This Month:

Coordinates & Survey Data

Welcome to **INFOCUS**, C3 Consulting Solution's Monthly Newsletter. This month, we take a look at Coordinates and Survey Data.

Matching coordinates between those of imported surveys and of your Revit project can be a confusing and frustrating process. In this edition of INFOCUS, we'll attempt to explain what occurs during this process, how to get it right, and what to look out for that might otherwise cause you grief.

Prepare the file for import

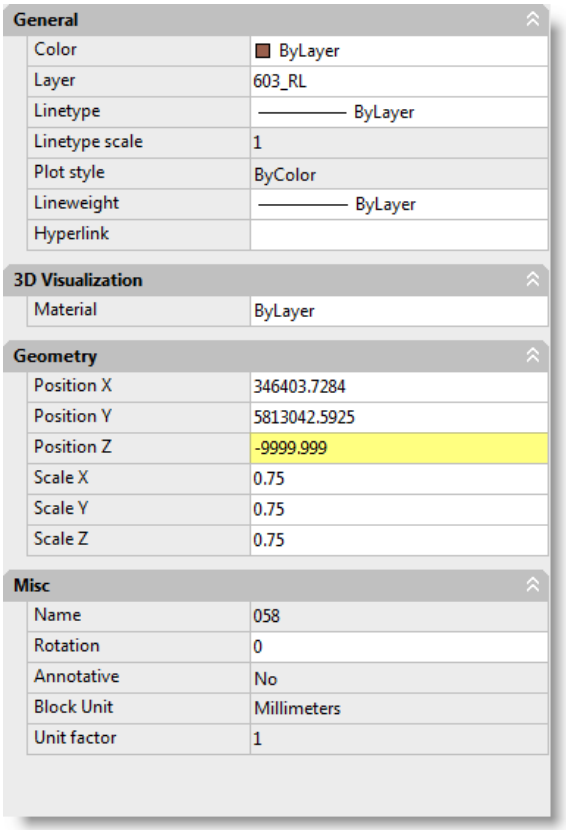
The first step in the process is to prepare your survey prior to importing it into Revit. You typically would receive it as a CAD file. In the example that follows, we'll be assuming this to be a DWG file.

For best results, you are best to prepare a *copy* of your survey file, and leave the original intact. For the creation of a topographical surface, we're only concerned with 3D data.

If any points on your survey do not belong to (or will not help form) a three-dimensional surface, they may not be relevant to the creation of the 3D topographical surface. As such they may cause complications or errors when importing the file into Revit. This includes If any points are far below, above or away from your 3D survey data. Geometry which is only two-dimensional is best kept in a separate file which can be imported later to display site features etc.

Firstly, ensure the data in the DWG is measured in millimetres. Usually, surveyors measure sites in metres, and supply their data consistent with this. While theoretically Revit can detect and reconcile this upon insertion into your Revit project, you are far better off to scale up the geometry from your survey file (usually by a factor of 1000, from a base point of 0,0,0). If you don't, you may experience display or accuracy problems – ghosting of elements is typical in this scenario.

Tip: Ensure all layers are turned on, unlocked and thawed. When prompted to select objects to scale, enter ***ALL*** at the command prompt. This will ensure that all objects are selected, even if they are not visible on your screen.



Go to a 3D view (e.g. View-3D Views-South West Isometric) and check Z value coordinates of visible geometry.

In AutoCAD, an easy way to test this is to select an object and inspect its Z value in the properties palette. Any such value less than zero indicates a point beneath the survey's datum, which (depending on the survey) is usually sea-level, as in the case of the Australian Height Datum.

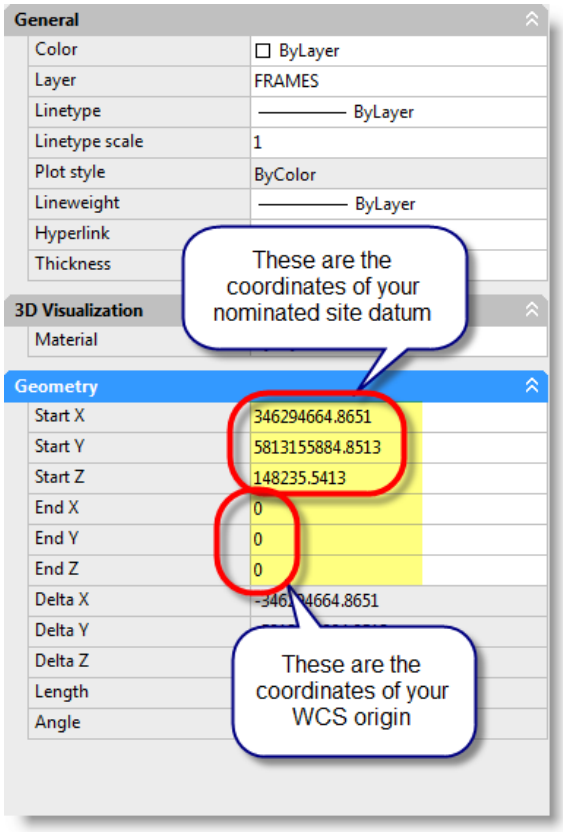
In *most* cases, if a point on your survey representing terra firma is *below* sea-level, then you'd be well served to double-check your survey's accuracy!

Revit currently does not support 64-bit floating point numbers, which (in practice) essentially means that you will experience display issues when importing a traditional survey, where the origin is greater than approximately 1.6km (1 mile) away from your site. To account for this, you'll need a local site datum. Any known point on your survey can be nominated as your local datum, however a surveyed benchmark is often best, as you'll need to know its X, Y and Z coordinates. Benchmarks usually would have their coordinates displayed on the drawing, but you can determine their location by using AutoCAD's ID command (type ID at the command line, and click on a point). Provided that the survey has been created with 0,0,0 as its origin, the coordinates should properly reflect the point's position.

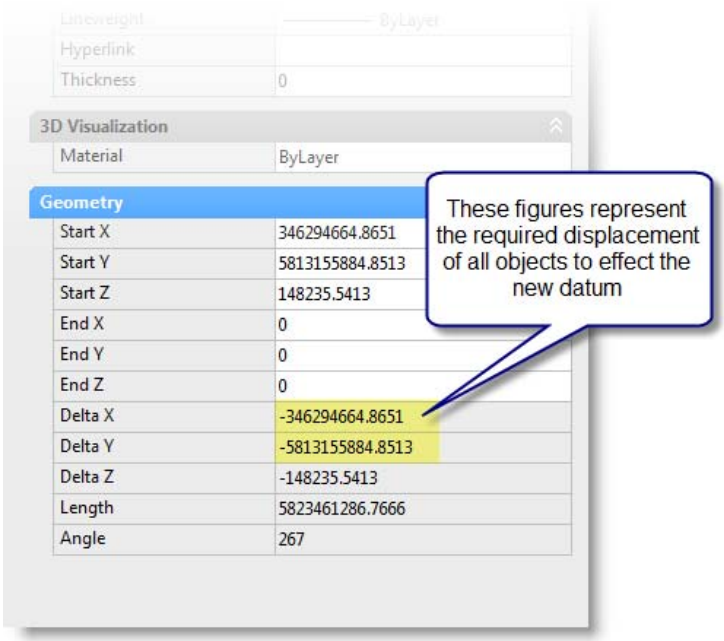
You'll need to locate this Datum point in the DWG file to be imported. If not already referenced by an object, a line can be used, one endpoint of which will have determinable X, Y and Z coordinates. This point should have a Z-value matching the reading taken from the survey at the same point.

When you've decided which point on the site you use as your local datum, draw a line from this point back to 0,0,0 in your WCS (World Coordinate System).

TIP: Use object snap (endpoint or insert) to ensure your line starts from a 3D point (e.g. a level mark). If you have trouble completing the line at 0,0,0, first click at the command prompt, and then enter the coordinates. This will cause AutoCAD to accept the coordinates as absolute and not relative to your last point.



The coordinates of each end of your reference line should reflect your original and new origins. Inspecting the properties of the line should reveal that the line begins at your new site datum (complete with easting and northing values, as well as its surveyed height (Z-coordinate)), and terminates at 0,0,0.



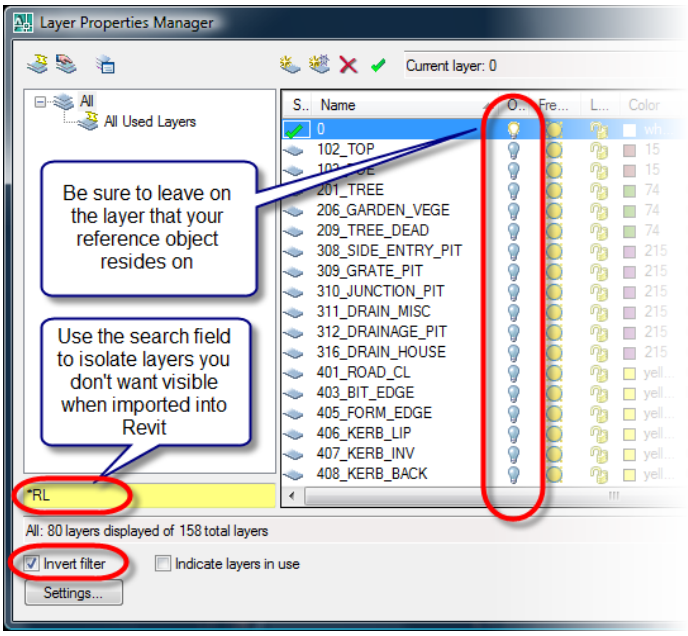
If you zoom to view the extents of your AutoCAD file, you'll see where your site is located relative to your survey's datum. *Usually* this will be Australian Map Grid (AMG).

If the site is sufficiently far enough away from your datum, all you may initially see will be the line itself, until you zoom in far enough to see the site data.

The extents of the line (indicated by its Delta X and Delta Y properties as shown left) indicate the difference between the new local datum (or origin) and the WCS origin.

While this reference line is not crucial to the exercise once you've done this several times, it just makes things easier to see and understand during the process. It serves as something easy to spot (amongst many other elements), within known coordinates. The X and Y coordinate values of the end point of your reference line (0,0 so far in this tutorial) don't really matter. The Z coordinate, however, should remain equal to zero. It is, in fact, better that the line terminates just outside your site boundary somewhere, otherwise Revit may not import the site using the origin-to-origin method, instead causing Revit to default to center-to-center. As a result, you may have trouble seeing the imported file altogether, even when you attempt to zoom to the extents of your view.

Before importing the file into Revit, it's helpful to know exactly what layers the 3D data you'll need are stored on. Typically, the layer structures of survey files don't make a lot of sense without some translation document to accompany them. While you can query the elements in Revit to establish which layers they reside on, it's just as easy to determine this information while in AutoCAD. Knowledge of this and other aspects of your survey might lead you to request certain methodologies be followed by your surveyor on future survey work.



You'll save time by preparing the layers in the DWG file prior to its insertion into Revit. The AutoCAD layer filter is more convenient and powerful than what you'll have at your disposal in Revit, so isolate the layers containing 3D point data, and turn off others. This can save a great deal of time when trying to select or deselect layers from the import instance. You should leave on the layer that contains your reference point (or other object) – so you can see it, but you don't necessarily want to use it along with the other layers to generate the toposurface.

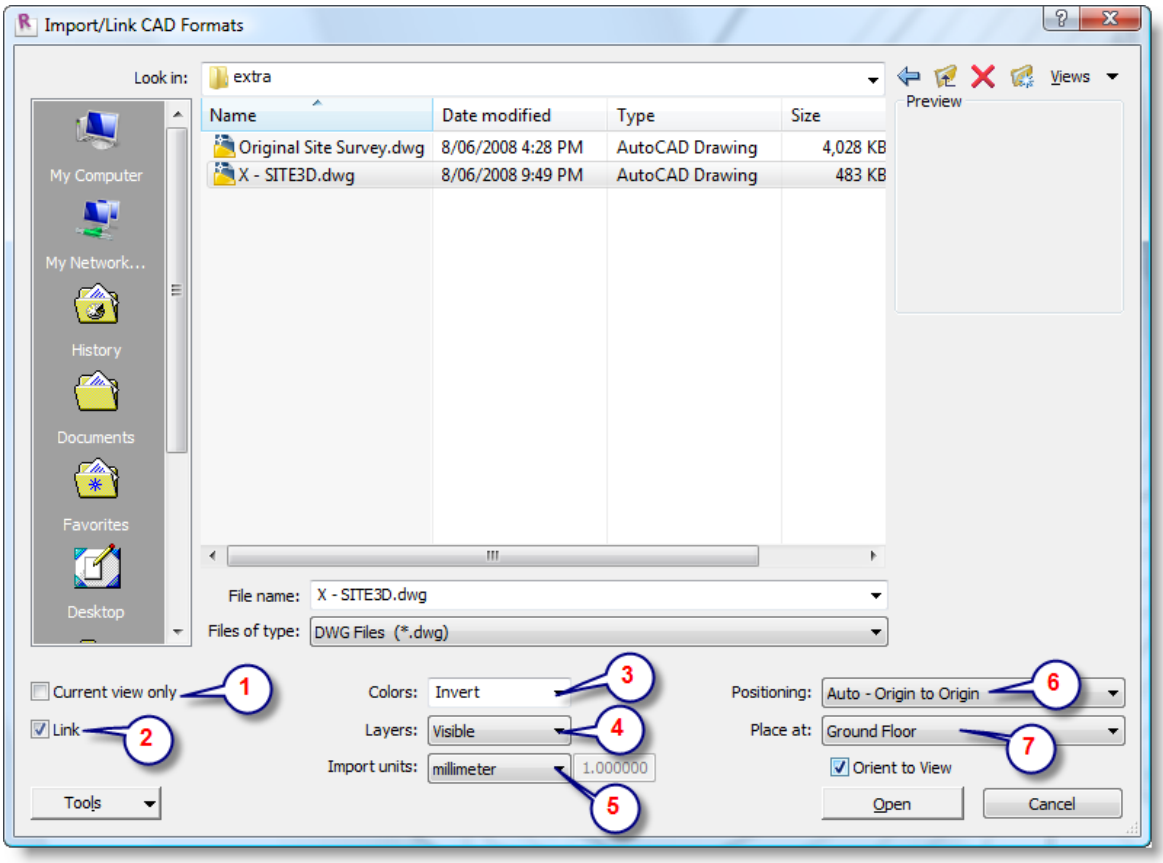
For all sites that exist further than 1.6km away from their survey's datum (which are usually all surveys measured to AHD and AMG), you need to relocate ***all*** objects to reconcile between their original (WCS) and new (local) datums. Again, you'll need to ensure all layers are turned on, thawed and unlocked, otherwise you may leave some objects behind. You need to move everything from your new site datum (starting point of your reference line) to your WCS origin (0,0,0). You can create and use a custom script file or lisp file to do this. If your survey coordinates are all measured to a local datum (i.e. within 1.6km, you may not have to relocate any objects within your survey. This scenario may be covered at a later date).

Once you've moved the geometry successfully, the site should be close to or surrounding WCS location 0,0. Save the file, as it should now be ready to import into Revit.

Side note: Be aware that other items may require attention for successful import into Revit. Some large or complex hatch patterns and linetypes may not successfully import. Revit does not support 'complex' linetypes – even from imported files.

Import the 3D data

In Revit, the best place to import this data is into a Site Plan view, with orientation set to True North. Import (and link) the 3D Survey data onto Datum Level (which should have a Shared level height value of 0) using Origin-to-Origin, with layers set to 'Visible'.



A brief comment about each of the numbered items from the above dialog box is included on the following page.

1. Current view only

As the title suggests, this imports (or links) into the current view only. While this can be useful, it is not uncommon to need to see an imported file in more than one view. In such cases, this should not be used.

2. Link

This essentially makes an external reference, linking the file into the Revit project. Updates to the linked file can be reloaded from the Revit project.

3. Colors

Given that AutoCAD users sometimes work on a black background, and the colours used are geared for this purpose, it can be useful to invert the colours since more often than not, Revit users operate with a white background.

You can also preserve (or retain) the colours used in the imported file, or change them all to black. This is useful particularly for 2D surveys or any other file that should remain present and visible for the duration of the Revit project.

4. Layers

Most Revit users would be used to the option 'ALL', but using either the *Visible* or *Specify* options can be particularly useful. Restricting the layers imported can keep the Revit project clean of unnecessary data that would otherwise be imported. It can also impact file performance.

5. Import Units

Best practice should be to import with 'native' units – i.e. to avoid requiring Revit to scale the imported file to reconcile between different unit types. If the Revit project units are millimetres, then make sure the units in any linked or imported file are also in millimetres.

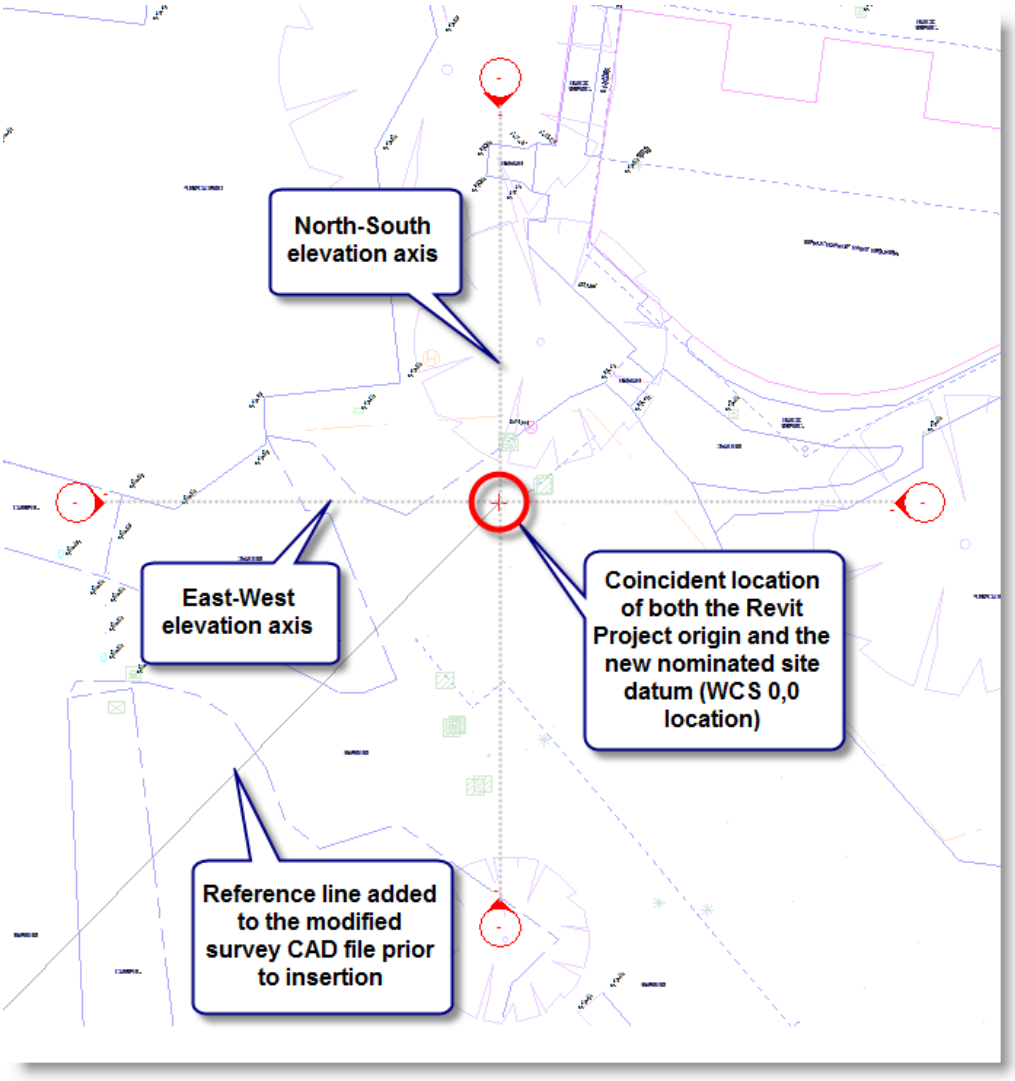
6. Positioning

Shared Coordinates and *Auto – Center to Center* should not have to be used (at least for surveys) if the methodology from this publication is used. These may be discussed in more detail at a later date.

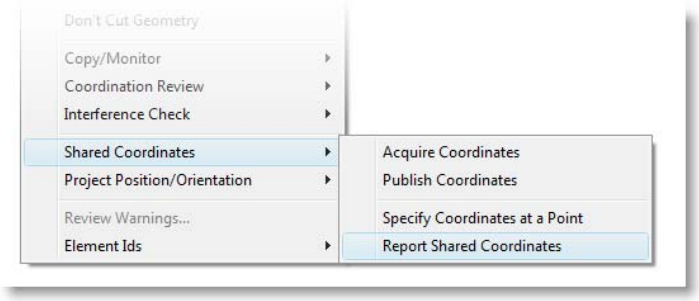
7. Place At

Any level in the project represents a possible Place At value. It refers specifically to vertical placement. For 3D survey data, any level that is located at a Shared Coordinates (i.e. absolute) value of 0 is appropriate. For 2D survey data, you are better to place these at higher levels, or offset higher from the same level.

The vertical placement of the imported instance should be immediately correct, and will be obvious if the nominated site datum (at start position of the reference line added to DWG file) is located perfectly over the Revit project origin. By default, the Revit project origin is located on the intersection of the axes formed between the north and south elevation and the east and west elevation markers (unless someone has moved them or messed around with your project template!). The lateral coordinates (eastings and northings) at the chosen site datum will still need adjustment, however.

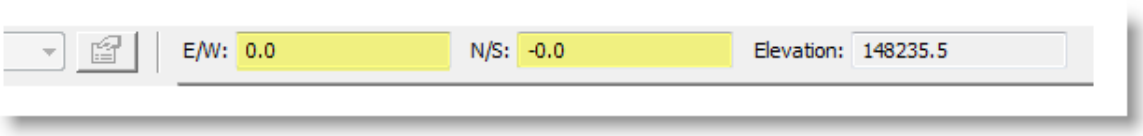


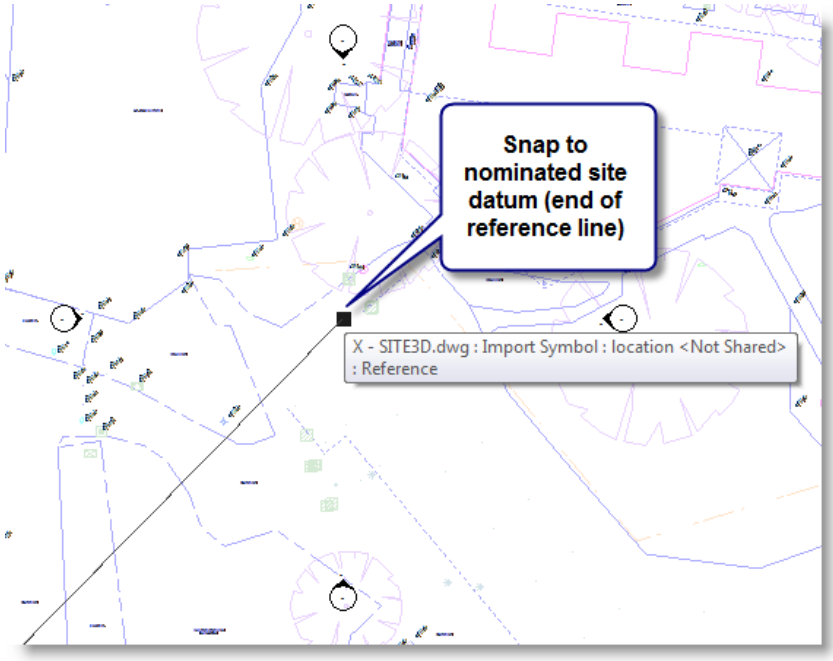
Neither of the elevation axes shown above will be visible in Revit – they are indicated above only for clarity.



You can test the lateral coordinates of any point by getting Revit to report the shared coordinates to you.

Use **Tools|Shared Coordinates|Report Shared Coordinates**, and snap to the start point of the reference line at your nominated site datum.





When you've clicked this point, the coordinates should be displayed on the options bar above the drawing area (shown in the image above).

Note that the elevation value for this known point should match the Z coordinate from the survey. In the image above, the height of the nominated site datum is indicated as 148235.5mm (or 148.235m).

In summary so far, we have learnt how to:

Prepare the survey file

- Reconciling Units (scale up to millimetres)
- Reconciling position (move all objects from new site datum to WCS 0,0)
- Deleting or moving any erroneous geometry
- Isolating layers that contain 3D point data (and any reference geometry)

Insert the DWG into Revit

- Onto Site level (which should be based at a shared coordinates height of 0)
- Using Origin-to-origin placement
- Ensuring only appropriate layers are visible

At this point, the survey should be in the correct position (vertically), but still requires more data reconciliation for its lateral (horizontal) placement. Moreover, the Revit levels and any model components already present are not yet reconciled to the site. We'll continue this in the next edition of INFOCUS. Stay tuned!

Feel free to contact us if you have any questions or feedback relating to this newsletter.

Don't forget to check out our online Knowledgebase.

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