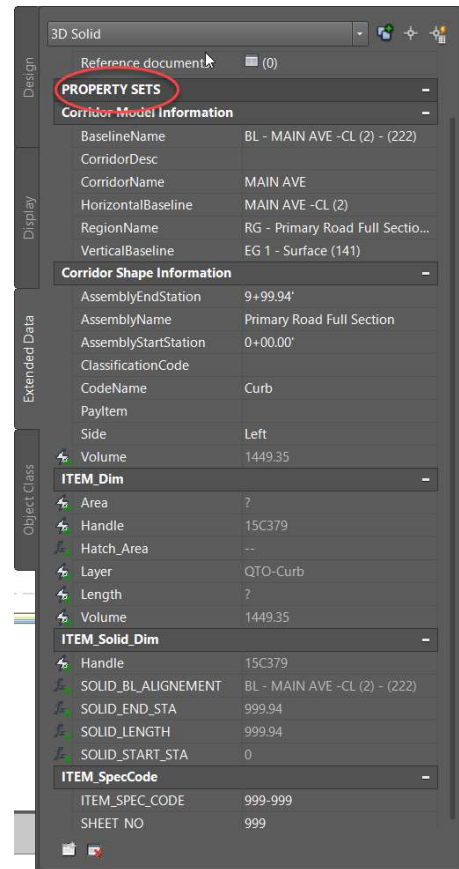


27.) Here is the result of the above steps. As you can see the order is not in as completed but alphabetical.



Name	Description	Type	Source	Default	Units	Format	Example
End_Sta	100 * [Corridor Shape Information:AssemblyEndStation]	Formula	100 * [Corridor Shape Information:Ass...			Standard	
ObjectID	Object ID	Automatic	Solid (3D):Object ID			Standard	
Start_Sta	100 * [Corridor Shape Information:AssemblyStartStation]	Formula	100 * [Corridor Shape Information:Ass...			Standard	
STREET_NAME	MAIN AVE CL	Text				Standard	
Total_Length	[End_Sta] - [Start_Sta]	Formula	[End_Sta] - [Start_Sta]			Standard	

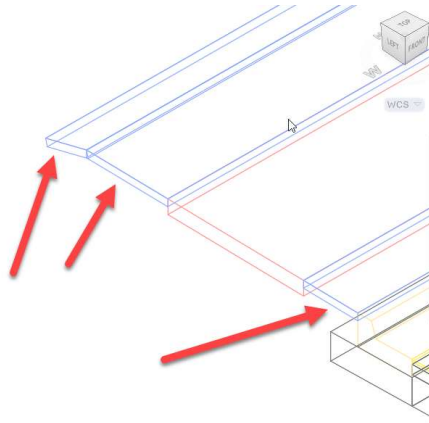
28.) Next back in mspace we'll now apply these new Property Sets and when you look at the extended data for one of the corridor solids it should look something like below. Keep in mind that now all this data can be displayed in a schedule and eventually exported out to Excel. Next step would be to go all apply these PS to the whole dwg and then manually change their spec, codes and sheet numbers. In the next section we'll show how to setup Schedules which will be used to group and total all these values that you can then export to Excel. Other items we can quantify will also include things like both gravity and pressure pipe.



Category	Property Name	Value
Design	Reference document	(0)
	PROPERTY SETS	
	Corridor Model Information	
	BaselineName	BL - MAIN AVE -CL (2) - (222)
Display	CorridorDesc	
	CorridorName	MAIN AVE
	HorizontalBaseline	MAIN AVE -CL (2)
	RegionName	RG - Primary Road Full Sectio...
Extended Data	VerticalBaseline	EG 1 - Surface (141)
	Corridor Shape Information	
	AssemblyEndStation	9+99.94'
	AssemblyName	Primary Road Full Section
Object Class	AssemblyStartStation	0+00.00'
	ClassificationCode	
	CodeName	Curb
	PayItem	
	Side	Left
	Volume	1449.35
	ITEM_Dim	
	Area	?
	Handle	15C379
	Hatch_Area	--
Layer	QTO-Curb	
Length	?	
Volume	1449.35	
ITEM_Solid_Dim		
Handle	15C379	
SOLID_BL_ALIGNMENT	BL - MAIN AVE -CL (2) - (222)	
SOLID_END_STA	999.94	
SOLID_LENGTH	999.94	
SOLID_START_STA	0	
ITEM_SpecCode		
ITEM_SPEC_CODE	999-999	
SHEET NO	999	

29.) There are two commands that we won't cover here but are necessary to convert the subassemblies that are only links to a usable 3D Solid. When you export a corridor to 3D Solids these subassemblies since they have no thickness are made into what is called a "Body". By first using the "CONVTOSURFACE" command and then using the "THICKEN" command you can convert these Zero Thickness Bodies into 3d Solids. Here in our sample corridor we have three areas that are Bodies. The inside blvd, outside blvd and the

Daylight links. For our schedule section coming up next I have already converted these to a 0.25' thick 3D solid.

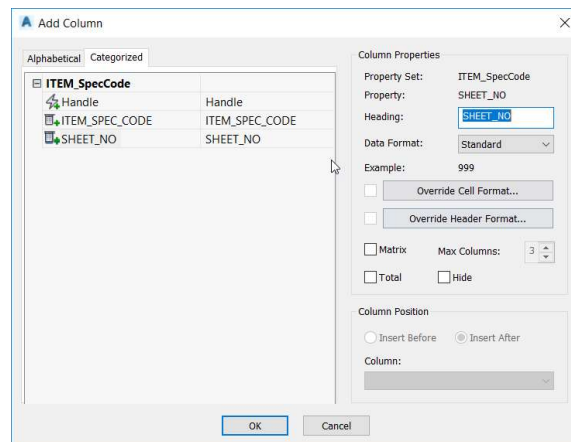


SCHEDULES: Schedules are like Tables, but Schedules are intended to list your Property Set data in tabular format.

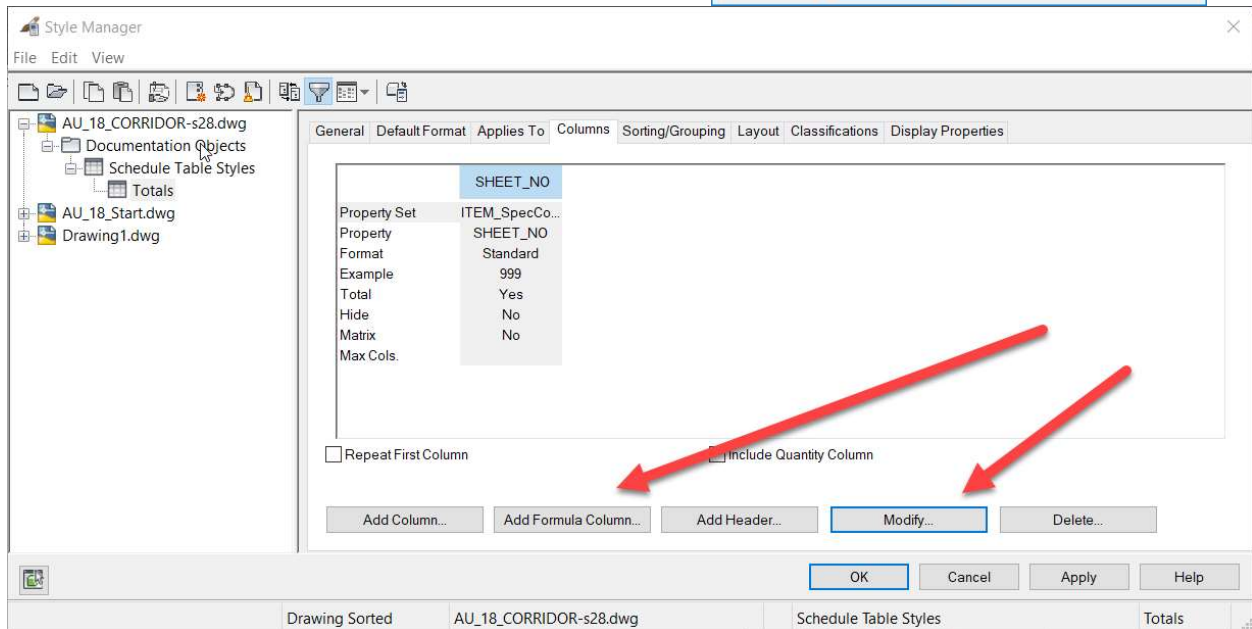
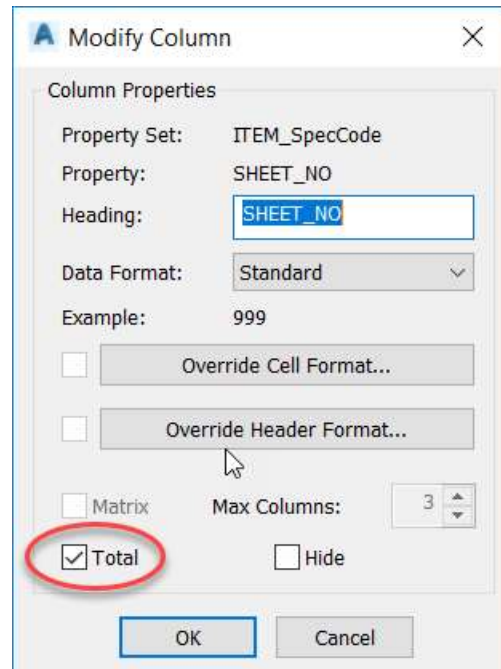
- 1.) Type in Schedule, then right click on The Schedule Table Styles and make a new listing called Totals.
- 2.) Go to the “Applies To” tab and add in the following object types:

- Auto Corridor Feature Line
- Auto Feature line
- Feature line
- Hatch
- Poly line, 2D and 3D
- Solids 2D and 3D
- Survey Figure

- 3.) Now Columns tab, “Add Column” and choose “Sheet_NO”, click ok.



4.) Now click on Modify, toggle Total, click ok.



5.) Now let's add a schedule to our drawing so we can start seeing out totals. Now the command to add a schedule to a drawing is not what you would think. For this we will need to use the -scheduleadd command. When you run the command make sure to use these below settings as you hit enter on the command line.

property set definition. After property sets are attached, the values for automatic properties are determined from the object, and you can enter values for the manual properties. Essentially what this does is as soon as an object is created in Civil 3D, its corresponding Property Sets will automatically be applied with no user input. Any manual PS that are applied can be later edited.