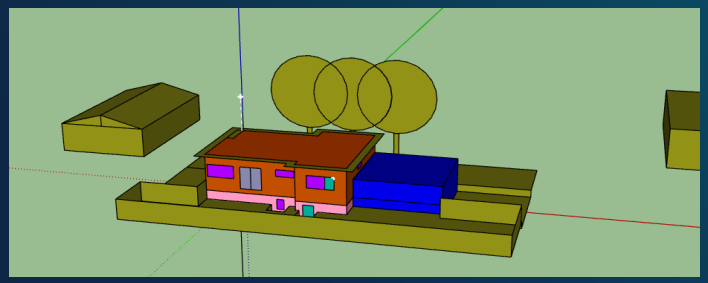
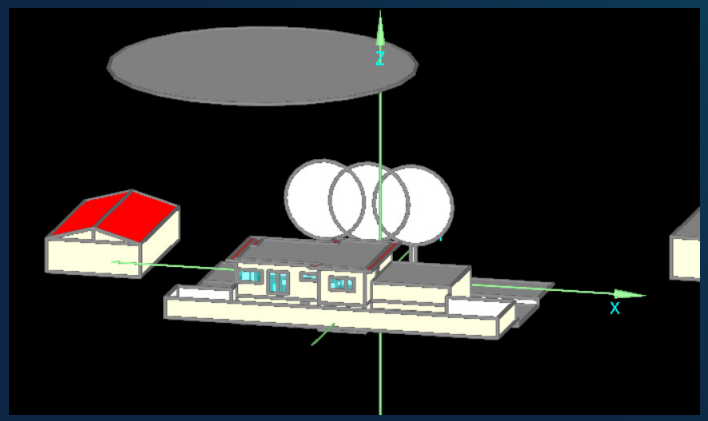
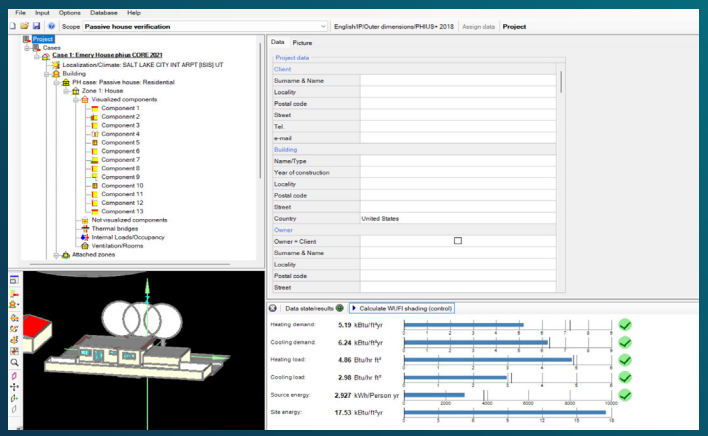
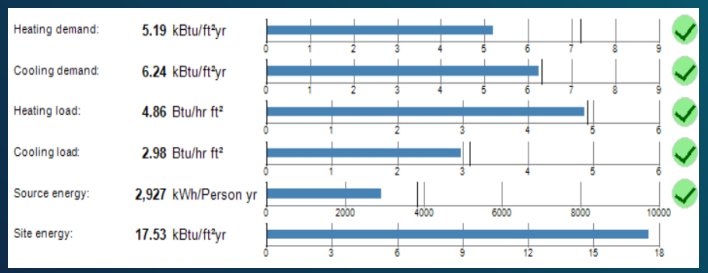
Phius

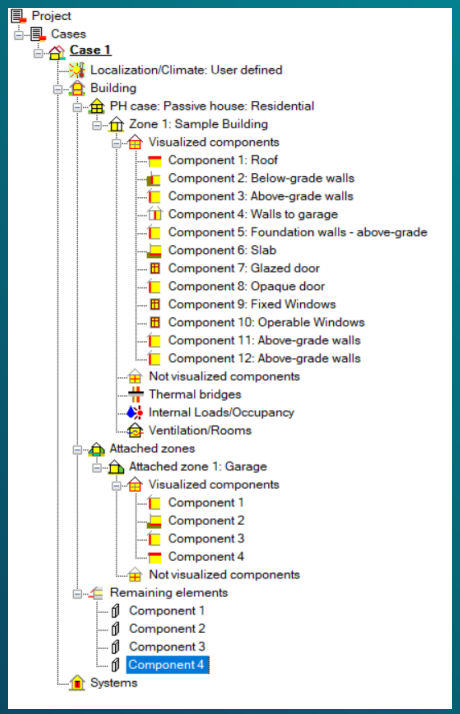
GUIDELINES FOR 3D GEOMETRY IN WUFI® PASSIVE











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July, 2026

Guidelines for 3D Geometry in WUFI® Passive

Version 26.1.0

July 2026

Table of Contents

1 - WUFI Passive

1.1 Introduction

Thank you for your interest in learning WUFI Passive! WUFI Passive is a building energy modeling software that offers profound contributions to passive building design, broadening the scope of modeling methods through the capability of implementing static modeling procedures. WUFI Passive is the result of a collaboration between Fraunhofer-Institute for Building Physics (IBP) and Phius to suit the North American market.

This guide should be used as a framework for building 3-D geometry, importing it into WUFI Passive, and navigating WUFI Passive.

1.2 Accepted Software

As indicated in the Phius 2024 Certification Guidebook, **Section 1.4.3.1 *Accepted Modeling Software***, all projects pursuing Phius Certification (Performance Path) must be modeled in one of the following softwares:

WUFI Passive: V.3.5.0.1
WUFI Passive Free: V.3.5.0.1
METr: v.1.59/2.45 or newer

Process Tips:
A free version of WUFI Passive with limited capabilities is available for download.

This guide provides modeling support for WUFI Passive.

For full modeling capabilities, a license for the full featured software is required. Licenses are available in one, three, and ten-year periods. Licensure includes featured automatic updates through the duration of the license. Additional software packages may be purchased from the web shop. A summary of features included in the paid versus free version is outlined here.

Individuals completing the Phius Certified Passive House Consultant (CPHC) Training receive an eight-week license of WUFI Passive as part of the certification process.

1.3 System Requirements & Recommendations

A computer system with the following performance parameters is recommended for installing WUFI® Plus or WUFI® Passive:

Operating System: Current Windows OS
CPU: 1.6 GHz or higher
RAM: 4 GB or better
Video Adapter: 128 MB or better, OpenGL 2.0 capable
Hard Disk: 300 MB free space

Additional hard disk space needed for project files averages 1-2 GB per project.
https://wufi.de/en/software/product-overview/system-requirements/

1.3.1 WUFI Passive Usability Settings

Phius recommends the setup shown below in Figure 1.1. To update the `Usability` settings, go to `Options → Usability` from the main toolbar in WUFI Passive. This will bring up options for the settings noted below.

- ☑ **Tool tip PHIUS+ Certification**: Checking these boxes turns on "hover-over" hints, which can be helpful for modeling. Keep in mind that the modeling protocol outlined in the Phius Certification Guidebook takes precedence over these tips.
- ☑ **Comments**: Allows users to type in notes or comments on specific tabs directly in the software.
- ☑ **Data recovery**: Automatically saves copies of the current WUFI Passive file being worked on.
  - Default file path: C:\ProgramData\WUFI\WUFIpassive\res
- ☑ **Show edit icons in table**: Any input in WUFI Passive that has an associated built-in calculator or additional table available to input data will automatically show a grey square with a "..." inside of it. Click this square to navigate to the built-in calculator.

Example:

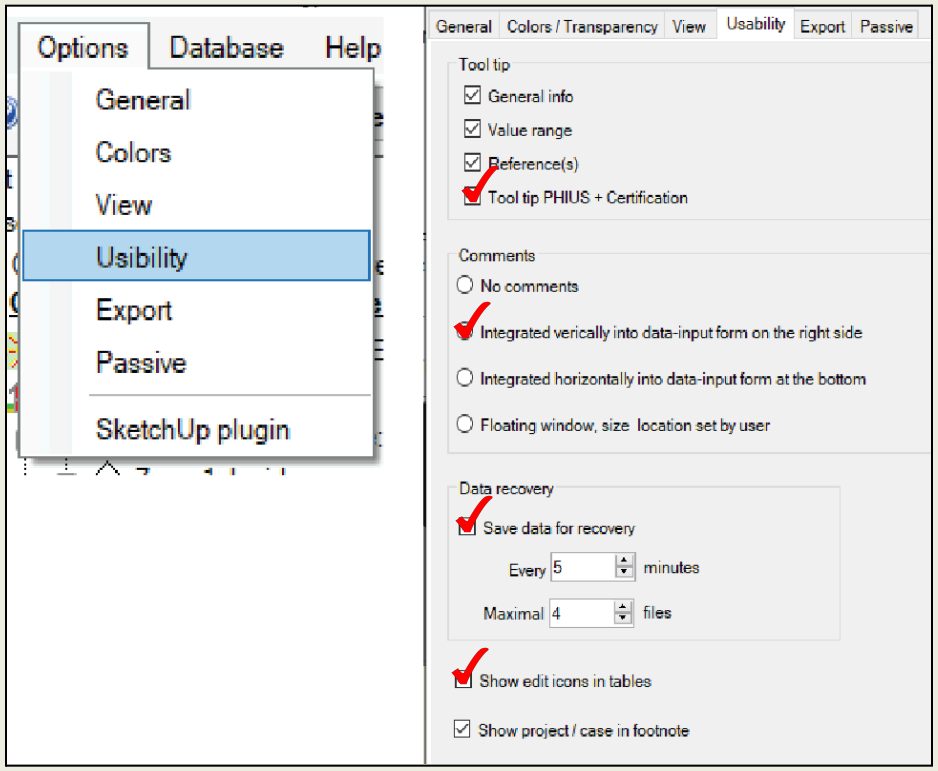


Figure 1.1. Screenshot from WUFI Passive showing the "WUFI Passive Usability Settings" recommended in Section 1.3.1.

2 - Creating 3-D Geometry

Energy models created in WUFI Passive include a 3-D geometry of the building. There are several options for creating the 3-D building geometry in WUFI:

- Building wizard
- WUFI's native 3-D editor
- SketchUp import
- gbXML import[1]

This guide will focus on Phius' recommended 3-D modeling process in SketchUp and the importing process from SketchUp to WUFI Passive through a direct SketchUp plugin. The plugin allows the user to define zones and properties of building components within SketchUp that can then be directly transferred into WUFI Passive.

2.1 Installing the WUFI Passive Plugin in SketchUp

To install the WUFI Passive plugin in SketchUp:

1. Right click on the WUFI Passive icon and select `Run as Administrator` to open WUFI Passive.
2. In WUFI Passive go to `Options → SketchUp Plugin`. Check `Use plugin into Sketchup`. Copy the following text from the WUFI Passive Screen (you will paste this text in step 4) (Figure 2.1):
   Sketchup.find_support_file("Plugins")
3. Go to SketchUp and open the Ruby Console:
   Sketchup 2021 or newer: `Extensions → Developer → Ruby Console`
   Older versions of Sketchup: `Window → Ruby Console`
4. Paste the text that you copied from WUFI Passive (step 2) into the Ruby Console. Hit `Enter`, and the file extension will appear in the Ruby Console window (Figure 2.2). Copy the entirety of the text populated in the window; you will paste this text in step 5. Close SketchUp. (This file path may vary depending on how and where SketchUp is installed (C: drive vs D: drive), but generally this file path will look something like: C:/Users...SketchUp/Plugins).
5. Go back to WUFI Passive and paste the extension from the Ruby Console under `SketchUp 'Plugins' subfolder:` and click `Install Plugin`.
6. Phius recommends checking the check-box to select `Group components when importing from SketchUp`.

In SketchUp, confirm that the plugin was installed correctly by checking that `WUFIplus` appears under the `Extensions` tab.

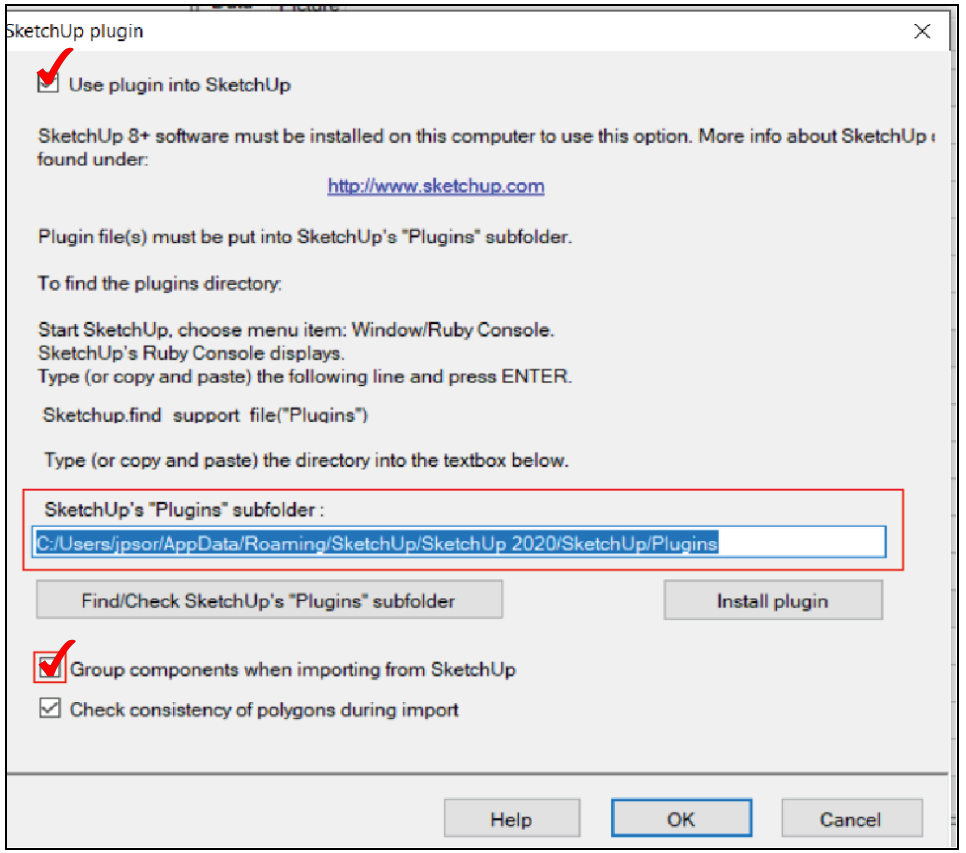


Figure 2.1. Screenshot from WUFI Passive showing steps 2 and 5 from Section 2.1.

[1] WUFI Passive does support gbXML files corresponding to CAD programs such as Revit, but there are known challenges with this method of import and it is not currently recommended.

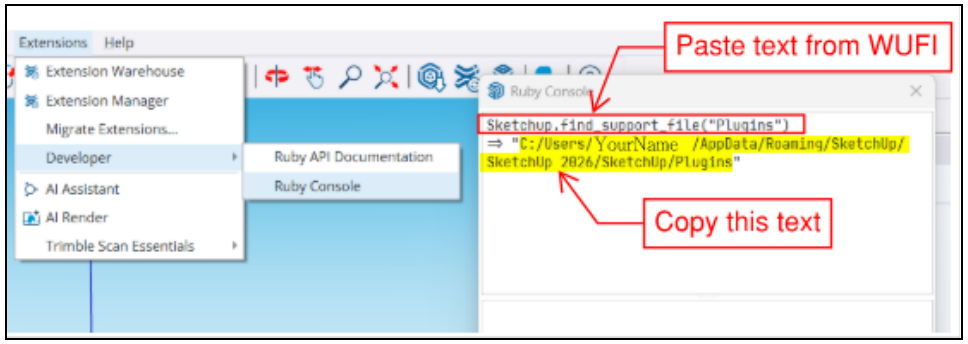


Figure 2.2. Screenshot from SketchUp showing step 4 from Section 2.1.

2.2 Preparing the 3-D Model in SketchUp

After the WUFI Passive plugin is installed in SketchUp, create a 3-D model to match the geometry of the building, and include any surrounding buildings or obstructions. This section describes the geometry modeling process.

Building geometry from scratch in SketchUp is the most reliable and tested method for importing geometry into WUFI Passive. Importing geometry from other softwares such as Rhino, Revit, ArchiCAD or AutoCAD into SketchUp can be done, but these file types must be cleaned up before importing to avoid convergence errors.

2.2.1 Create Tags

Before modeling any geometry in SketchUp, create tags to differentiate among components. In the `Tags` menu, click the `+` icon to create each new tag. Create a tag for each assembly type as shown in Figure 2.3. Set the SketchUp view to `Color by tag` to easily confirm which surfaces are assigned to which tags.

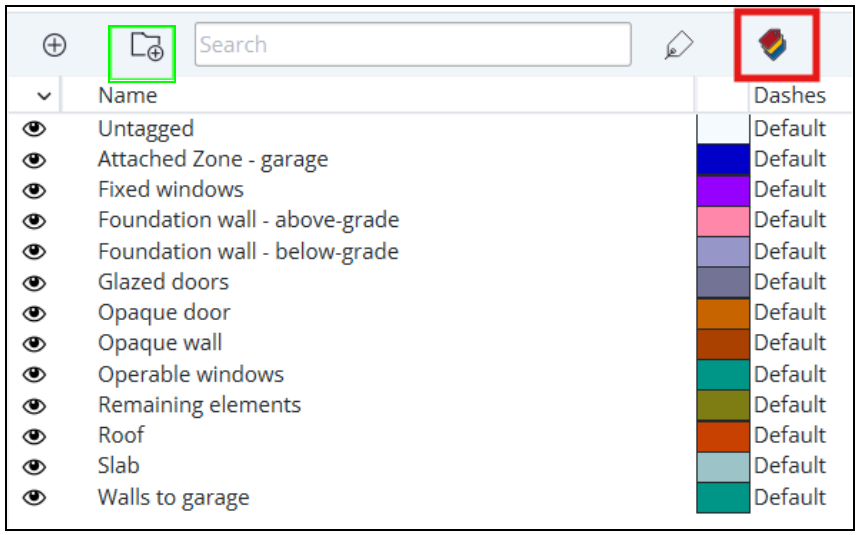


Figure 2.3. Common assemblies/tags. The green rectangle indicates the “add tag” button. Red rectangle indicates toggle to color the model geometry by tag.

When modeling in WUFI Passive, windows and walls need to be separated by assembly; e.g., a brick rainscreen wall assembly with exterior insulation should be a separate component from an exterior insulating finish system (EIFS) assembly and a fixed window will be a separate component from an operable window. Therefore, create a separate tag for each unique assembly type.

2.2.2 Create Building Mass

To prepare a 3-D model in SketchUp for WUFI Passive, follow these rules of thumb:

- The model should reflect only the building geometry, as measured to the exterior of the thermal envelope. The model should include extrusions (greater than 6”) that are within the thermal envelope such as elevator pits, penthouses, bumpouts, etc.
- The building components/elements should be modeled as single planes with no thickness.
- Within the model, each surface should be its own clickable unit. If groups are created in SketchUp, explode them before importing into WUFI Passive.
- Minimize the number of surfaces where possible to simplify import into WUFI Passive.

Set up the 3-D geometry as follows:

1. Import an architectural floor plan for a typical floor (typically the ground floor) that includes the extents of the envelope insulation. Scale the plan to the correct size.
2. Trace the extents of the outside face of insulation on the plan to create a closed polygon. This should create a single, flat surface.
3. Extrude the surface to the top of the roof insulation (Figure 2.4).
    a. If different floors have significantly different layouts, extrude the ground floor plan only to the level of the top of the roof insulation (if the next level is smaller) or to the underside of the floor insulation (if the next level is larger) of the varying floor plan (Figure 2.5). Then, import the architectural plan for that level at the height of the top of the extruded polygon. Repeat step 2.
    b. If you have a pitched roof, extrude the surface to the top of roof insulation at the lowest point of the roof. Then, draw triangles to extend the walls to the high point of the roof insulation, and create a sloped surface for the roof.
4. At any spaces that project beyond the typical thermal envelope such as penthouses and elevator pits, draw a polygon on the surface of the building mass in the appropriate location, to the extents of the thermal envelope of the projection. Then, extrude that rectangle to the appropriate height.
5. Where opaque wall types vary (e.g. wood-framed versus metal-framed), draw lines on the surfaces to divide them into unique surfaces.
6. Assign surfaces to the correct tags.

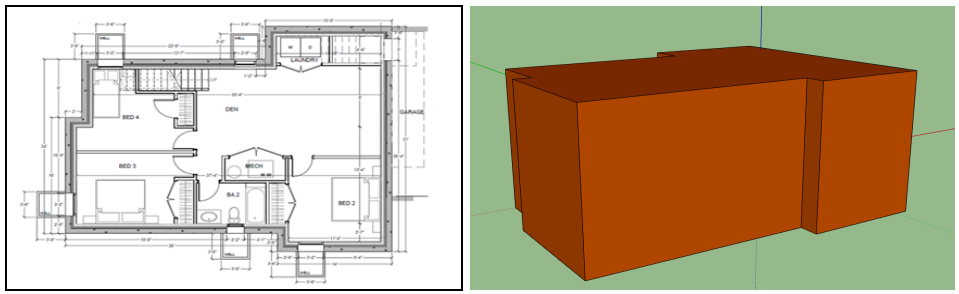


Figure 2.4. Building volume created by extruding the traced plan.

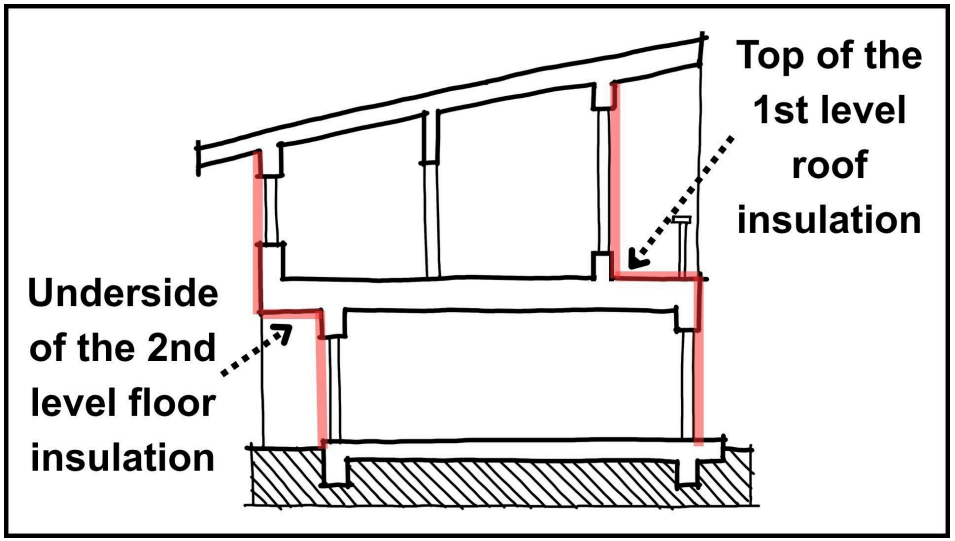


Figure 2.5. Section diagram showing where you would extrude a floor plan to the underside of floor insulation and to the topside of roof insulation.

2.2.3 Windows and Doors

Draw windows and doors onto the building walls, and skylights onto the building roof as applicable. Windows and doors should be drawn in the same plane as the wall (Figure 2.6). Details such as reveal depth will be assigned directly in WUFI Passive (see Section 3.3.2.2 below).

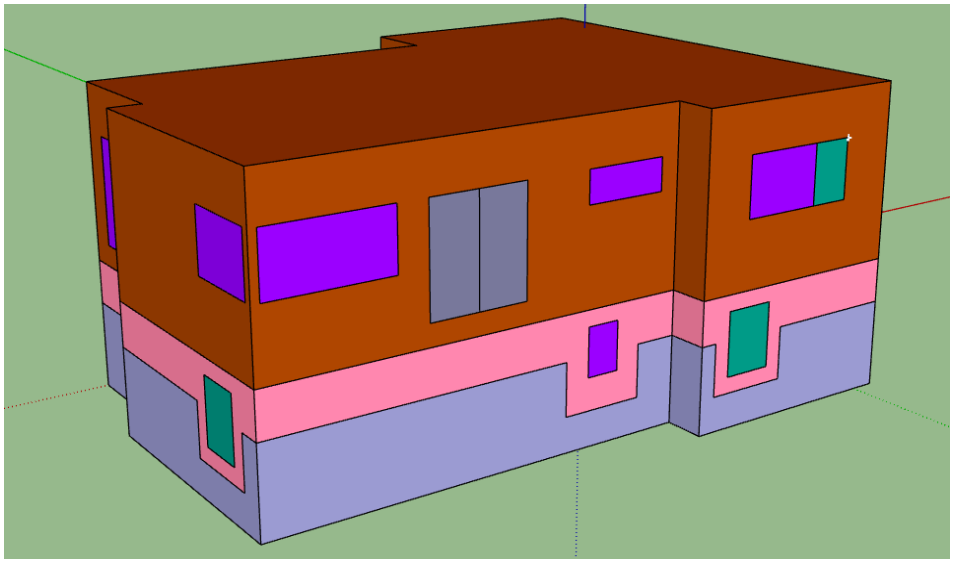


Figure 2.6. Building geometry with different wall types, windows, and doors drawn in.

Draw each lite as a single polygon to represent both glass and frame, as shown in Figure 2.7 below. Draw windows at their actual size and configuration, based on a window schedule; do not use rough opening dimensions (Figure 2.8). There should always be, at a minimum, a small area of opaque wall between any surface edge and a window or door frame.

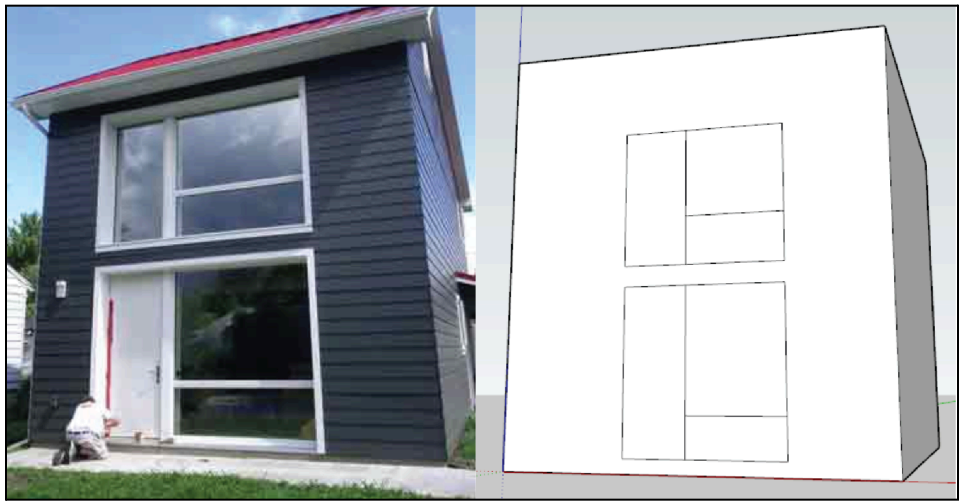


Figure 2.7. Model each lite of glass and door as a separate surface, to match the actual building configuration.

WINDOW AND EXTERIOR DOOR SCHEDULE									
ID	FRONT VIEW	UNIT SIZE		R.O. SIZE		ROUGH SILL HEIGHT	OPERATION TYPE	TOTAL UNIT U-FACTOR	SHGC
		WIDTH	HEIGHT	WIDTH	HEIGHT				
01		2'	3'	2'-2"	3'-2"	3'-1 1/2"	W1 Casement 18		

Figure 2.8. When modeling doors and windows, use the actual unit size (shown in red), not the rough opening dimensions.

Process Tip: If a building has repetitive windows, the following steps will simplify the modeling process:

1. Draw the geometry of one window.
2. Group line segments.
3. Click the move tool and press the `Ctrl` key while clicking on a corner of the window.
4. Enter the distance between windows.
5. Press `Enter` to create the first copy.
6. Type an asterisk followed by the number of repetitions (e.g. `*5` for five windows) to create an array of equally spaced groups (Figure 2.9).

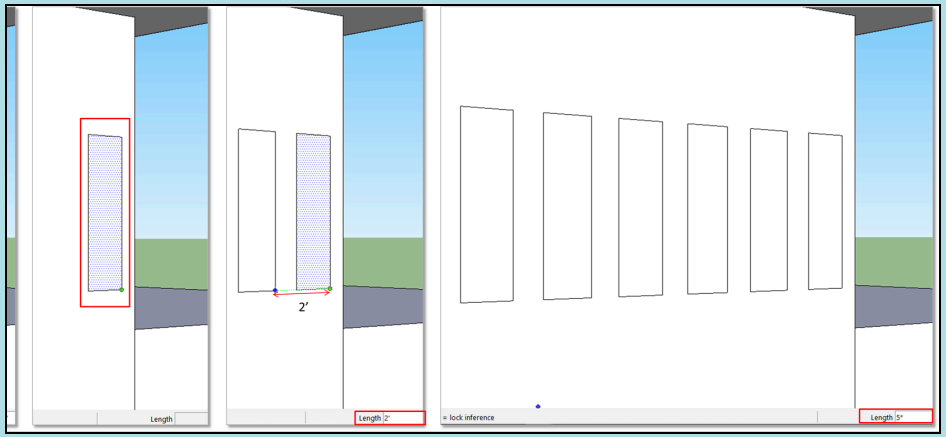


Figure 2.9. The SketchUp process for creating an array of repeating windows.

2.2.4 Site Shading / Context

The geometry should include opaque site context and shading elements that will have a direct impact on the building's performance (neighboring buildings, overhangs, trees, etc). This reduces the time and complexity to calculate the numerical inputs that were once required in past versions of WUFI Passive to account for horizontal/landscape obstructions entries, overhang, and related shading components.

Process Tip: WUFI Passive does allow for numeric overhang inputs which may be useful for early design analysis.

2.2.4.1 Permanent Obstructions

Model adjacent buildings as single-plane surfaces and model trees as simple two-dimensional circles “lollypop trees” (Figure 2.10)

Process Tip: It is not necessary to model the buildings in full; the face of adjacent buildings that is farthest from the project building need not be modeled, as shown in Figure 2.10.

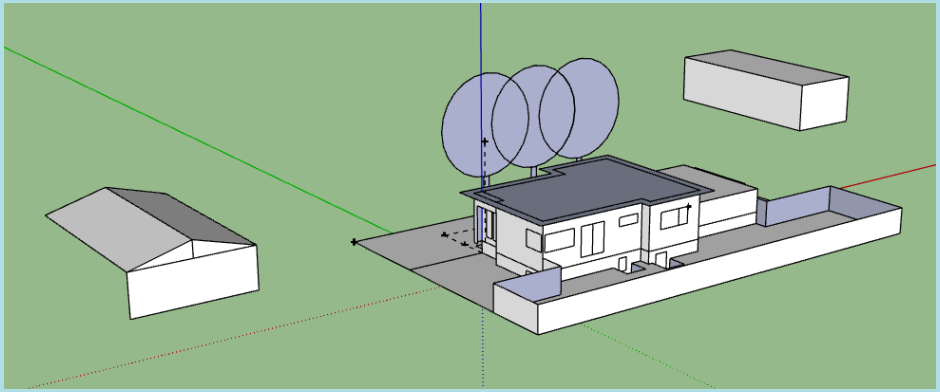


Figure 2.10. Adjacent shading elements including buildings, trees, and fencing modeled in SketchUp.

Process Tip: Usually, shading elements such as balconies or overhangs are modeled in contact with wall components in SketchUp. Once these geometries are imported into WUFI, this may generate interference errors between wall components, causing failure to import. Therefore, it is better to separate the shading element by a few inches from the wall component plane in SketchUp (Figure 2.11). Delete unnecessary shading surfaces (those that will be fully covered/shaded by surfaces above).

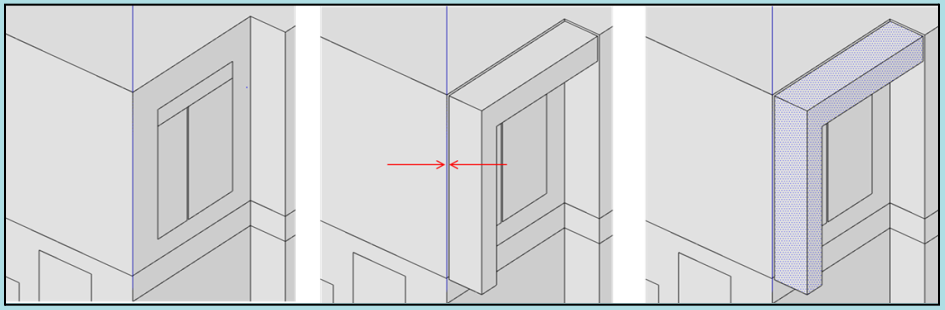


Figure 2.11. Shading elements on the building are modeled separately with a small space between the shading element and the building.

2.2.4.2 Seasonal Shading

As an alternative to modeling trees as permanent obstructions as described in Section 2.2.4.1 above, if the building is impacted by surrounding deciduous trees, you may account for the difference in summer and winter shading as described in this section.

To account for deciduous trees or seasonal shading using 3-D visualized geometry in WUFI Passive, refer to the Site Shading Modeling in the New WUFI Passive Shading Tool webinar and Contact Phius for access to the calculator and SketchUp plugin (Figure 2.12).

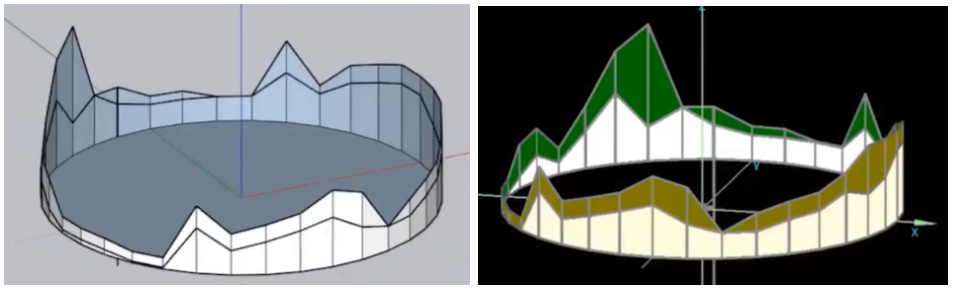


Figure 2.12. Winter and summer seasonal shading circles in SketchUp (left) and WUFI Passive (right).

2.2.5 Centering Circles

Phius recommends creating two additional circular components in SketchUp that will allow the project’s geometry to be centered in WUFI Passive (Figure 2.13). The component `Type` will be set to `Opening`, with `Outer air` assigned to both inner and outer sides. The idea is that the midpoint between these two components coincides with the ground level of the project in SketchUp. The largest circle should encompass the full model geometry so that the Z-axis falls in the middle of the WUFI Passive model (Figure 2.14).

When the geometry is imported into WUFI Passive, these components will not shade or otherwise affect the project, but Phius recommends deleting them (this will not undo the centering). If not centered, the building geometry will appear far away from the origin in WUFI Passive, which will make navigating the 3-D geometry in WUFI Passive difficult.

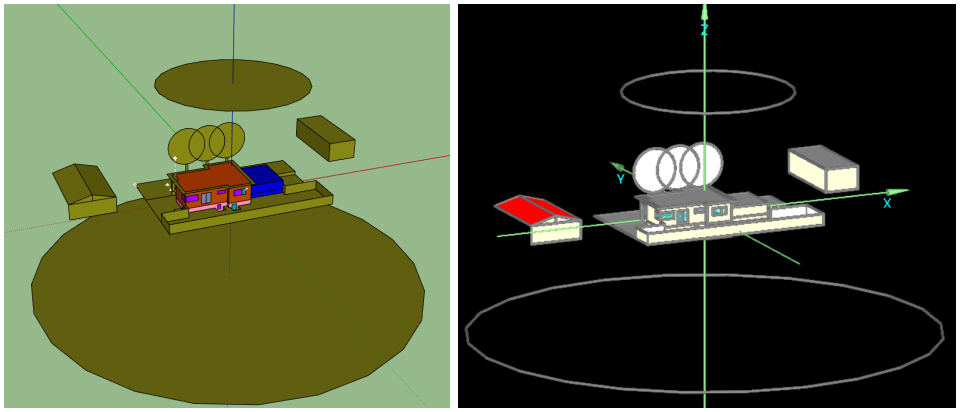


Figure 2.13. SketchUp (left) and WUFI Passive (right) showing the modeled centering circles.

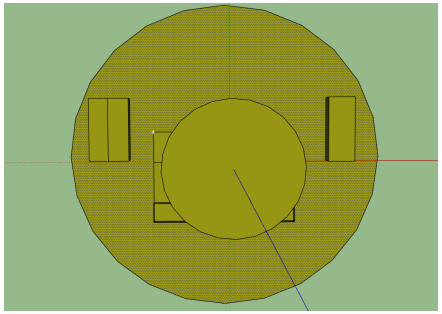


Figure 2.14. The largest centering circle encompasses the full extents of the model, as shown in plan.

2.2.6 Modeling to Avoid Import Errors

There are often extraneous geometries, line segments, and object intersections within the SketchUp model. If this occurs, WUFI Passive will notify you that not all polygons were imported. The geometry may be fixed within WUFI Passive or SketchUp. If fixes are made within SketchUp, the file must be reimported into WUFI Passive. If the fix is made in WUFI Passive, there is no way to connect the changes back to the previously imported .wps file from SketchUp.

This section includes guidance for modeling atypical geometries in SketchUp to avoid import errors.

2.2.6.1 Non-Linear Geometry

WUFI Passive divides curved elements (circular walls or windows) that were modeled in SketchUp as a single component into multiple flat planes/segments.

In the case of transparent components, segments may be broken into components that are too small to appropriately reflect the frame conditions, leading to unresolvable errors in WUFI Passive (re-import of geometry required). To solve this issue, model curved window elements in SketchUp as flat components (Figure 2.15).

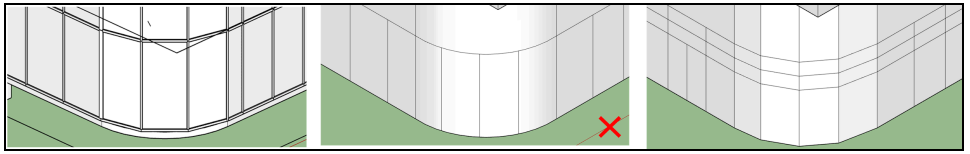


Figure 2.15. SketchUp images showing how curved elements should be approximated as flat components.

2.2.6.2 “C”, “L”, and “U” Shapes in Building Geometry

When a building geometry has unique non-rectangular surfaces, import errors may occur where an entire surface is missing. Breaking these shapes into true rectangles, as shown in Figure 2.16 below, typically fixes this issue. A common occurrence where this may appear is at bumped-out building geometry, as shown in Figure 2.17 below.

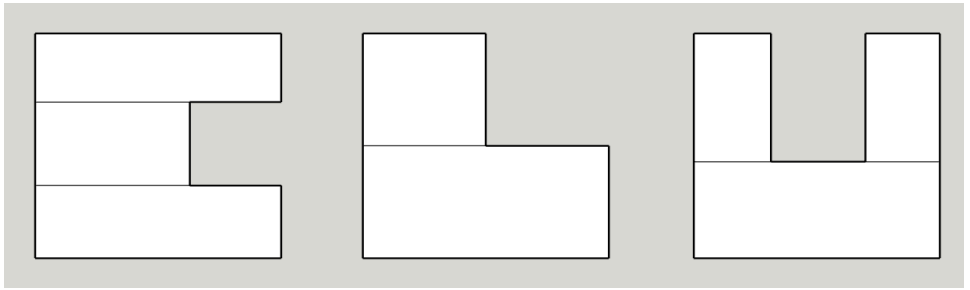


Figure 2.16. Modifying “C”, “L”, or “U” shaped geometry to avoid import errors.

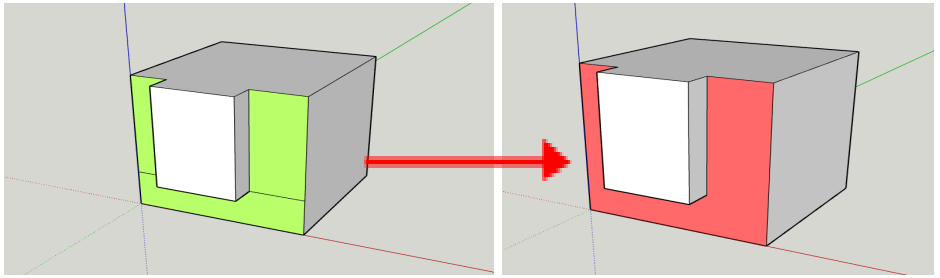


Figure 2.17. Modifying “U” shaped geometry at a bump-out condition to avoid import errors.

2.2.6.3 Fenestration at Geometry Edges and Corners

Glazing or fenestration components that join at a corner or edge of the building geometry can create “C” shapes in the opaque wall. This may lead to the glazing not getting properly cut out of the opaque wall geometry, leading to overlapping or missing geometry. To address this issue, add a small gap between the window and corner of the building geometry, so that the wall is a single rectangular shape with a rectangular hole punched through it, as shown in Figure 2.18.

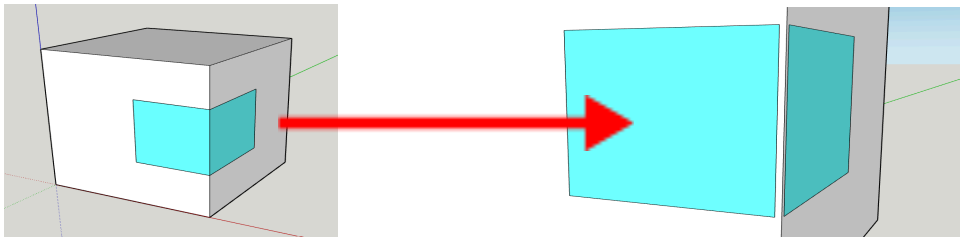


Figure 2.18. Modifying “C” shaped opaque wall geometry at a corner window condition to avoid import errors.

2.2.6.4 Intersecting Lines and Planes

Overhangs or other shading components that protrude from an otherwise smooth, continuous surface can create import errors if drawn directly on the face of the building surface. Similar to the correction above, add a small gap between the building geometry and shading component so that the components are completely isolated from each other, as shown in Figure 2.19. It is best practice to separate all components intersecting with the building using this method (including roof overhangs, fences, “attached zone” geometry such as garages, etc.).

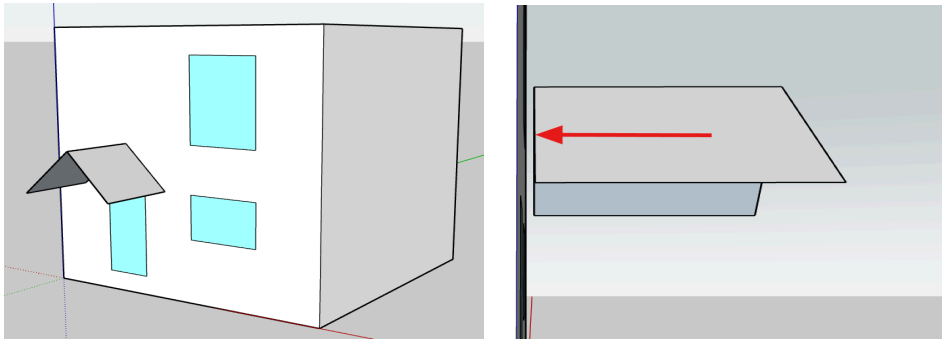


Figure 2.19. Isolating shading geometry from building geometry to avoid import errors.

2.2.6.5 Other Oddities & Miscellaneous Tips

Buildings come in all shapes and sizes. In general, when a particular component is having difficulty importing properly into WUFI Passive, try splitting geometry into smaller, more simplified shapes until it successfully imports. This can also help with isolating the particular area or line segment that is causing problems. For example, if a rectangle is split into two triangles, and only one of them successfully imports, split the triangle into two smaller triangles. If, again, only one half imports correctly, zoom into the lines surrounding the area that is missing and double check that all lines are connected properly, lines are on the same plane and orthogonal, and there are no extra/unnecessary lines drawn that may be getting in the way. More often than not, there will be a micro-mistake that is causing the issue.

Process Tip: Complete a test import of the building massing **prior to** adding fenestration and shading components.This will help identify early any problem geometry, which is more difficult to fix when the model becomes more complex.

Hidden Geometry: Beware of hidden or accidental geometry. SketchUp automatically creates surfaces when three or more lines are connected on the same plane (as shown in Figure 2.20), so double check that there are no interior surfaces prior to import. This can be tricky to see and fix in WUFI Passive, but the tools in the geometry viewer side-ribbon can be used to adjust the visibility settings to identify and remove hidden components, as shown in Figures 2.21-2.23 below. Use the `Transparent/Opaque` tool to turn surfaces slightly transparent to see hidden geometry components. When a surface is selected, it becomes opaque. To delete the hidden geometry, first right click on the component that is in front of it, open the `Properties` dialogue box, and check the box for `Enable not visible/not selectable`. Close the dialogue box, then use the `Switch option not visible/selectable (on/off)` tool in the side-ribbon (Figure 2.21) to hide the surface. This allows the user to select the accidental geometry and delete the component(s).

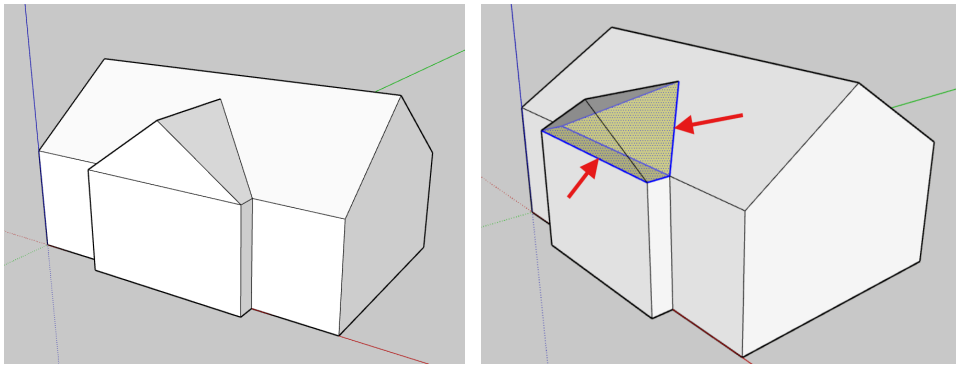


Figure 2.20. Hidden or accidental geometry planes caused by a dormer/bump-out condition.

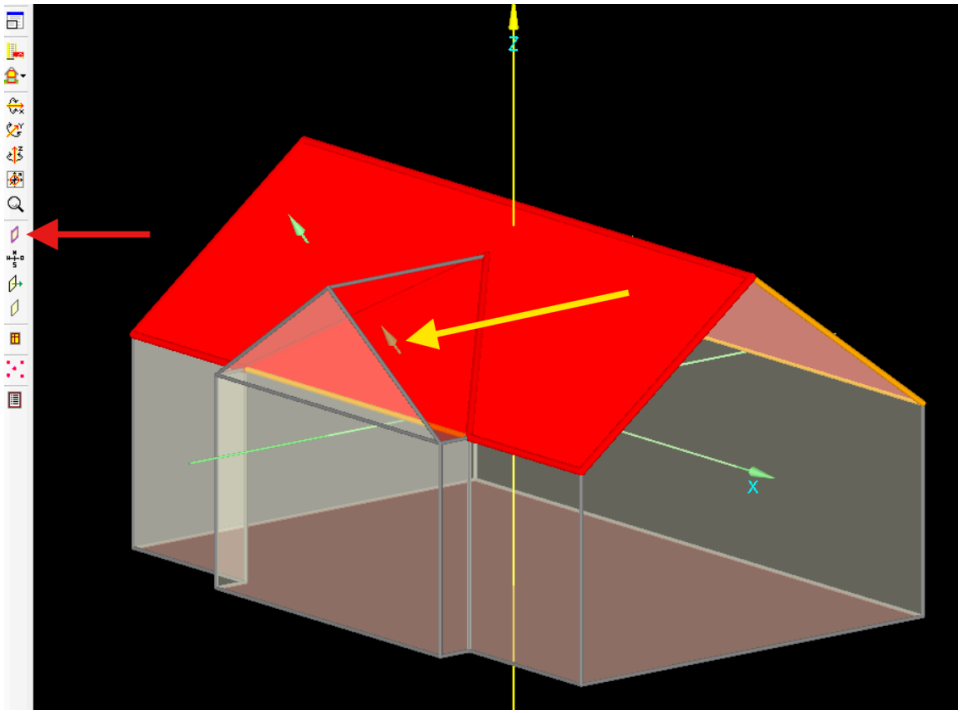


Figure 2.21. The `Transparent/Opaque` tool turns surfaces slightly transparent.

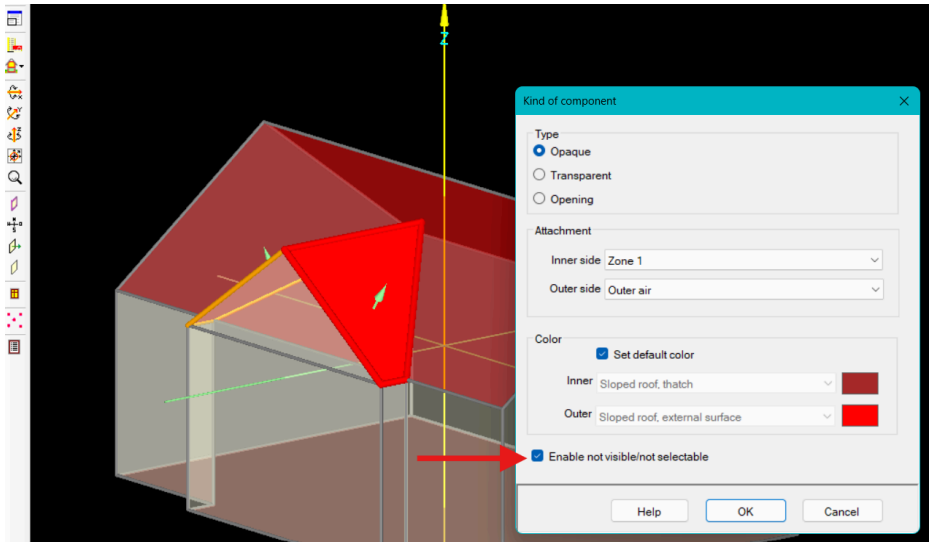


Figure 2.22. To hide a component, check the box for `Enable not visible/not selectable`.

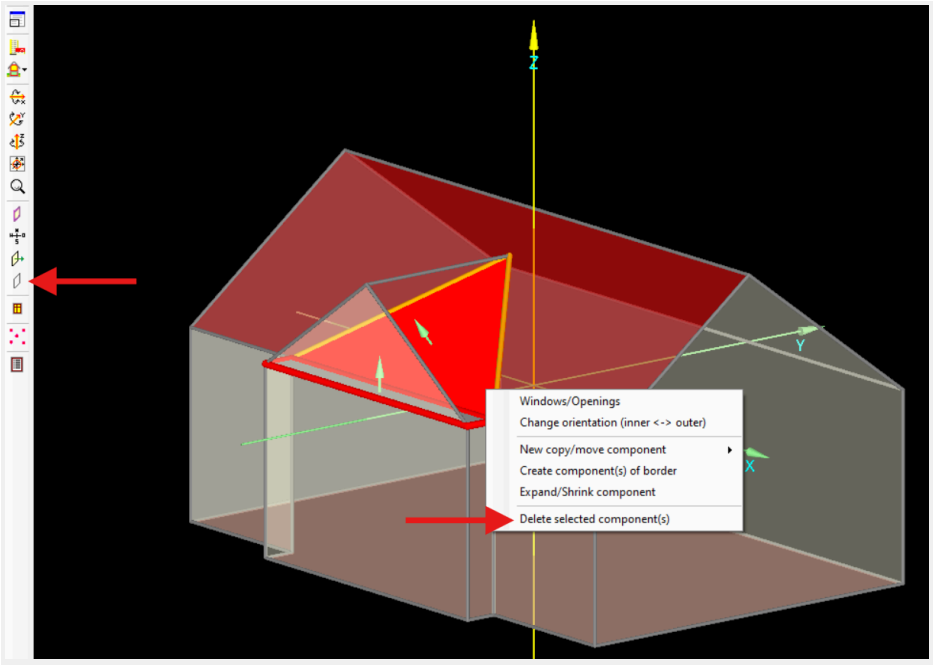


Figure 2.23. Using `Switch option not visible/selectable (on/off)` to hide the surface, then deleting the extraneous component.

Offsets: When there are small offsets (<6”) in the building geometry (e.g., due to varying levels/types of insulation), align the planes with the farthest extruding component as shown in Figure 2.24.

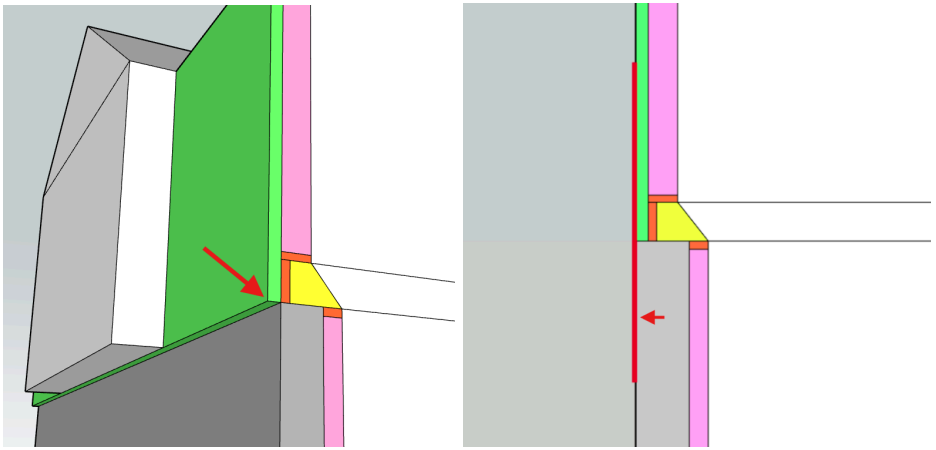


Figure 2.24. A basement wall is offset from the above grade wall due to the transition from exterior continuous insulation to interior cavity insulation. In this case, the above grade wall protrudes out further, so the basement wall should be extruded to align.

Rim Joists: Rim joists should not be separate surfaces in the geometry. They should be treated the same as the “typical” wall assembly in that location. Only separate walls when there is a true change in the base assembly (e.g., above grade vs. below grade walls) as shown in Figure 2.25. This relates to thermal bridge modeling protocol: the reduction in thermal performance of the adjacent opaque wall due to thermal bridging at the rim joist should only be accounted for with a thermal bridge calculation.

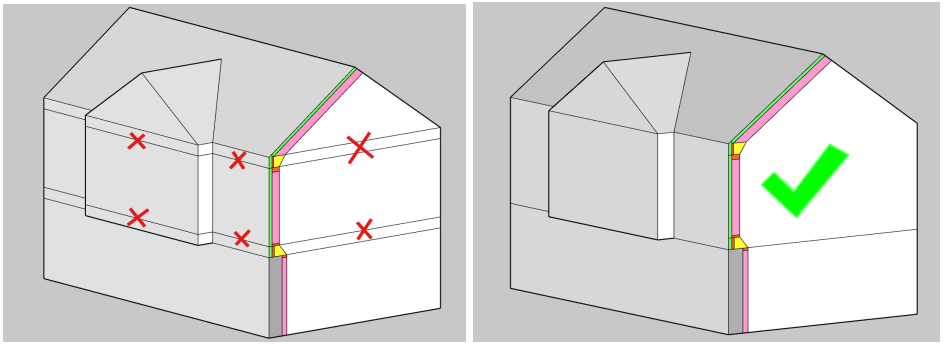


Figure 2.25. Do not separate rim joists from walls. Extra lines can be erased except where the wall transitions from above to below grade assemblies.

Fenestration Components Within a Plane: When modeling fenestration components, be sure that the geometry is on the same plane and that it is truly being cut out of the host plane. This can be easy to miss in SketchUp in larger buildings, but pay attention to the line weights in SketchUp: lines that cut a plane are thinner, while lines at the edge of a surface appear slightly thicker. In WUFI Passive, use the `Windows/Openings` tool in the ribbon to confirm the fenestration is embedded in the host plane.

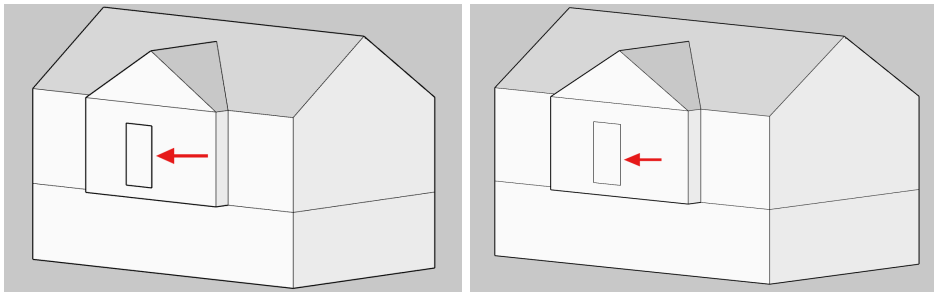


Figure 2.26. Line weights in SketchUp indicate whether objects are on the same plane.

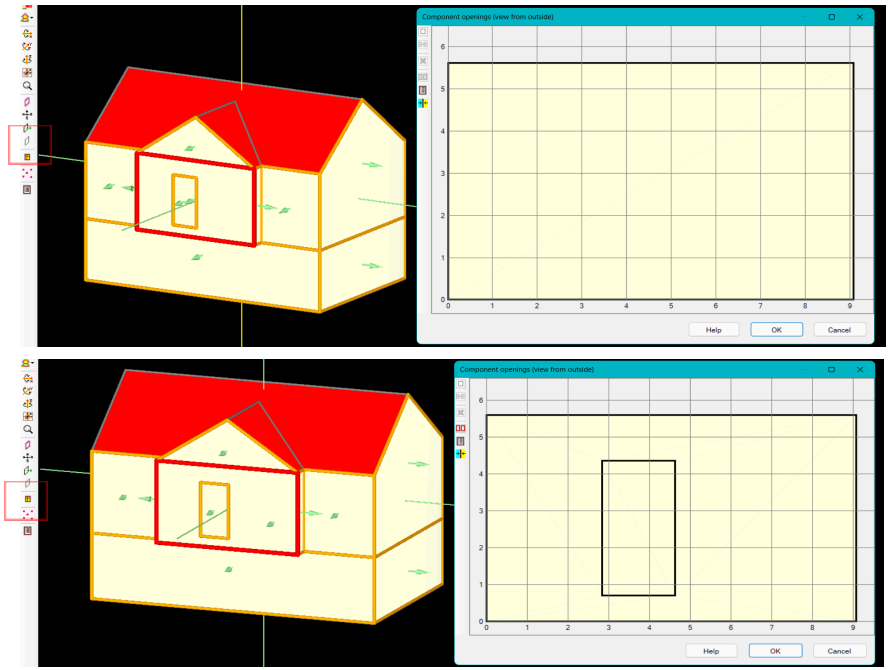


Figure 2.27. Use the `Windows/Openings` tool in the geometry viewer side-ribbon to confirm whether fenestration components are being cut out of the host plane. In the top image, the door appears to be cutting out of the wall, however there are no openings according to the `Component openings` dialogue box. In the bottom image, the door is shown as truly embedded in the wall.

Checking Surface Orientation: Before exporting the geometry from SketchUp, the final step is to check that all surfaces are oriented correctly. This avoids the need to regroup and flip surfaces in WUFI Passive, which can be time consuming if there are many backwards surfaces. This is especially important if using colors in SketchUp to distinguish different assemblies because it becomes less clear whether the plane is facing the right way once it is painted. In SketchUp, the default material when drawing objects is white on the outside and blue-gray on the inside. So, prior to export, select all surfaces and use the paint bucket tool to apply the default material. Orbit around the model to check that all surfaces are white. If any are blue-gray, right click the surface and select `Reverse Faces` from the list of options to. The surface should turn white and is then oriented correctly.

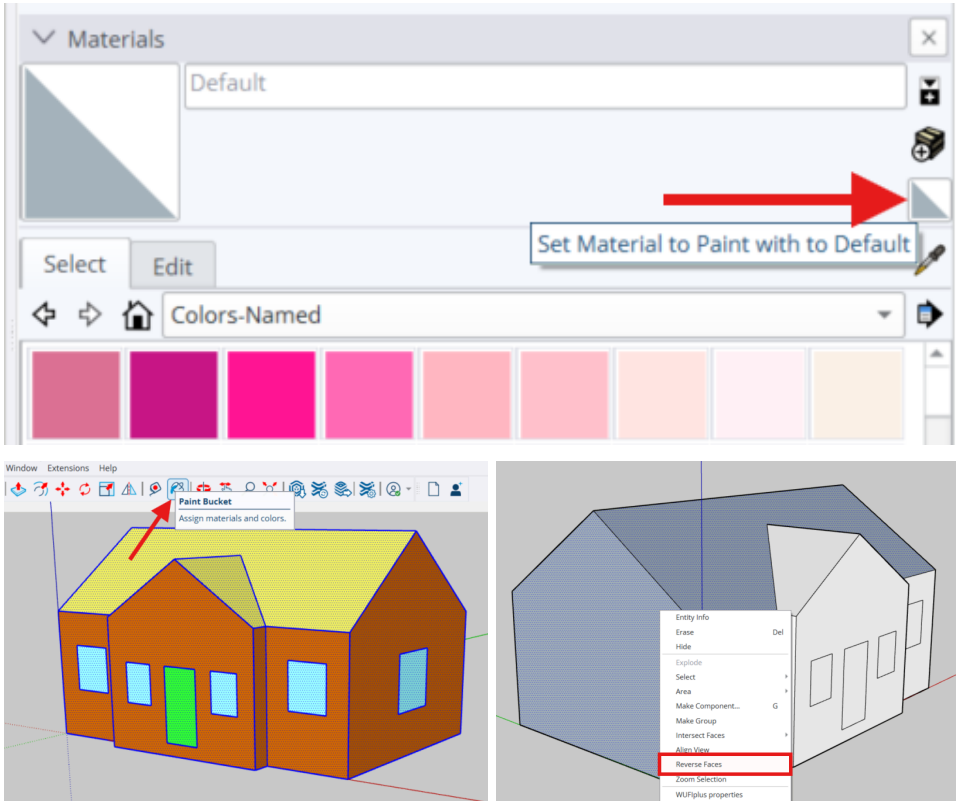


Figure 2.28. First, set the material to Default. Then, select all surfaces and apply the default material using the paint bucket tool. Check all surfaces of the model and reverse the faces of any that are blue-gray.

2.3 Assign Properties

Upon completing the geometry, assign WUFI Passive properties to the components of the model within SketchUp. Components with the same WUFI Passive properties assigned and the same orientation from horizontal will be grouped together when importing into WUFI Passive.

When assigning WUFIplus properties, right click on the tag name and choose `Select all with same tag` to select all surfaces of the same assembly type. Then, right click on one of the surfaces to assign WUFIplus properties to all surfaces with that tag (Figure 2.29).

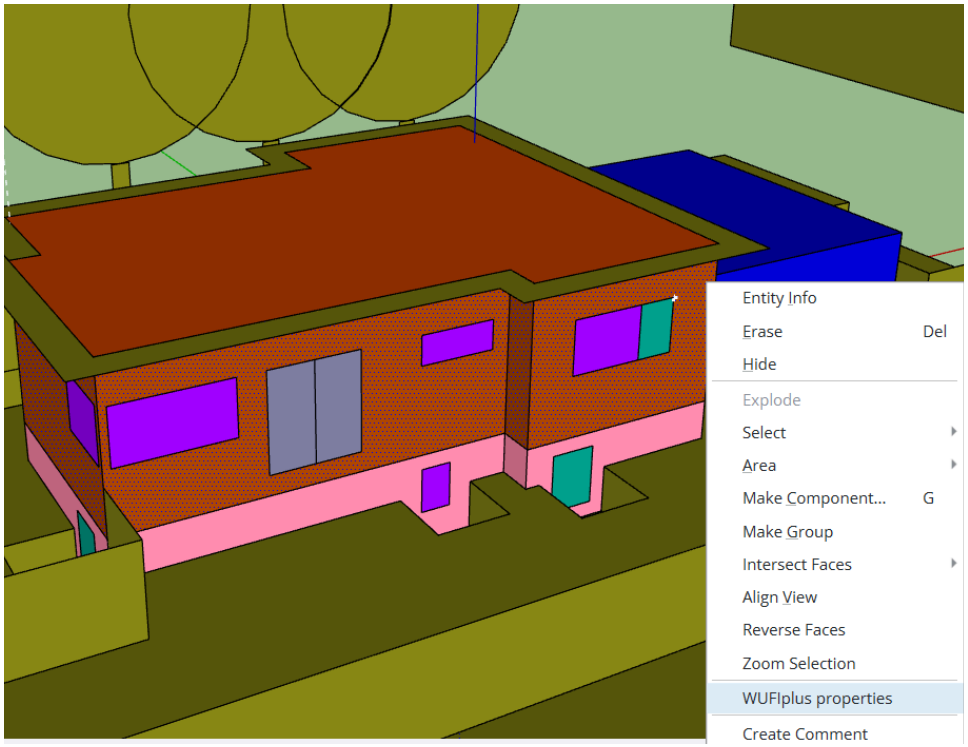


Figure 2.29. WUFIplus properties tab after right-clicking a component in SketchUp.

Process Tip: To ensure that all components have been assigned WUFI Passive properties, right click and `hide` each component after assigning it WUFIplus properties. This method will ensure that no components are missed or unintentionally assigned incorrect properties.

To combine surfaces of the same assembly type into a single component for import into WUFI, there are a few options:

- For simple models with 12 or fewer individual components, Phius recommends assigning each unique component type to different inner and outer sides. Use a table or list to document the types assigned to different components; see Appendix A for an example.
- For projects with more than 12 individual component types, creating additional zones in SketchUp may be beneficial; see the Example.

The following sections summarize the various WUFIplus property options in SketchUp, outlined in Table 2.3.0:

Table 2.3.0 SketchUp Assignment Properties

Component Types	Transparent
	Opaque
	Not Relevant (will not import into WUFI)
	Opening
Inner Side	Respective zone/zones created
	Outer air
	Ground
Outer Side	Respective zone/zones created
	Outer air
	Ground
	Adiabate (Space with same inner conditions)
Orientation Options	Ok
	Reverse by export

Example: To make grouping in WUFI Passive easier for larger projects, use multiple Zones in SketchUp to group surfaces of the same component type together (Figure 2.30). Assign the inner side of surfaces of identical component types to the same zone (Figure 2.31). These components will then be imported together into WUFI Passive in separate zones (Zone 1, 2, 3, etc.). Once in WUFI Passive, you can revise the `Inner side` of each group of windows back to the appropriate conditioned zone (typically Zone 1), and the surfaces of the same assembly type will remain grouped together as separate components. Then, in WUFI Passive, under `Building` → `PH Case`, delete the remaining zones that no longer have visualized components. This process is beneficial when buildings have multiple window or wall types (fixed, operable, storefront, glazed doors, sliding glass doors etc.).

Document all zones used and which component is assigned to each. Include the list of zones with the SketchUp model when submitting to Phius for design review.

The drawback with this approach is that, each time SketchUp is opened, the number of zones under WUFIplus properties automatically defaults to 1. The user must re-enter the correct number of zones each time.

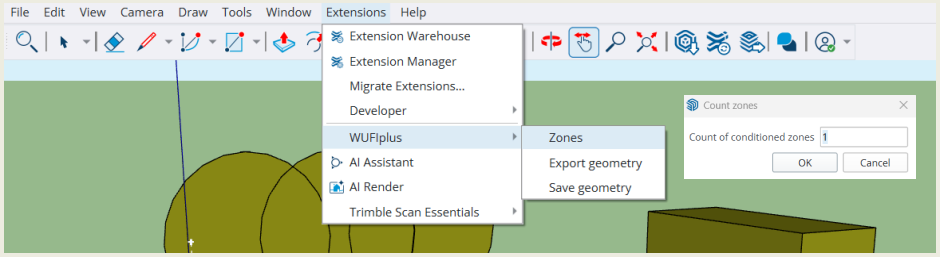


Figure 2.30. Modifying zone count in SketchUp WUFIplus properties.

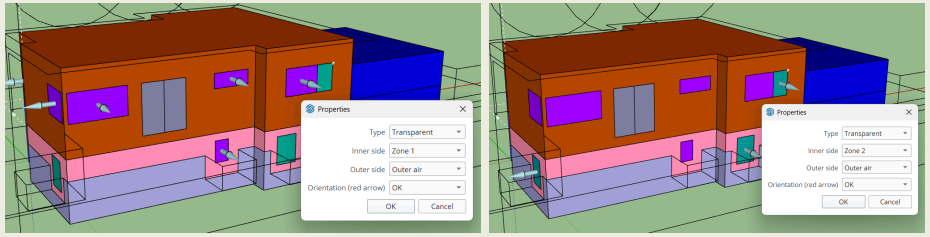


Figure 2.31. The purple (fixed) windows will be grouped together as a single component when imported into WUFI Passive; the green (operable) windows will be grouped together separately.

2.3.1 Component Types

`Transparent` and `Opaque` are the most commonly used. Select `Transparent` for all transparent assemblies, including fixed and operable windows and glazed doors. Also select `Transparent` for spandrel panels and blank-off louvers. Select `Opaque` for all opaque assemblies including walls, roofs, and slabs on grade, as well as doors with less than 33% glazed area. Select `Opaque` for shading elements such as canopies and trees.

`Not relevant` is the default setting and will result in the component not being imported into WUFI Passive.

`Opening` will default when a hole in the middle of a component is created; the user should not assign this component type.

2.3.2 Inner Side

The inner side should typically be set to Zone 1. If you are using multiple zones in SketchUp to group objects for import into WUFI Passive, assign components of the same type to the same zone.

Assign the inner side to `Outer Air` for shading elements that are not part of the building envelope (e.g. trees, parapets, overhangs, adjacent buildings).

If multiple zones are required due to differences in usage or set points, a separate model should be created as set points and usage type are not editable for individual zones.

2.3.3 Outer Side

Use `Outer Air` for enclosure assemblies that separate interior space from exterior air.

Use `Ground` for assemblies that separate interior space from the ground (e.g. below-grade walls, slabs on grade).

Assign the `Adiabate` property (called `Space with the same inner conditions` in WUFI Passive) to components that have the same properties on both sides, resulting in the absence of heat transfer through the respective component. Use this setting for the outer side of a component that is attached to a conditioned space that is not part of the certified portion of the building. For example, a multifamily building that has a first floor commercial space outside of the Phius-certified boundary would assign the outer side of the commercial space to `Adiabate`.

WUFI Passive will count the area of components assigned to `Space with the same inner conditions` towards the surface area of the project for the airtightness testing criteria, but the surface area will not be included when calculating the envelope-to-floor area ratios used to determine the space conditioning targets. This means that these components contribute to meeting the whole-building airtightness criteria, but transmission losses are assumed to be negligible. `Adiabate` should be assigned to any component that is in contact with a conditioned space outside of the passive building thermal envelope.

Select the same zone as the inner side only if the adjacent zone is also being certified.

If there are any attached zones (spaces with unconditioned [or semi-conditioned] fully enclosed spaces that are sheltered from true exterior conditions, create an additional zone in SketchUp under `Extensions → WUFIplus → Zones`. Assign this zone to the outer side of building enclosure components that touch the attached zone. Spaces with the outer side assigned to an attached zone will count the area of the components towards the surface area for the airtightness testing criteria and for calculating the envelope to floor area ratio used to determine the space conditioning targets. In WUFI Passive, you will create a separate Attached Zone and reassign the outer side of these components to that Attached Zone.

Table 2.3.3.0 summarizes the inner and outer side assignments for elements facing various adjacent space types.

Table 2.3.3.0 Inner & Outer Side Assignments			
Applicable components	**Inner Side**	**Outer Side**	**Used for**
Components in contact with unconditioned but sheltered spaces	Zone 1	Attached Zone	Attics, attached garages etc.
Components in contact with other certified spaces	Zone 1	Zone 1	Mixed-use projects where multiple models are needed to capture varying building usage.
Components in contact with other conditioned but not certified spaces	Zone 1	Space with same inner conditions	Conditioned spaces outside of the passive building enclosure.

2.3.4 Orientation Options

When you click on a component in WUFI Passive, a green arrow appears pointing in the direction of the “Outer” side. In SketchUp, arrows appear when assigning WUFIplus properties. The arrow always starts from the ‘Inner’ side and points to the “Outer” side.

In SketchUp, when assigning WUFIplus properties, there are two options for Orientation. If the arrow is pointing outward, choose `OK`. If the arrow is not pointing to the outer side of the component, it is cleaner and quicker to flip the orientation of that component directly in SketchUp by selecting the component, right clicking and choosing `Reverse Faces`. This will ensure the SketchUp model is correct for future use. Refer to Section 2.2.6.5 for additional tips on this process.

The orientation of the arrows does not matter for shading elements.

Table 2.3.4.0 WUFIplus Properties for Common Assemblies				
Component Type	**Property**	**Inner Side**	**Outer Side**	**Orientation Setting**
Windows	Transparent	Zone 1	Outer Air	Arrow points outward
Walls / Roof	Opaque	Zone 1	Outer Air	
Slab / Floor	Opaque	Zone 1	Ground	
Shading Elements	Opaque	Outer Air	Outer Air	Does Not Matter

2.4 QA SketchUp Model Before Export

When the SketchUp model is complete and all WUFIplus properties are assigned, refer to Table 2.4.0 and perform a quality assurance check to avoid needing to re-import later.

If you mislabel or misassign a component in SketchUp, or need to make changes, properties can be changed in WUFI Passive to avoid the need to re-import. Phius recommends also fixing the SketchUp file at the same time in case a future re-import from SketchUp to WUFI Passive is required.

Table 2.4.0 QA Checklist Prior to Export		
Item No.	**Complete?**	**Item**
2.4.1	☐	Confirm overall building dimensions (plan and section).
2.4.2	☐	Check window sizes and locations.
2.4.3	☐	Confirm site shading/context is modeled.
2.4.4	☐	Simplify geometry; reduce number of polygons imported to WUFI Passive. Delete lines that divide coplanar, adjacent surfaces in the same component into multiple surfaces.
2.4.5	☐	Spot check that WUFIplus properties are assigned correctly.

2.5 Finalizing SketchUp Model for Export

After checking the model, save the SketchUp (.skp) file as a .wps file: go to the SketchUp toolbar and select `Extensions → WUFIplus → Save Geometry`. See Section 3 below for guidance on how to import the .wps file.

Process Tip: Using the `Export geometry` option has known issues and is not recommended.

Note that saving a .wps file is **not** the same as saving the SketchUp (.skp) File. They are two separate files. To save a SketchUp file, go to `File → Save` in SketchUp. You cannot open a .wps file in SketchUp; if you want to revise your .wps file, you must open the SketchUp file, make the edits, and re-save the .wps file.

3 - Navigating WUFI Passive

3.1 Opening WUFI Passive

When opening a blank/new WUFI Passive file, dialog boxes and menus will appear as shown in Figure 3.1.

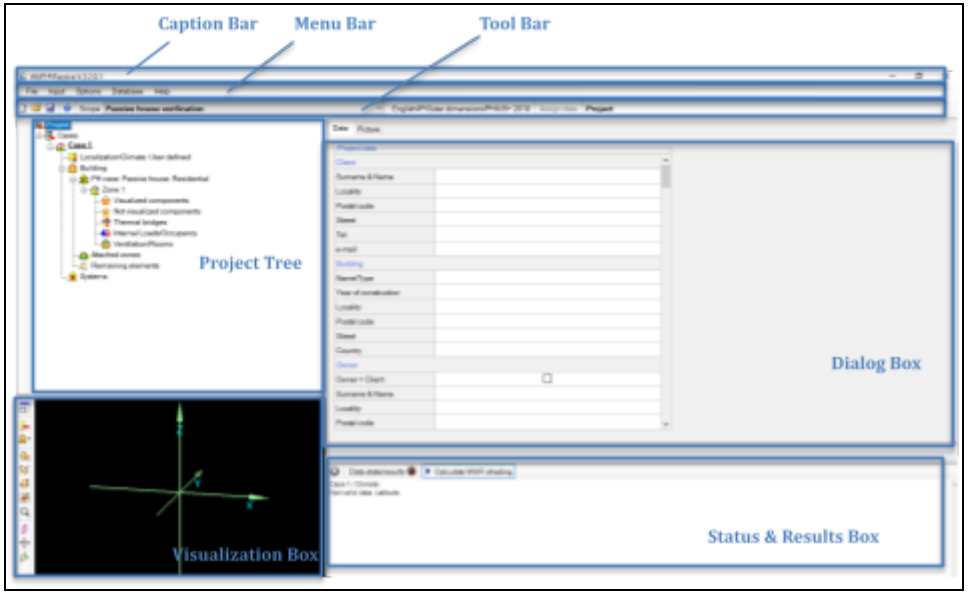


Figure 3.1. WUFI Passive user interface.

Before beginning, Phius recommends expanding the visualization box so all options are visible on the toolbar (Figure 3.2).

3D Preview of Building - WUFI-Passive Tools

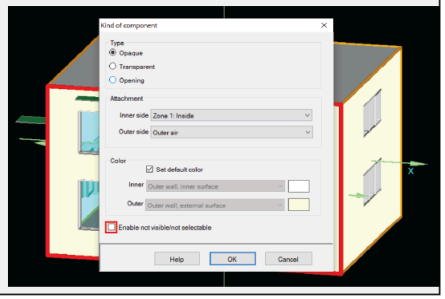
Expands the 3D visualized geometry window.	1
Building Wizard: Overrides existing geometry.	2
Zones: 'Left click' and hold will hide/view elements assigned to different zones.	3
Axis Rotations: Rotate the 3D visualized geometry around the axis chosen. Example: 'Left click' the 'Z' axis button to rotate counter-clockwise. 'Right click' the 'Z' axis button to rotate clockwise. If an axis rotation option is selected, a mouse scroll wheel will rotate the building.	4
Center the Building: Re-centers the 3D visualized geometry window on the origin point.	5
'Left click' = zoom in. 'Right click' = zoom out. If selected, a mouse scroll wheel will zoom.	6
Toggles all components between opaque and transparent.	7
Toggles the compass rose on and off.	8
Toggles the green vector arrows on and off. PHIUS recommends keeping these vectors turned on.	9
Toggles components that have 'Enable not visible/not selectable' on and off. See notes below.	10
Select a component with a 'Left Click'. While component is highlighted, 'Right Click' to open 'Kind of Component' properties. Check/Uncheck the box for 'Enable not visible/not selectable'. 	
Select a component (wall or roof) with a 'Left Click'. Click the 'Comonent Openings' icon and a 2-D view of the component selected will appear. Windows and openings can be edited in this view.	11
Toggles vertices on/off. Useful when making small adjustements to building geometry in WUFI. When not making adjustements to vertices, PHIUS recommends toggling this option off.	12
Options dialogue box. Allows adjustments to be made to color/transparency of all component types, vertice sizes and other options for view in the 3D visualized geometry window.	13

Figure 3.2. Full WUFI Passive toolbar and function of each button.

3.2 Importing Geometry

To import the .wps file in WUFI Passive, go to the Project Tree, click on the `Building` tab, and then select `SketchUp Import`. Navigate to your .wps file and click `Open` (Figure 3.3).

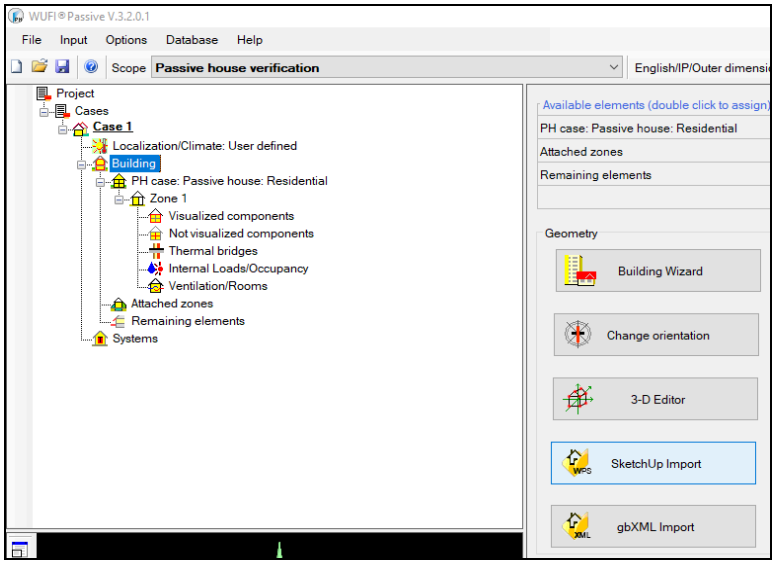


Figure 3.3. Building tab for SketchUp import.

3.3 Verifying Geometry Import

After importing the SketchUp geometry into WUFI Passive, refer to Table 3.3.0 and perform a quality assurance check.

Table 3.3.0 QA Checklist After Import

Item No.	Complete?	Item
3.3.1	☐	Confirm there are no holes (missing components) in the building geometry.
3.3.2	☐	Check that all windows imported.
3.3.3	☐	Confirm site shading/context imported.
3.3.4	☐	Confirm the building is oriented correctly.

When importing the .wps file geometry into WUFI Passive, some components may fail to import. If the SketchUp file had extraneous line segments, object intersections, or irregular shapes, those objects are most likely to have issues. If this occurs, WUFI Passive will notify you that not all polygons were imported. There are two options to correct this:

- If only a few polygons were not imported and the missing polygons are obvious, the geometry may be fixed directly within WUFI Passive utilizing vertices from within the visualization box (Figure 3.4). Refer to Section 3.4.
- If many polygons were not imported, and/or it is not clear in the visualization box which polygons are missing, it may be efficacious to edit the geometry in SketchUp and re-import into WUFI Passive.

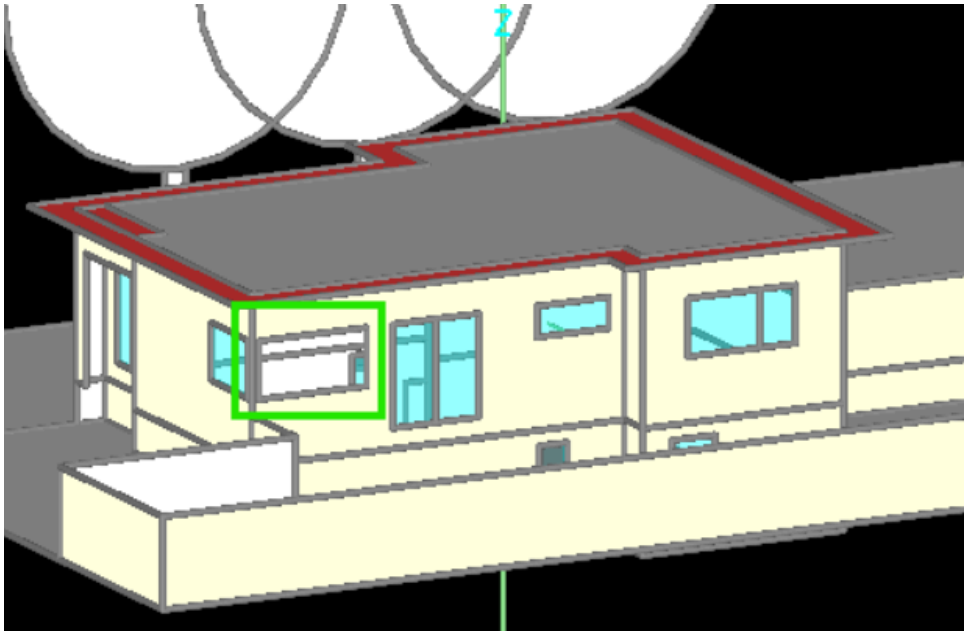


Figure 3.4. One surface was not imported from SketchUp to WUFI; this surface can be redrawn in WUFI Passive per Section 3.4.

Process Tip: If some components in the geometry do not import, check that each component was assigned a WUFIplus property in the SketchUp model and did not default to the `not relevant` setting. Revisit Section 2.3 for additional guidance.

3.3.1 Reassigning Zones / Component Properties

Individual imported components are visible in the Project Tree, under `Visualized Components`. Fill in the `Name` parameter for each component for organization (Figure 3.5).

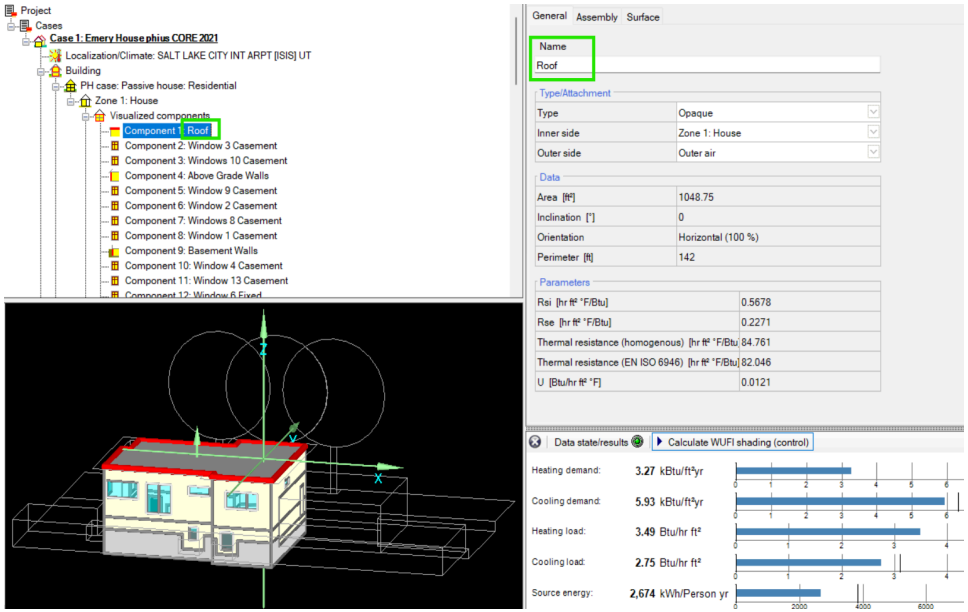


Figure 3.5. Assigning component name.

After assigning component names, consolidate zones and confirm that inner and outer sides are assigned correctly. Grouping like components should be a standard practice utilized in every energy model for ease of use, speed, and consistency. Grouping becomes significant when assigning assemblies and attachment types. For this reason, only components with the same properties and inclination may be grouped.

To group components, click one component. Then, while holding `Ctrl`, select all like components. Right click on one of the selected components and choose `Group`.

Ungrouping components is also an option if required to define unique properties. To ungroup, right click on the component and select ‘Ungroup.’ There are two options:

- `Ungroup main component`: Ungroups only the red surface that is selected.
- `Ungroup all selected components`: Ungroups all surfaces within that component.

If you assigned WUFIplus properties in SketchUp with multiple zones as outlined in Section 2.3, when you import to WUFI Passive, several zones will appear in the model. Consolidate to one zone as follows:

1. For all components in zones other than Zone 1, click on each component and reassign the `Inner side` to `Zone 1` (or to an attached zone if appropriate).
2. Then, delete all zones except Zone 1: under `Building → PH case → General`, click on each zone and click `Delete` (Figure 3.6).

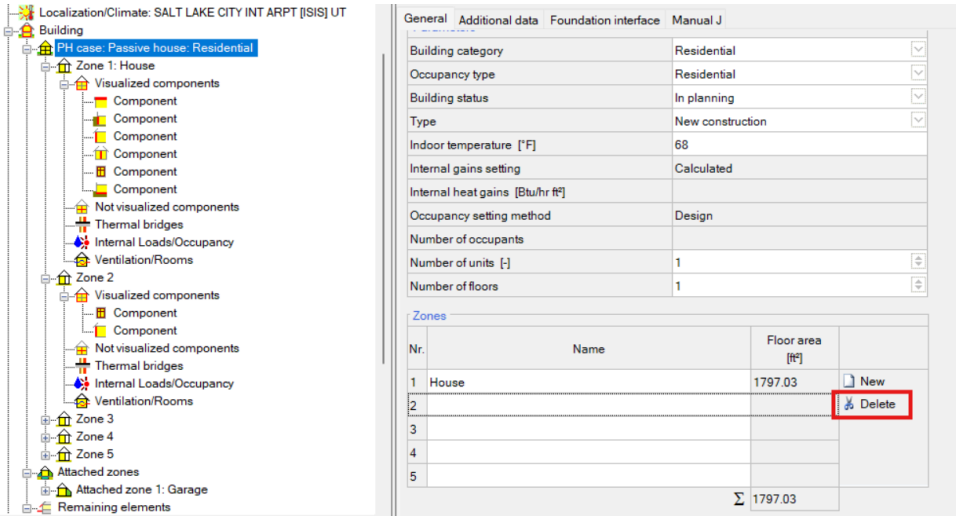


Figure 3.6. Deleting extraneous zones.

If you assigned properties by modifying inner and outer sides as outlined in Section 2.3, click on each component and reassign the inner and outer sides to the correct options.

3.3.2 Individual Component Orientation

When the geometry is successfully imported into WUFI Passive, check the orientation for all components. The arrow from the WUFIplus properties in SketchUp will become a green vector arrow in WUFI. Vector arrows should be pointing in the “outer” direction; the vector starts at the inner side and points toward the outer side of each component. This is relevant when WUFI Passive calculates criteria such as solar gain for windows and transmission losses for opaque components. If the direction of a vector arrow needs to be changed, right-click the component and select `Change orientation (inner<->outer)`.

To quickly check that all surfaces are oriented correctly, right click in the black space of the 3-D visualized geometry window and choose `Select all components`. This will activate the green vector arrows for all components.

Process Tip: Be careful when changing component orientation, as grouped elements will not necessarily have the same vector orientation. If some surfaces in a grouped component have incorrect vector orientations, you should first ungroup these components before changing the vector orientation; see Figures 3.7-3.10 below. If changes are made in the WUFI Passive geometry, Phius recommends making the same adjustment in the SketchUp model in case re-import is required in the future.

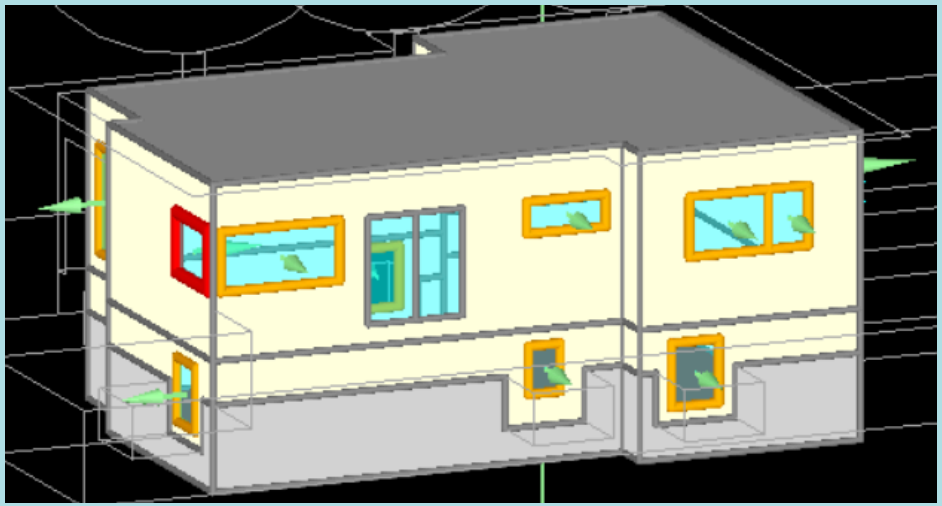


Figure 3.7. A single surface in the component has the wrong orientation, as indicated by the vector pointing inwards.

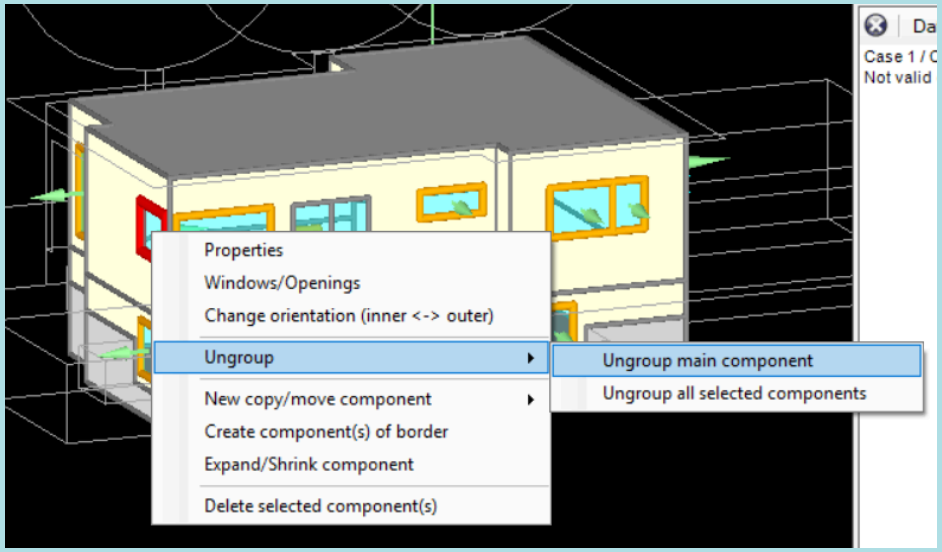


Figure 3.8. Right click to ungroup the surface from the rest of the component.

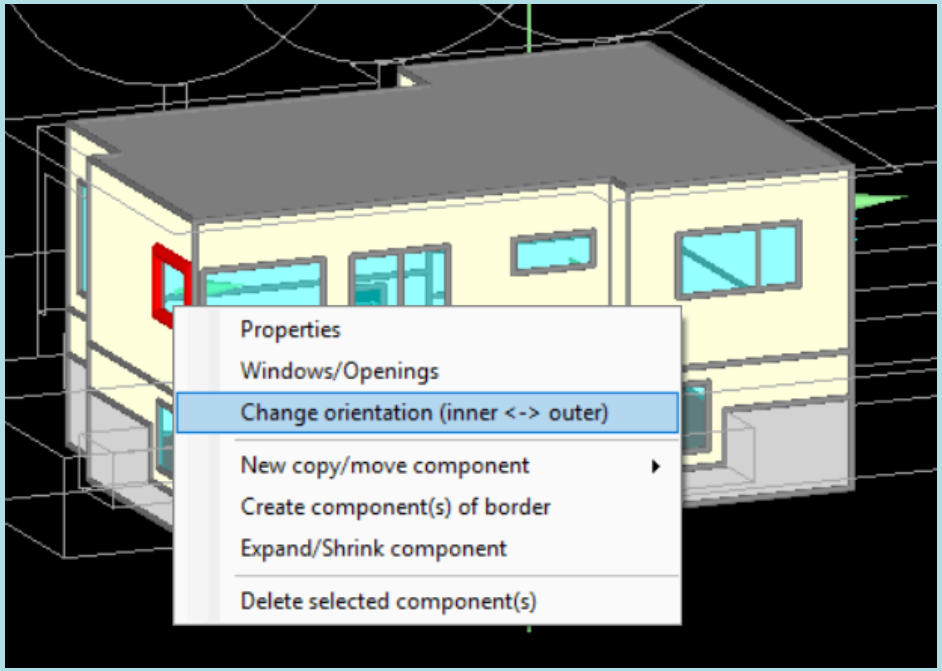


Figure 3.9. Change the orientation of the component.

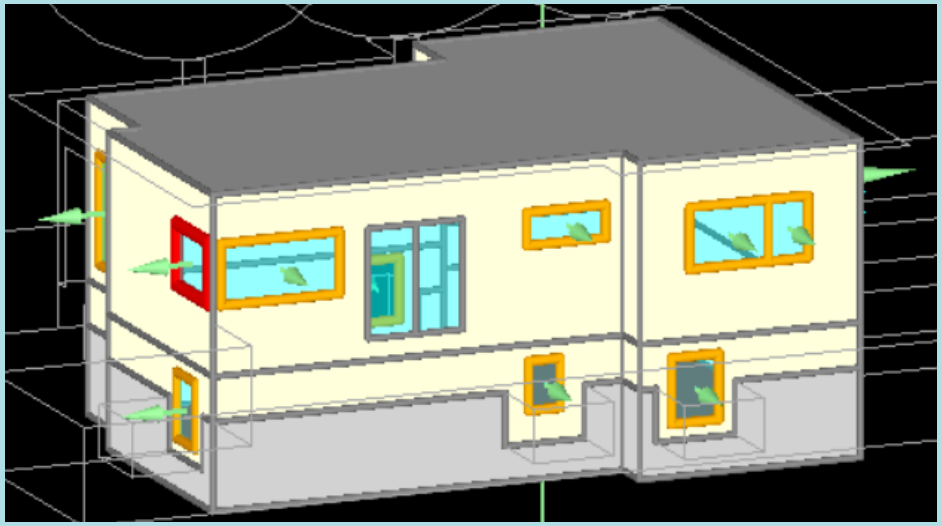


Figure 3.10. Regroup with other like components and check orientation.

For larger projects, it can be challenging to check the orientation of all surfaces by viewing the green orientation arrows: arrows for smaller components can get hidden, and arrows for transparent components can be difficult to see. Sections 3.3.2 and 3.3.2.1 outline options for quickly checking that all surfaces are oriented correctly.

3.3.2.1 Changing Component Color to Check Component Orientation

A simple way to quickly check that all opaque components are oriented correctly is to change the color settings for the inner walls to a more obvious color to easily show whether any components are reversed. Some of the default colors for other component types (roofs, slabs, etc) are shown in Figure 3.11.

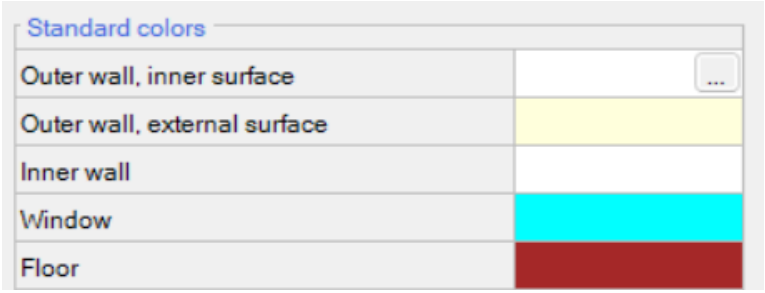


Figure 3.11. Some default component colors in WUFI Passive.

At first glance, the model in Figure 3.12 appears to have imported well.

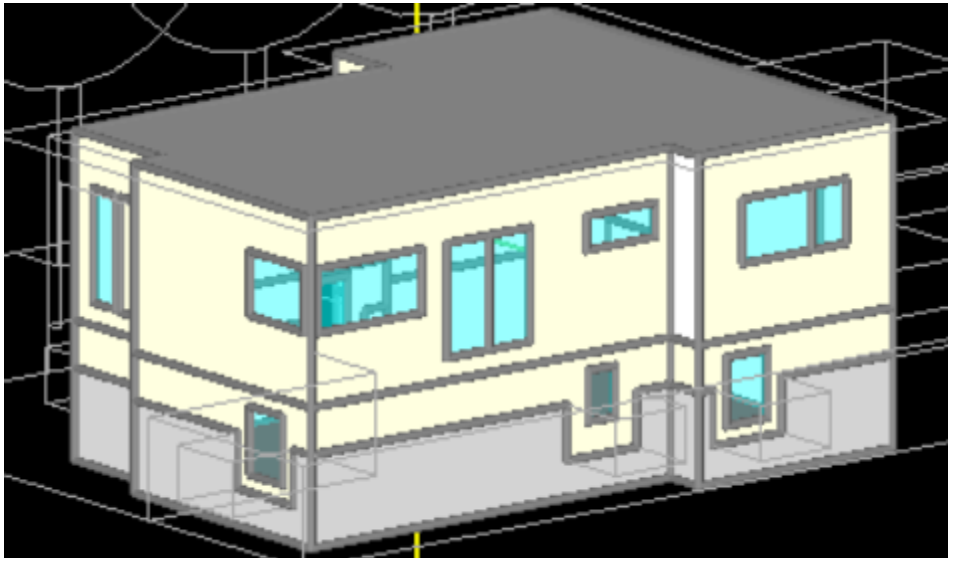


Figure 3.12. Model imported into WUFI Passive.

Go to `Options → Colors` to change the color settings of geometry components. Set the interior side of roofs and walls to magenta, and the outer side of all components to white. It quickly becomes clear that one of the opaque surfaces is reversed (Figure 3.13).

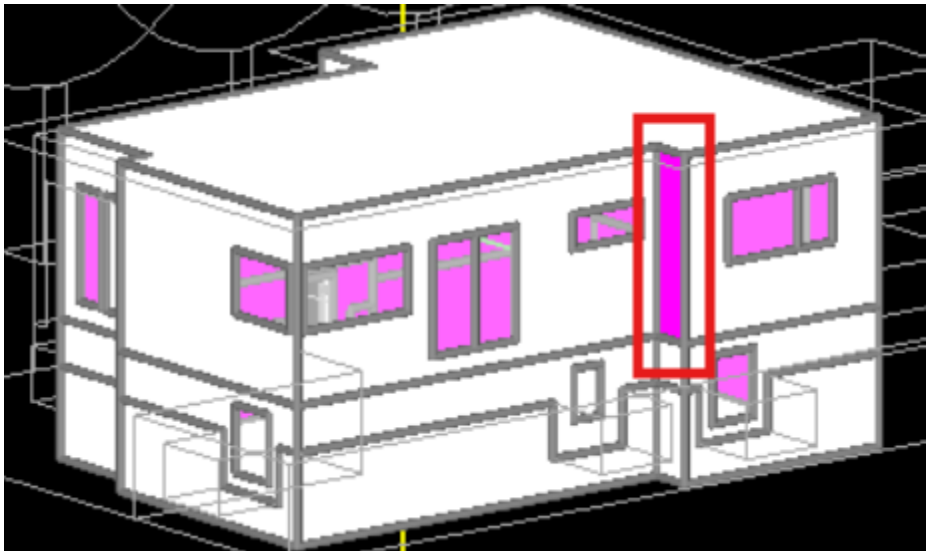


Figure 3.13. The wall surface in the red rectangle is reversed. Note that window components are transparent, so the inside face of walls beyond will be visible.

3.3.2.2 Adjusting Window Reveal Depths to Check Component Orientation

The most common components to be oriented incorrectly are windows. Windows are transparent and are assigned the same color on both the interior and exterior side, so it can be tricky to confirm the windows are oriented properly at first glance.

As described in Section 3.3.2, a visual inspection of the vector arrow orientation is a reliable way to confirm if the windows are oriented correctly.

Alternatively, assigning window reveal depths can also be helpful in telling if window components are reversed. Before reveals are assigned, the windows will appear flush with the exterior walls (Figure 3.14).

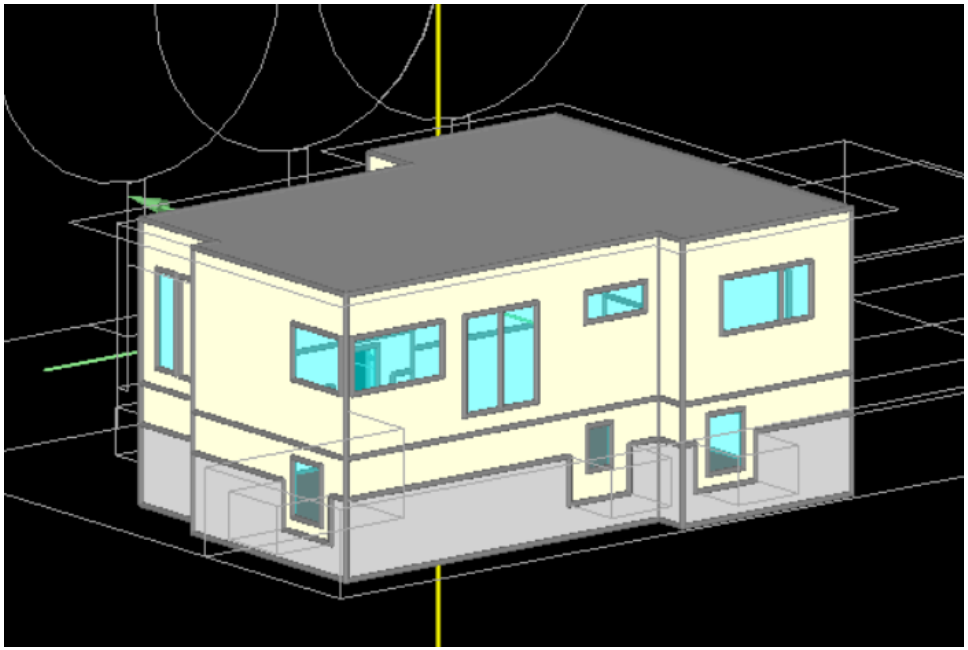
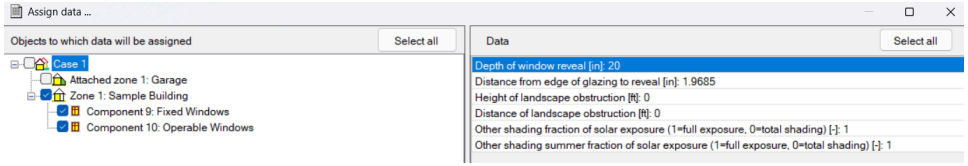


Figure 3.14. Windows after import, reveal depth = 0.

As an initial check of window orientation, change the window reveal depths to clearly show any incorrectly oriented windows. Click on a window. Under `Solar Protection → General`, assign a large value (e.g., 20 in.) to the `Depth of window reveal` input. After entering the parameter for a single window, assign reveals in bulk to all windows and glazed doors by clicking `Assign data` at the top of the screen. This button allows the user to choose which data to assign and check the boxes for which window components that data will be assigned to. Hold `Ctrl` to select more than one of the `Data` entries on the right side of the screen. Selected entries will be highlighted in blue. For this example, the same depth of window reveal is assigned to all windows (Figure 3.15).



(Figure 3.15. Assigning window reveal depth of 20 in. to all window components.)

In the example below, one window component is oriented incorrectly, as evidenced by the window protruding out from the face of wall (Figure 3.16). To rectify, change the orientation of that component by right-clicking and selecting `Change orientation (inner <-> outer)` (Figure 3.17).

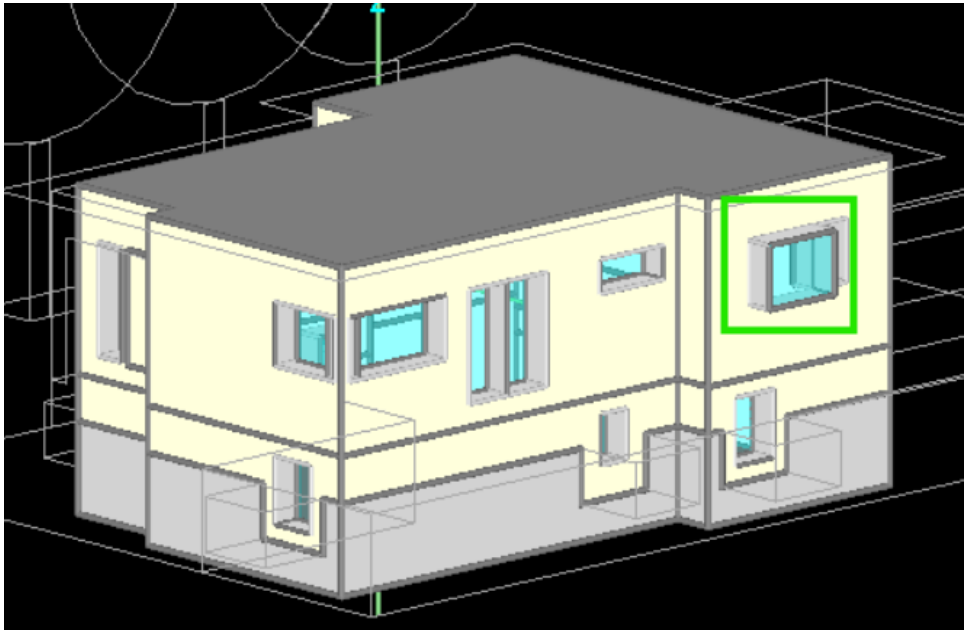


Figure 3.16. Visualization of window reveal depth of 20 in, with one component [green rectangle] oriented incorrectly.

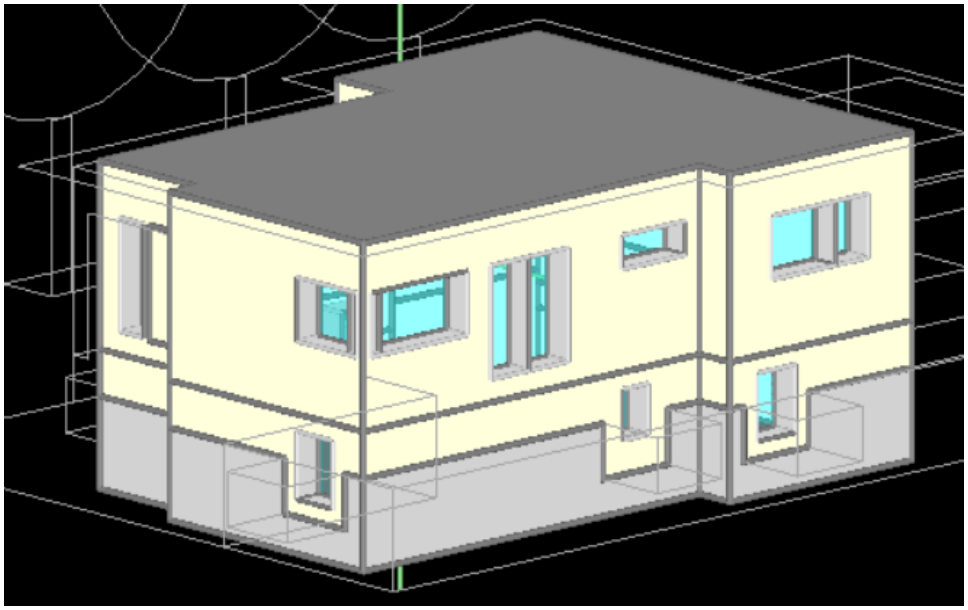


Figure 3.17. Visualization of window reveal depth of 20 in, with all components oriented correctly.

After component orientation is confirmed, revise all window reveal depths to the appropriate depth for each window component, based on project details, per the instructions in the Phius Certification Guidebook.

3.3.3 Building Orientation

Verify that the modeled orientation of the building matches the orientation that is found in the architectural drawings. To check the building orientation, turn on the built-in compass rose by clicking the `Orientation` icon. Rotate the model to view from the sky (in plan). Verify that the north arrow matches the direction of the north arrow as shown on the site plan (Figure 3.18).

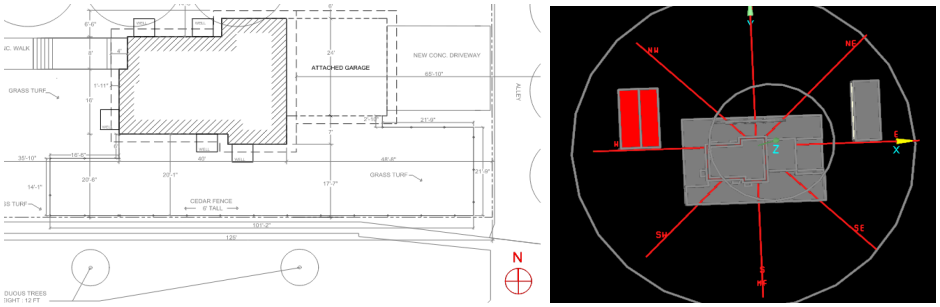


Figure 3.18. Orientation of the model matches the site plan.

If the orientation is incorrect, right-click the `Orientation` icon to reach the `Change orientation` dialog box (Figure 3.19) and adjust the orientation to match the site plan.

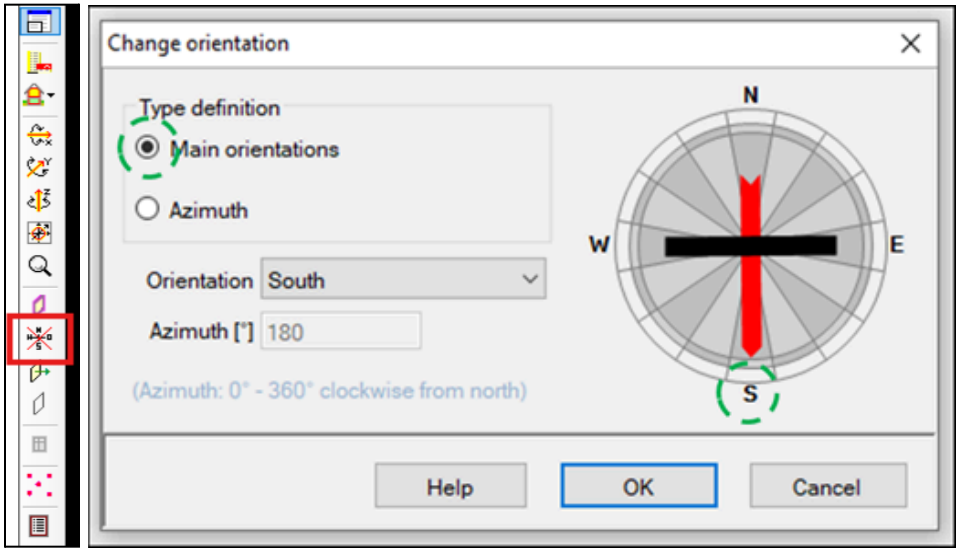


Figure 3.19. Modifying the model orientation.

3.3.4 Re-Importing Geometry

If significant changes to the model geometry are required (e.g., adding additional rooms or modifying dozens of windows) after the WUFI Passive modeling is complete or nearly complete, it will be simplest to update the geometry in SketchUp and reimport into WUFI Passive. In this case, re-review all model inputs. Below is a list of the major model inputs that will require re-entry after model reimport:

- All Components:
  - `General` tab:
    - `Name`
    - `Inner Side` (depending on zone tagging method during import)
    - `Outer Side`
  - Confirm that component orientation is correct as described in Section 3.3.2.
  - Delete extraneous zones after reassigning all components to Zone 1.

- Opaque Components:
  - `Assembly` tab:
    - Assign the appropriate assembly
- Transparent Components:
  - `Window Parameters` tab:
    - Assign the appropriate window type
  - `Solar Protection` tab:
    - `General` tab:
      - Depth of window reveal
      - Distance from edge of glazing to reveal
    - `Shading Device` tab
    - `Window Overhang` tab

Process Tip: If only minor changes are required (e.g. modifying the size of a few windows and doors, adding a canopy, splitting a wall area into two different wall types), it will be faster to make those changes in WUFI Passive directly. However, Phius recommends also making those changes in SketchUp simultaneously in case a future reimport is required. At this time, there is no way to export the geometry from WUFI Passive back to SketchUp.

3.4 Editing Geometry in WUFI Passive

As noted in Section 3.3 above, editing geometry directly in WUFI Passive is not recommended except for small changes. This Section summarizes the methods for making changes to the model geometry in WUFI Passive directly. Any changes made in WUFI Passive should be duplicated in the SketchUp file used for the original import.

3.4.1 Creating Geometry Using Vertices

If an entire surface is missing, you may create a new surface in WUFI Passive using three or more vertices. Click the `Vertices visible/invisible` tool to toggle the vertices on and off.

Process Tip: For projects with complex geometry, turning on the vertices may slow down the model. For this reason, it is recommended to keep them off when not in use.

The vertices can be used to create, edit, and add geometry components and measure distances. Unnecessary vertices may also be deleted (e.g. after centering circles are deleted, their vertices will still exist, but can be removed).

To create a component in WUFI Passive, select the vertices counter-clockwise, clicking each vertex while holding the `Ctrl` key. Figure 3.20 shows the process for creating a floor.

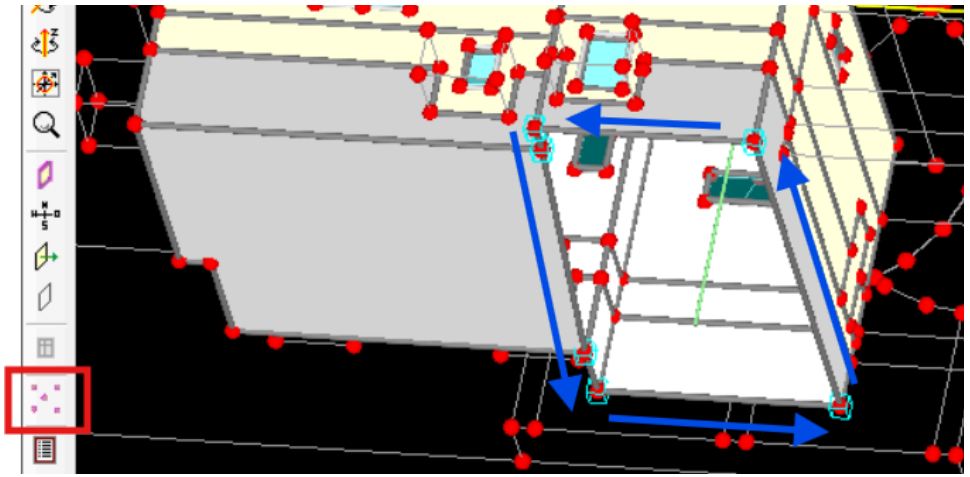


Figure 3.20. Vertices visible/invisble tool (red rectangle) and selecting vertices to create component.

Once the vertices are selected, right click and select `Make component of selected vertices` (Figure 3.21).

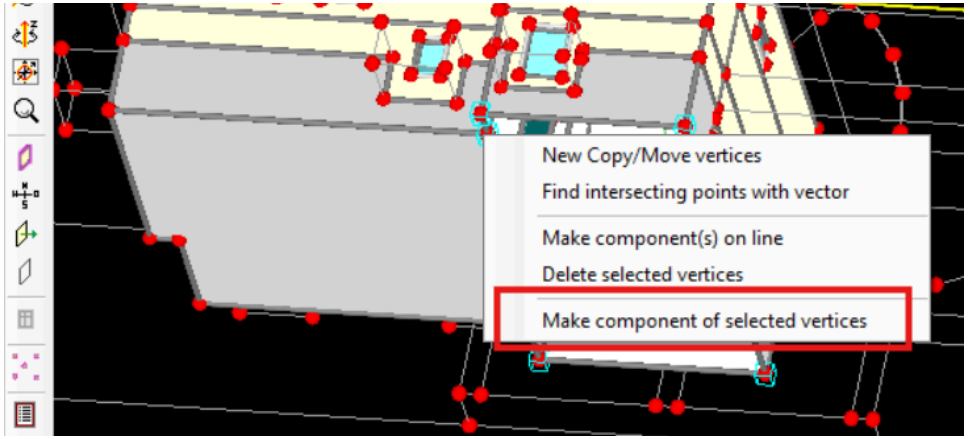


Figure 3.21. Creating a component out of the selected vertices.

A dialogue box will appear to assign WUFI Passive properties to the new component, including component type and inner and outer sides (Figure 3.22). These can also be edited after the component is created.

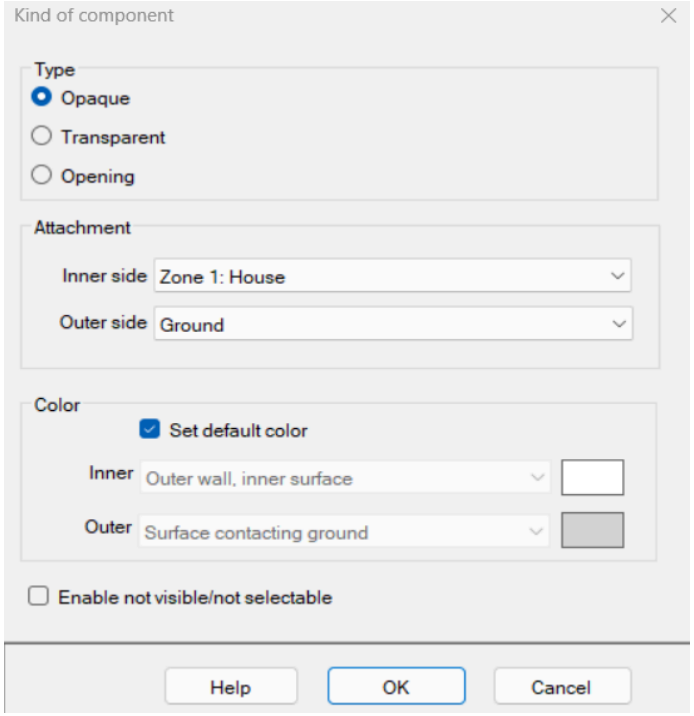


Figure 3.22. Component assignment dialog box.

Click `Ok` after selecting properties; the geometry is created (Figure 3.23).

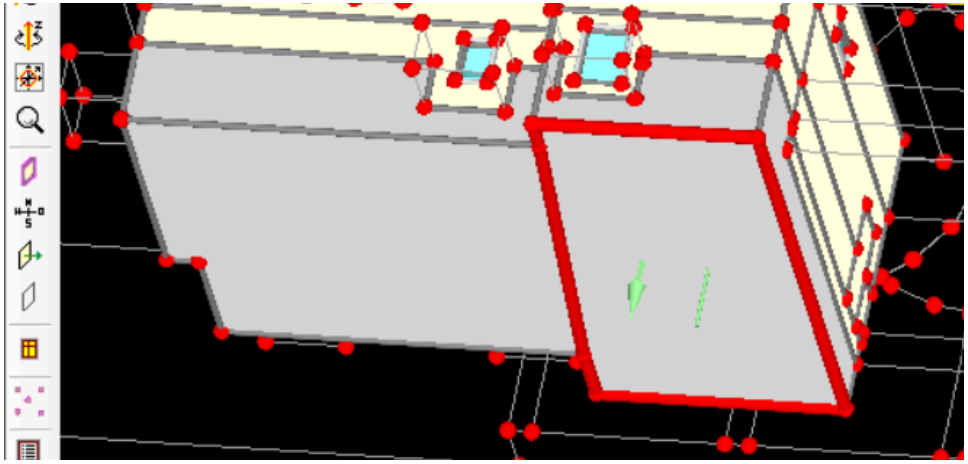


Figure 3.23. Newly-created slab-on-grade component.

3.4.2 Other Vertex Operations

If additional vertices are needed to create or modify a component, WUFI Passive provides several options to create them. The vertex editing options are different depending on how many vertices are selected. This guide will not exhaustively address all options; Phius recommends testing them individually to better understand the potential uses.

The most commonly used vertex modification tool is `New copy/move vertices`; when one or more vertex is selected, this function will create duplicate(s) of the selected point(s), which will copied to the user-defined X, Y, and Z distances relative to the selected vertex or vertices. For example, if a vertex is copied 3 ft in the Z direction, a new vertex will be created 3 ft above the original (Figure 3.24).

Process Tip: It is best practice to model in SketchUp orthogonally so that the X and Y axes run parallel to the building (assuming it is rectangular).

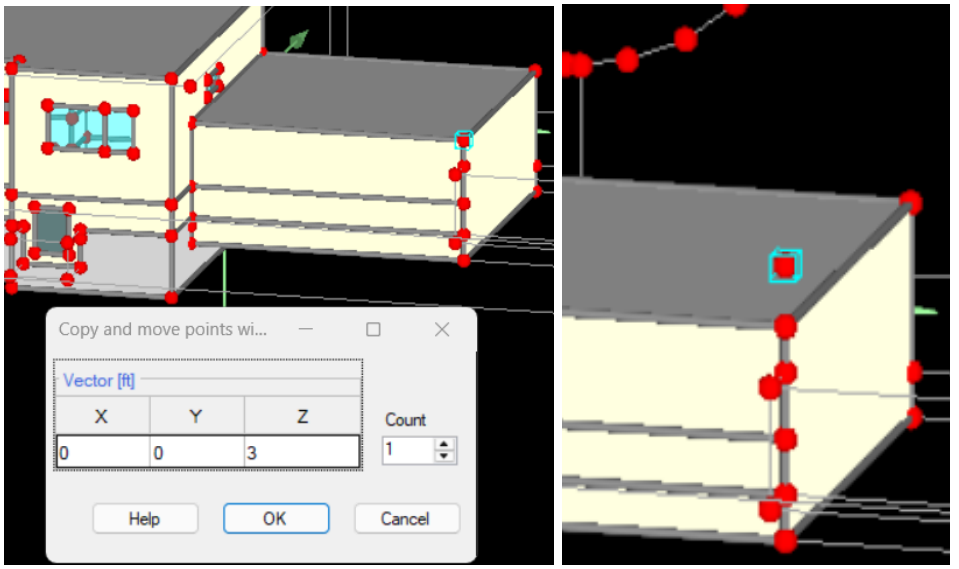


Figure 3.24. Creation of a new vertex 3 ft above an existing vertex.

When two vertices are selected, the `2 points operation` option becomes available, which can be used to measure distances between vertices, find intersection points between vertices, add vertices to a line, or place vertices at equal spacing along a line.

3.4.3 Component Tools

To shift an entire surface (for example, to adjust the height of the roof), use the `New copy/move component` and `Create component(s) of border` tools as follows:

1. Right click on the component that you would like to move. Select `New copy/move component`, then `New copy/move main component` (Figure 3.25).
    a. If you want to shift all surfaces in a component, select `New copy/move all components`.
2. Enter the distance you would like to copy the component in the X, Y, or Z direction(s). Enter the number of copies under `Count`. Entering “1” will create one copy and leave the original component in place (Figure 3.26).
    a. Increasing the “count” will create several parallel surfaces, which can be useful for creating repeating parallel elements such as pergola beams.
3. Delete the original component. Name the new component as appropriate.
4. Right click on the new component and select `Create component(s) of border`. Enter the distance and direction for the border component (Figure 3.27).
5. In the `Kind of component` dialog box that appears, select the appropriate component type and attachment.
6. After creating the border element, verify that the component surfaces are oriented correctly, and change their orientation as described in Section 3.3.2 if required (Figure 3.28).

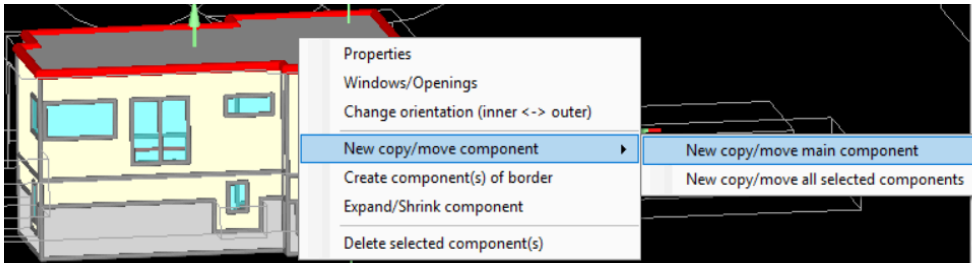


Figure 3.25. Copy/move main component.

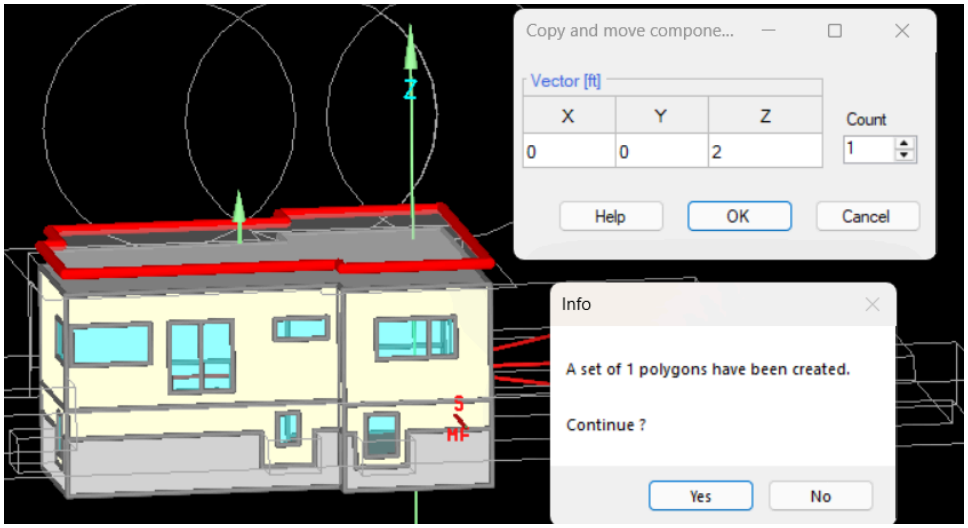


Figure 3.26. Create one additional surface, 2 ft above the original roof.

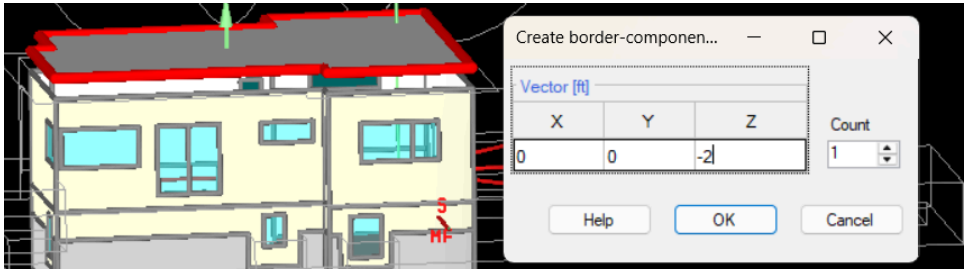


Figure 3.27. Creating a 2 ft-tall border component.

Figure 3.28. Completed border component.

3.5 Editing Windows in WUFI Passive

Windows may be added in WUFI Passive by first selecting the wall/roof component (in the 3-D visualization) that will contain the window, then right-clicking and selecting `Windows/Openings`. The `Component openings` dialog box and toolbar will appear (Figure 3.29).

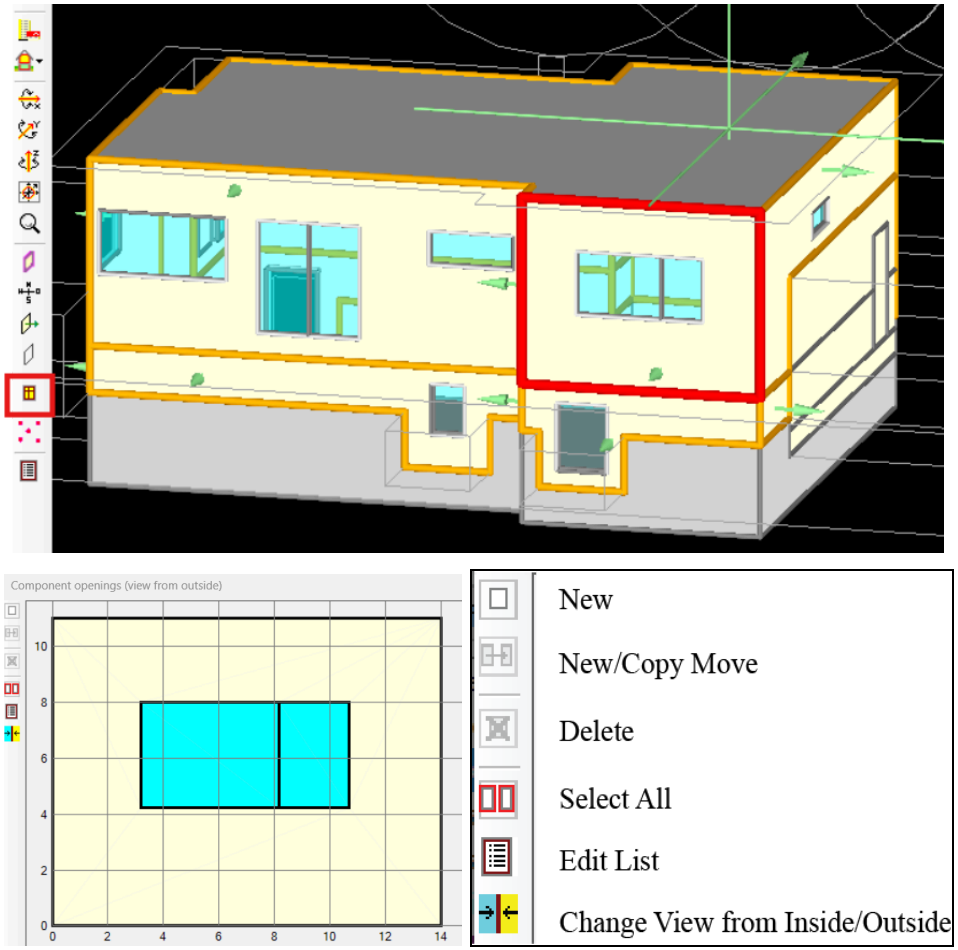


Figure 3.29. `Component openings` dialog box.

To create a new window or opening select `New`. Then, input the shape, position, and dimensions of the window (Figure 3.30).

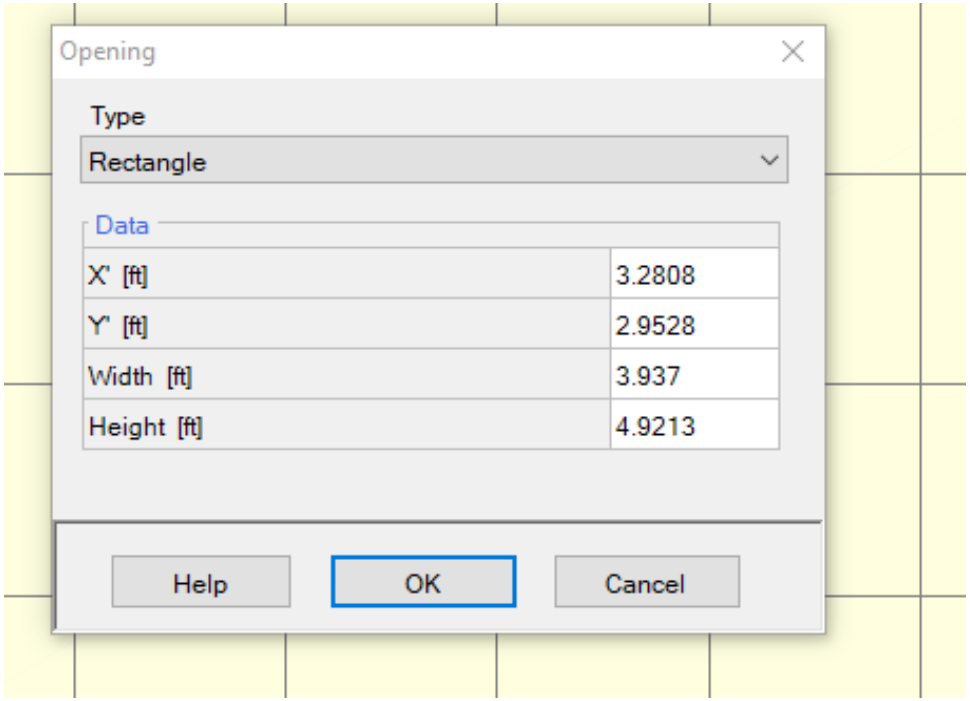


Figure 3.30. Creating a new window within the `Component Openings` dialog box.

To view and/or modify openings on the surface, select `Edit list` (Figure 3.31). In the table list, there are options to delete openings, add new openings, move openings, or modify the size of existing openings. All opening locations are listed with coordinates indicating the location of the bottom left vertex of the opening relative to the bottom left vertex of the opaque component surface, as viewed from the exterior.

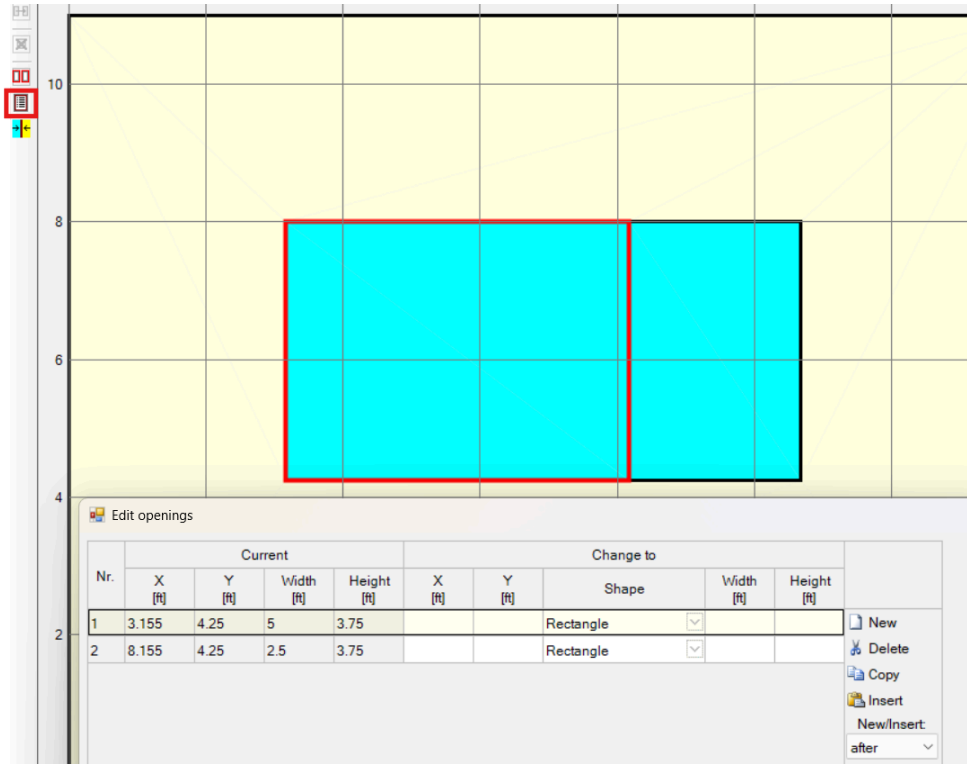


Figure 3.31. Editing openings in the `Edit list` dialog.

Alternatively, instead of clicking `Edit list`, you can also copy an opening by selecting it, right clicking, and choosing `Copy and move`. You will be prompted to enter the X and Y coordinates and the number count. After a window is created, you can also click and drag the window to the desired location in the dialog box. Once you close the dialog box the changes will be reflected on the building geometry.

3.6 Non-Visualized Components

Due to limitations with how non-visualized components interact with visualized components, Phius does not recommend using non-visualized components.

Exceptions: A non-visualized component may be used to represent small amounts of opaque envelope area such as an elevator pit or other extrusions that do not include windows. If non-visualized components are included in the model, remember to add to the “sum of visualized components” for the calculation of targets.

3.7 Openings

A SketchUp import may automatically generate a component categorized as an `Opening` when there is an extrusion from an opaque component, which creates a void at the plane of that opaque component. Otherwise, `Opening` components should not be used for Phius Certification models. These components should be set to `Outer air` on both sides, which will move them to the `Remaining elements` section in the project tree and exclude them from the total envelope area.

For all other modeling-related questions, refer to the most updated version of the Phius Certification Guidebook. Contact Phius with further questions.

3.8 QA WUFI Passive Before Submission for Phius Review

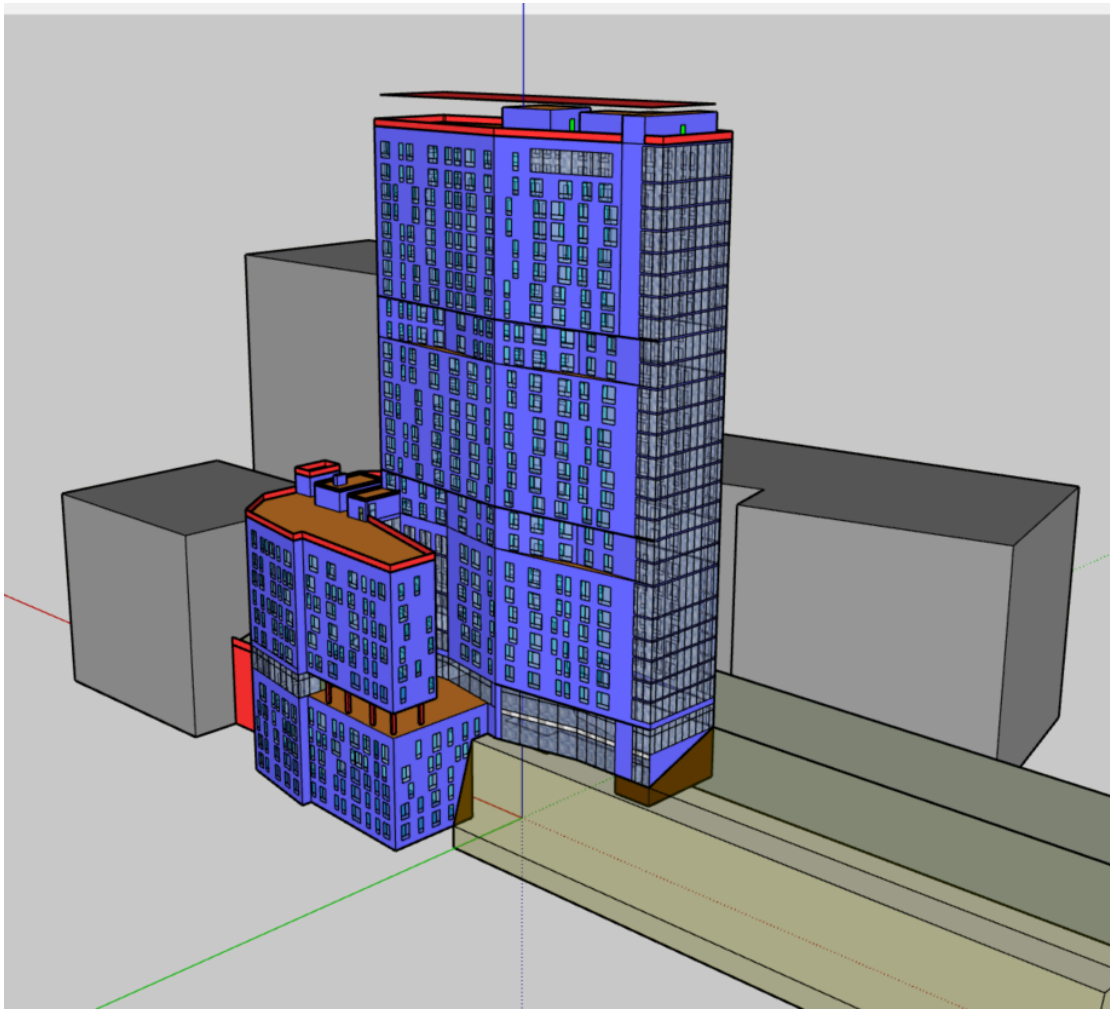
Before submitting a model for Phius review, always check the model geometry as outlined in Table 3.9.0.

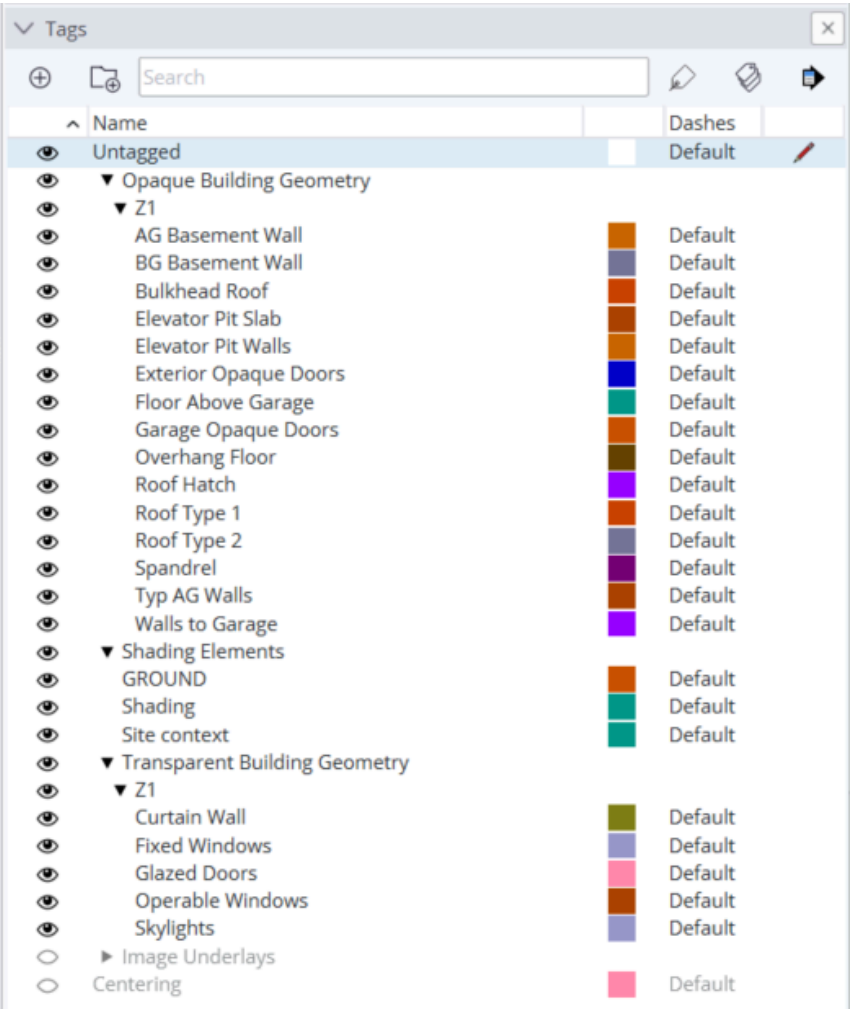
Table 3.9.0 QA Checklist Prior to Submission

Item No.	Complete?	Item
3.9.1	☐	Confirm component orientation.
3.9.2	☐	Confirm naming of all components.
3.9.3	☐	Spot-check geometry measurements.
3.9.4	☐	Confirm the building is oriented correctly.

Appendix A - Sample Component Properties Tracker

It is recommended to avoid increasing the number of zones in SketchUp when preparing the geometry for import to WUFI Passive. This is due to the need to re-enter the quantity of zones every time the SketchUp file is re-opened, which could lead to import errors if not communicated between team members collaborating on the model, or if the project is handed off to someone else. Even in very large projects, it is possible to assign unique properties to all model components without creating additional zones. The example Properties Tracker below demonstrates how a long list of unique components can be tagged and imported in unique groups in WUFI Passive. Once all options are exhausted, only then should an additional zone be added.





Type: Opaque

Outer/Inner Side Attachment	O: Outer Air	O: Ground	O: Adiabate	O: Zone 1
I: Outer Air	*Site Context / Full-Year Shading*			
I: Ground				
I: Zone 1	**Horizontal ↑:** Roof Type 1 **Horizontal ↓:** Overhang Floor **Vertical:** Typ AG Walls	**Horizontal ↑:** Roof Type 2 **Horizontal ↓:** Floor - slab on grade **Vertical:** BG Basement wall	**Horizontal ↑:** Roof Hatch **Horizontal ↓:** Floor Above Garage **Vertical:** AG Basement wall	**Horizontal ↑:** Bulkhead Roof **Horizontal ↓:** Elevator Pit Slab **Vertical:** Walls to Garage
I: Zone 2				

Type: Transparent

Outer/Inner Side Attachment	O: Outer Air	O: Ground	O: Adiabate	O: Zone 1
I: Outer Air	*Seasonal Shading (Summer)*			
I: Ground				
I: Zone 1	**Horizontal ↑:** Skylights **Horizontal ↓:** n/a **Vertical:** Fixed Windows	**Horizontal ↑: n/a** **Horizontal ↓:** n/a **Vertical:** Operable Windows	**Horizontal ↑: n/a** **Horizontal ↓: n/a** **Vertical:** Spandrel	**Horizontal ↑: n/a** **Horizontal ↓: n/a** **Vertical:** Curtain Wall
I: Zone 2				

Type: Opening				
Outer/Inner Side Attachment	**O: Outer Air**	**O: Ground**	**O: Adiabate**	**O: Zone 1**
I: Outer Air	*Centering Circles*			
I: Ground				
I: Zone 1	**Horizontal ↑: n/a** **Horizontal ↓: n/a** **Vertical:** Exterior Opaque Doors	**Horizontal ↑: n/a** **Horizontal ↓: n/a** **Vertical:** Elevator Pit Walls	**Horizontal ↑: n/a** **Horizontal ↓: n/a** **Vertical:** Garage Opaque Doors	**Horizontal ↑: n/a** **Horizontal ↓: n/a** **Vertical:** Glazed Doors
I: Zone 2				