Altair WinProp 2025.1

Getting Started Guide

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Contents

Wi-Fi Router in a Building

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This example considers the application of analyzing a Wi-Fi router in a building.

This chapter covers the following:

1.1 Example Overview

This example considers the application of analyzing a Wi-Fi router in a building.

The antenna pattern was obtained using Altair Feko, but the steps on how to use Feko to obtain the antenna pattern are not in the scope of this example.

The 3D model of a building is created in WallMan.

Coverage plots are produced using ProMan for a Wi-Fi router located inside the building using two different propagation models, namely: multi-wall model (COST 231) and 3D ray tracing (SRT) model.

The main elements and terminology in the WallMan and ProMan graphical user interface (GUI) are also discussed.

> **Note:**
>
> This example does not specify the exact floor plan for the building, but instead, it highlights the steps to create these structures in WallMan.
>
> You are encouraged to create your own floor plan and internal structures using WallMan.

1.2 Topics Discussed in Example

Before starting this example, check if the topics discussed in this example are relevant to the intended application and experience level.

The topics discussed in this example are:

- WallMan
    - Launch WallMan.
    - View the WallMan graphical user interface (GUI).
    - Create a new indoor database (3D model of the building) using WallMan.
- ProMan
    - Launch ProMan.
    - View the ProMan graphical user interface (GUI).
    - Specify the computation method.
    - Launch the Solver.
    - View the prediction results.

> **Note:** Follow the example steps in the order they are presented as each step uses its predecessor as a starting point.

> **Tip:** Find the completed model in the Altair installation directory, for example:
>
> `Altair\2025.1\help\winprop\examples\GetStarted_models\Project1_Indoor_Scenario`.

1.3 Example Prerequisites

Before starting this example, ensure that the system satisfies the minimum requirements.

The requirements for this example are:

- Feko 2025.1[1] or later should be installed.

1. WinProp is included as part of the Feko installation.

1.4 Introduction to Wall Manager (WallMan)

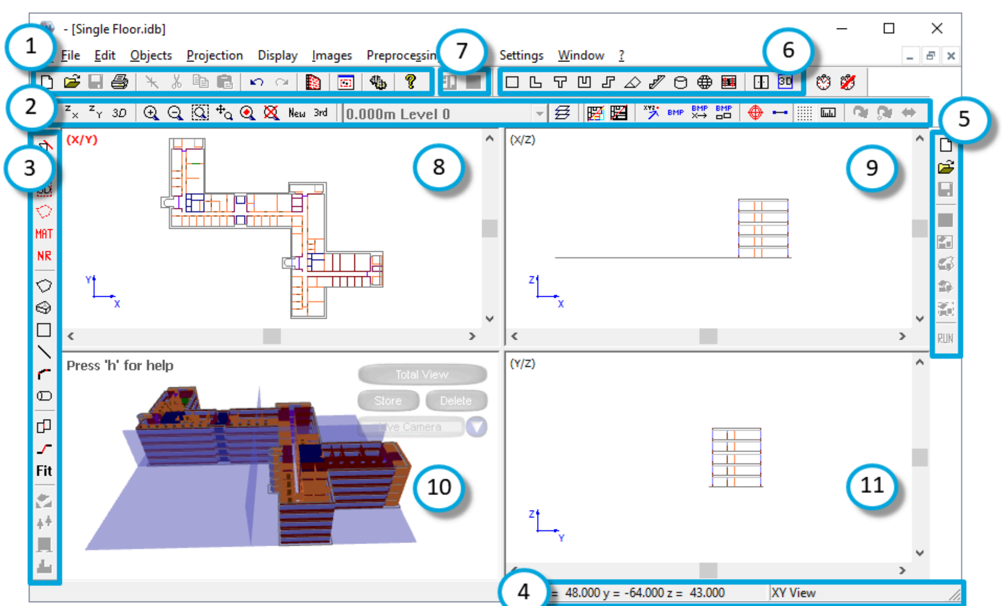
WallMan tool is used to prepare a geometry database (3D model) that is used as part of a ProMan project. Preparing geometries in WallMan, or even just converting them from other sources in WallMan, is a common step in indoor and urban scenarios.

1.4.1 Launching WallMan

Launch WallMan in Microsoft Windows using the Feko and WinProp Launcher utility.

1.4.2 User Interface Layout

View the main elements and terminology in the WallMan graphical user interface (GUI).



1. *Standard toolbar*

   The standard toolbar gives access to commonly used menu items including **New Database**, **Open Database**, and **Save Database**.

2. *View toolbar*

   The view toolbar gives access to tools related to navigating the 2D views, changing the view, single wall view, and navigating the 3D view.

   The 2D views in WallMan show the database as a cross-section with a specified plane. The plane moves along the third axis (for example, the Z-axis in the X/Y view). Click the 3rd icon to modify the cut plane.

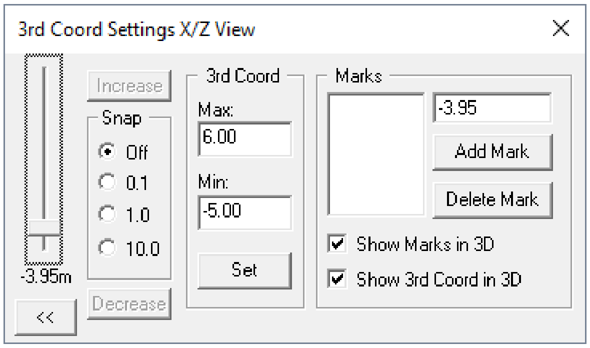


*Figure 1: The **3rd Coord Settings X/Y View** dialog.*

3. *Objects toolbar*

   The objects toolbar gives access to tools to create indoor objects, outdoor objects, and tools to select these objects.

4. *Status bar*

   The Status bar is a small toolbar that gives quick access to absolute coordinates at the location of the mouse cursor in the 2D view and also displays the currently active 2D window.

5. *Preprocessing toolbar*

   The preprocessing toolbar gives access to tools such as **New Project**, **Open Project**, **Save Project**, and defining the preprocessing area.

6. *Indoor lego toolbar*

   The indoor lego toolbar gives access to basic wall combinations for indoor database creation, for example, **Rectangular room**, **T-shaped room**, **Stairs**, and **Roof**.

7. *Clutter toolbar*

   The clutter toolbar gives access to tools such as editing or displaying clutter databases.

   > **Note:** A clutter[2] database is a pixel matrix and contains information about the land usage at a given location, for example, forest, water, residential or industrial.

8. *Cross-section view at the X/Y plane*

   The active view (for this example) as indicated by the text **(X/Y)** in red. A cross-section view of the model in the X/Y cut plane is displayed.

9. *Cross-section view at the X/Z plane*

   A cross-section view of the model in the X/Z cut plane is displayed.

2. These are also called morpho databases or land usage databases.

10. *3D view*

A 3D view of the model showing the location of the three cut planes (X/Y plane, X/Z plane, and Y/Z plane) in purple.

11. *Cross-section view at the Y/Z plane*

A cross-section view of the model in the Y/Z cut plane is displayed.

1.4.3 Creating a New Indoor Database

Define a new indoor vector database of a building or multiple buildings.

An indoor database is used when you want to create a model of a single building or multiple buildings (if the number of buildings is small).

> **Tip:** Use an urban database if the model contains several thousand of buildings.

1. On the **File** menu, click **New Database**.

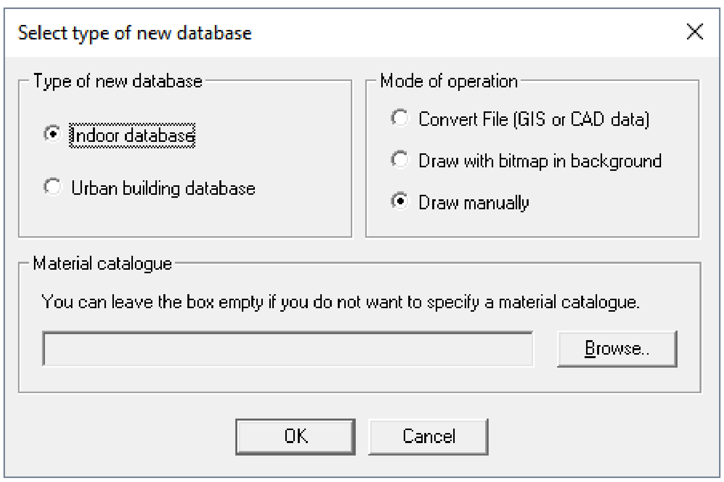


*Figure 2: The **Select type of new database** dialog.*

2. Use the default settings for **Select type of new database** dialog.
3. Under **Material catalogue**, browse to `GlobalMaterialCatalogue.mcb`[3].
4. Click **OK** to close the **Select type of new database** dialog.

3. `Project1_Indoor_Scenario\Database\GlobalMaterialCatalogue.mcb`

1.4.4 Specifying Default Values for New Objects

Define the default values for an object. Modify the default values before you create a new object to define objects with different upper and lower coordinates (for example, a window versus a door).

The **Default Values for New Objects** dialog should be displayed after completing Creating a New Indoor Database.

1. Specify the default values for new walls.
   a) In the **Height of walls relative to current plane** field, enter a value of 3 m.
   b) In the **Material Properties of new Walls** drop-down list, select **Brick; thickness: 10 cm**.
2. Specify the default values for new sub-division material (doors).
   a) In the **Material Properties of new Subdivisions** drop-down list, select **Wood (Fir); thickness: 5 cm**.

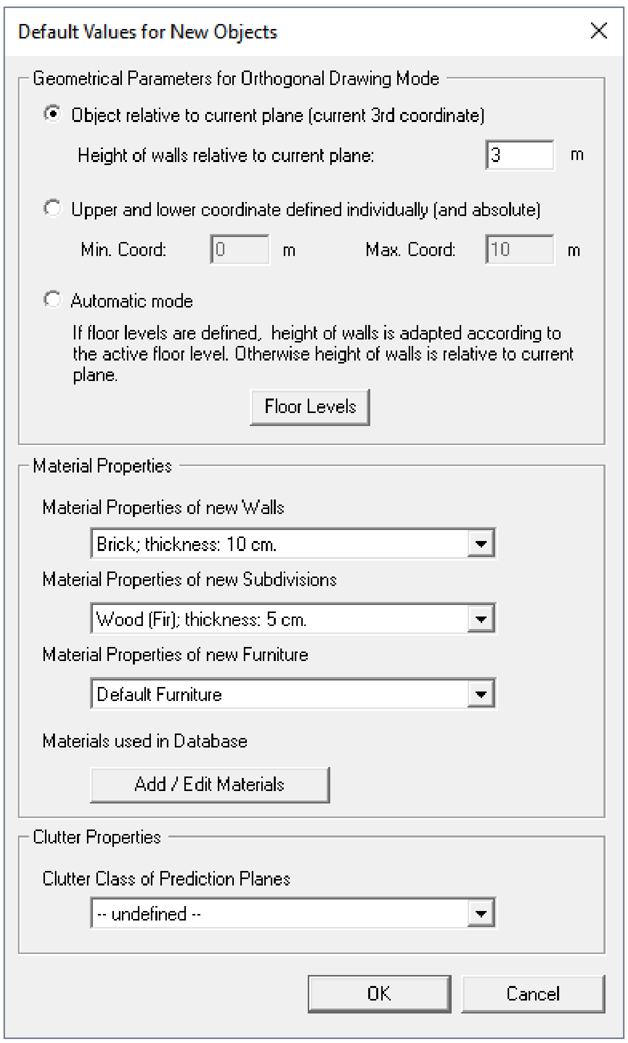


*Figure 3: The **Default Values for New Objects** dialog.*

3. Click **OK** to close the **Default Values for New Objects** dialog.

1.4.5 Enabling the Grid for 2D Views

Enable the grid and specify the grid size for 2D views.

1. On the **Settings** menu, click **Local settings**.

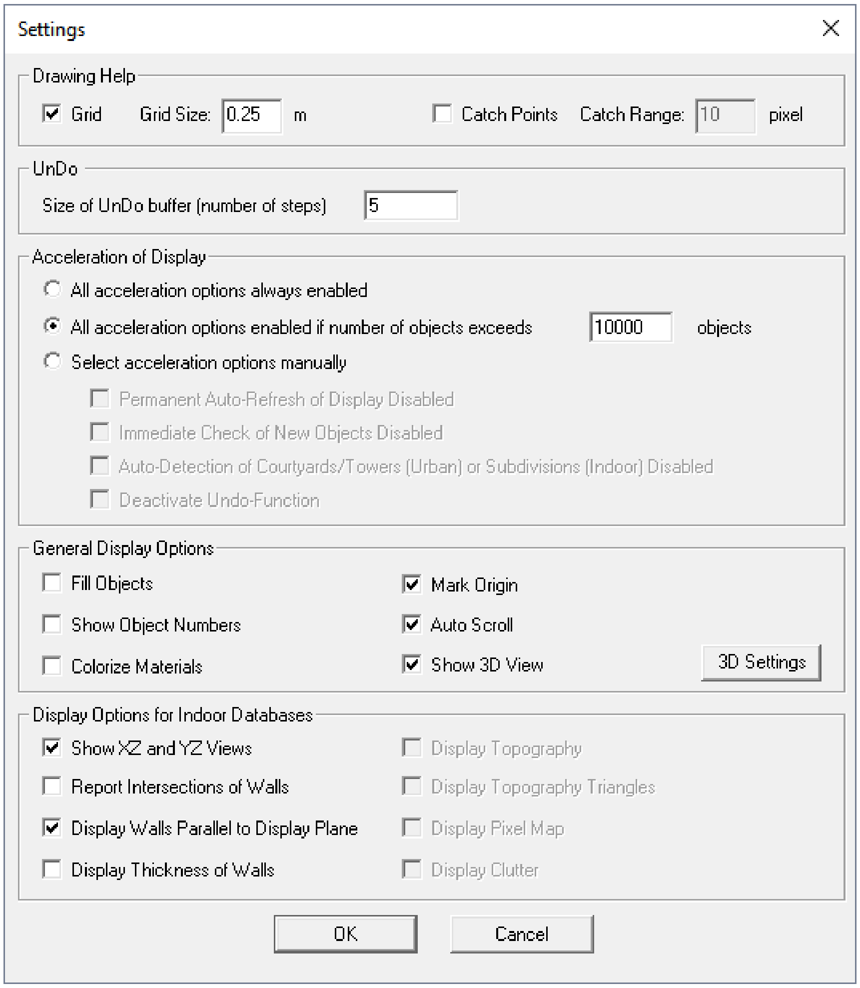


*Figure 4: The **Settings** dialog.*

2. Under **Drawing Help**, select the **Grid** check box.
3. In the **Grid Size** field, enter a value of `0.25` m.
4. Click **OK** to close the **Settings** dialog.

1.4.6 Adjusting the Zoom Level

The zoom level of the 2D views is adjusted by enabling the **Mouse Pan and Zoom Tool** and using the mouse wheel to zoom.

1. On the view toolbar, click the **Mouse Pan and Zoom Tool** icon to activate the tool.
2. Use the mouse wheel to zoom in the 2D views until the grid is visible.

> **Note:** The absolute coordinates of the mouse cursor is displayed in the status bar.

3. Click and drag the mouse to pan.

1.4.7 Adjusting the Cut Plane

Modify the third coordinate to move the cut plane. The cut plane results in a cross-section of the model in the 2D view that allows you to view detail and verify the model.

1. Verify that the **X/Y** window is active, or activate it by clicking in it.
   The **X/Y** symbol in the top-left of the window is red when the window is active.
2. Open the dialog to modify the cut plane using one of the following workflows:
   - On the **View** toolbar, click the 3rd **3rd Coordinate Settings** icon.
   - On the **Display** menu, click **Show 3rd Coord Dialog**.

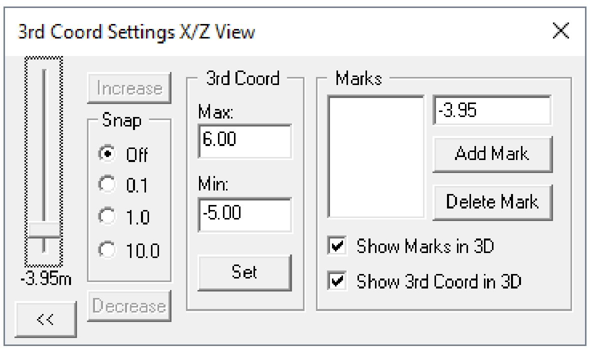


*Figure 5: The **3rd Coord Settings X/Y View** dialog.*

> **Note:** The current active window determines the cut plane that can be modified.

3. Move the slider and observe how the cross-section and 3D view change.

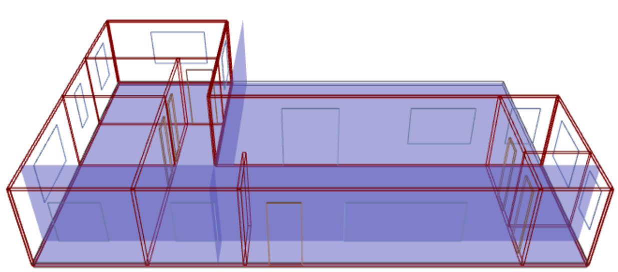


Figure 6: The XZ cut plane at -3.95 m.

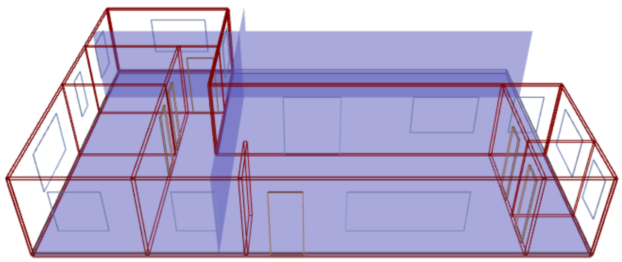


Figure 7: The XZ cut plane at 3.90 m.

4. Close the dialog again using one of the following workflows:
- Click the × in the top-right corner of the dialog.
- On the **View** toolbar, click the 3rd **3rd Coordinate Settings** icon.

1.4.8 Display Settings

Change the display settings of objects to validate the model visually.

On the **Settings** menu, click **Local settings** to launch the **Settings** dialog (see Figure 4).

Fill Objects

This option allows you to visualize the model as a 3D solid and reduce visual complexity.

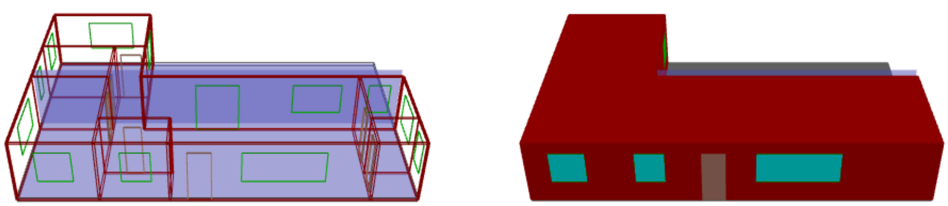


Figure 8: On the left, a model without fill, to the right, a model with fill.

Display Thickness of Walls

This option allows you to validate the model by viewing the thickness of objects.

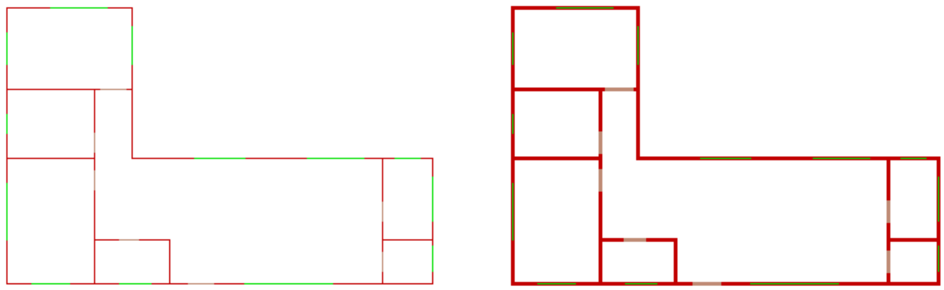


Figure 9: On the left, a model is displayed without the thickness of the walls, to the right, a model is displayed with wall thickness .

1.4.9 Creating a Model of the Building

Use WallMan to create a model of the building.

The model consists of a concrete floor, outer walls, interior walls, wooden doors, glass patio doors, and glass windows. The building has a height of 3m.

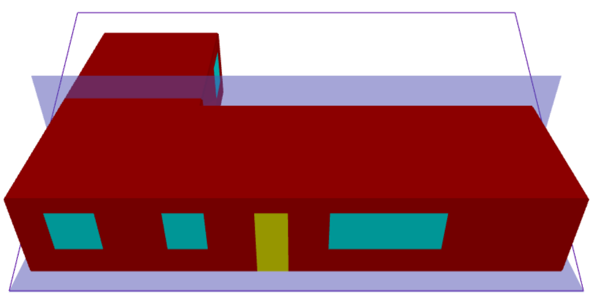


Figure 10: A 3D model of the building, consisting of planar polygons. Glass windows and glass patio doors are indicated in light blue and wooden doors in yellow.

> **Note:**
>
> This example does not specify the floor plan, or give exact locations or number of interior walls, wooden doors or windows, but instead, it highlights the steps to create these structures.
>
> You are encouraged to create your own floor plan and internal structures.

Specifying Coordinates of Objects

There are two workflows available when specifying coordinates of objects in WallMan.

- Create the object by viewing the current coordinates in the Status bar. Click at the exact location in the 2D view when drawing an object.

- Create the general shape of the object - the coordinates do not have to be precise. Select the object and on the **Object Properties** dialog, edit the coordinates.

> **Note:** Both workflows are demonstrated through the course of this example.

Drawing the Outer Walls

Define the outer walls of the building.

1. Verify that the **X/Y** window is active, or activate it by clicking in it.
   The **X/Y** symbol in the top-left of the window is red when the window is active.
2. Create outdoor walls in the X/Y window using one of the following workflows:
   - On the **Objects** menu, click **Enter Basic Objects** > **Enter Polygonal Object (3D)**.
   - On the **Objects** toolbar, click the **Add polygonal objects with orthogonal walls and a ceiling** icon.
3. Click twice at (-10, 6) to specify the first corner the polygon.
4. Click at the following coordinates to specify the corners of the polygon, for example:
   - (-5, 6)
   - (-5, 0)
   - (7, 0)
   - (7, -5)
   - (-10, -5)
5. Right-click at (-10, 6) to close the polygon.

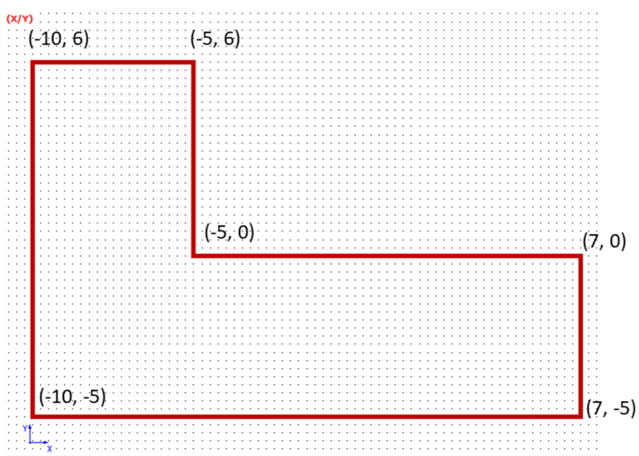


Figure 11: View of the model in the XY plane (top view) showing the outer walls.

> **Note:** All outer surfaces (including the floor and ceiling) of the building are created. The material is brick with a thickness of 10 cm.

6. Exit the draw mode using one of the following workflows:

- On the **Objects** menu, click **Select Objects** > **Select Single Object (Mouse)**.
- On the **Objects** toolbar, click the **Select Object** icon.
- Press F10 to use the keyboard shortcut.

Drawing the Interior Walls

Define the interior walls of the building.

1. Verify that the **X/Y** window is active, or activate it by clicking in it.
   The **X/Y** symbol in the top-left of the window is red when the window is active.
2. Create the interior walls in the **X/Y** window using one of the following workflows:
   - On the **Objects** menu, click **Enter Basic Objects** > **Enter Orthogonal Object**.
   - On the **Objects** toolbar, click the **Add Objects Orthogonal** icon.
   - Press F9 to use the keyboard shortcut.

   > **Note:** This tool creates a rectangle that is right-angled to the current projection plane. The rectangle is a line in the 2D view.
3. Click twice in the **X/Y** window to specify the start point of the interior wall.
4. Click again to specify the end point of the interior wall.

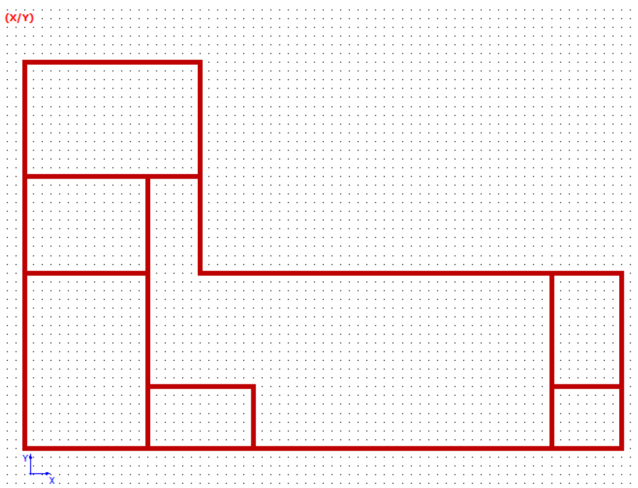


Figure 12: View of the model in the XY plane (top view) showing the outer and interior walls.

> **Note:** The interior walls are created and consist of brick with a height of 3m.

Drawing Wooden Doors

Define the wooden doors in the building.

1. Verify that the **X/Y** window is active, or activate it by clicking in it.
   The **X/Y** symbol in the top-left of the window is red when the window is active.
2. On the **Edit** menu, click **Default Values**.
3. Specify the height of the doors.
   a) Under **Geometrical Parameters for Orthogonal Drawing Mode**, select **Upper and lower coordinate defined individually (and absolute)** field.
   b) In the **Min. Coord** field, enter a value of `0`.
   c) In the **Max. Coord** field, enter a value of `2.5`.
4. Specify the material properties for the doors.
   a) Under **Material Properties**, from the **Material Properties of new Subdivisions** drop-down list, confirm that the material properties are set to **Wood (Fir); thickness: 5 cm**.

   > **Note:** The default material properties for new sub divisions were set in Specifying Default Values for New Objects.

5. Click **OK** to close the **Default Values for New Objects** dialog.
6. Create a door in the X/Y window.

   > **Note:** Create several doors. An exact layout is not important for this example.

   a) On the **Objects** toolbar, click the **Add Objects Orthogonal** icon.
   b) Click twice in the X/Y window to specify the start point of the door.
   c) Click again to specify the end point of the door.

   The **Insert Subdivision** dialog is displayed.

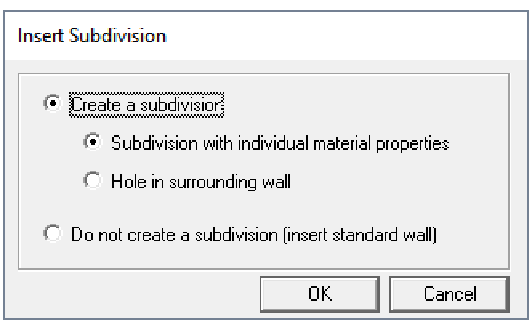


*Figure 13: The **Insert Subdivision** dialog.*

7. Click **OK** to insert the door and to close the dialog.

A door is created perpendicular to the XY plane with a height of 2.5 m.

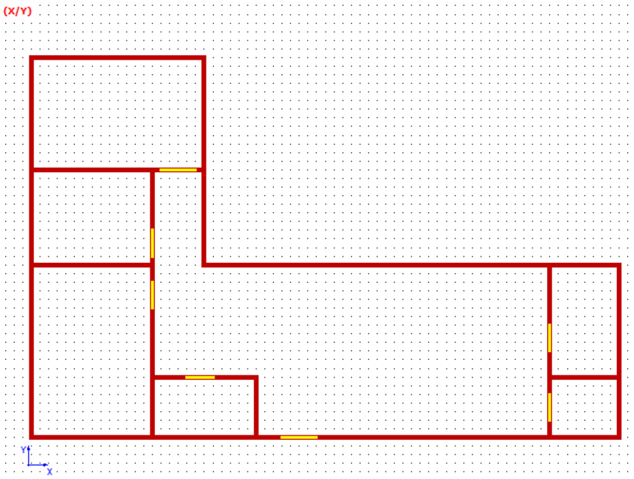


Figure 14: View of the model in the XY plane (top view) showing the outer and interior walls. The wooden doors are indicated in yellow.

Drawing Glass Windows

Define the glass windows in the building.

1. Verify that the **X/Y** window is active, or activate it by clicking in it.
   The **X/Y** symbol in the top-left of the window is red when the window is active.
2. On the **Edit** menu, click **Default Values**.
3. Specify the upper and lower coordinates of the windows in the X/Y window.
   a) Under **Geometrical Parameters for Orthogonal Drawing Mode**, select **Upper and lower coordinate defined individually (and absolute)** field.
   b) In the **Min. Coord** field, enter a value of `1`.
   c) In the **Max. Coord** field, enter a value of `2.5`.
4. Specify the material properties for the windows.
   a) Under **Material Properties**, from the **Material Properties of new Subdivisions** drop-down list, select **Glass; thickness: 5 mm**.

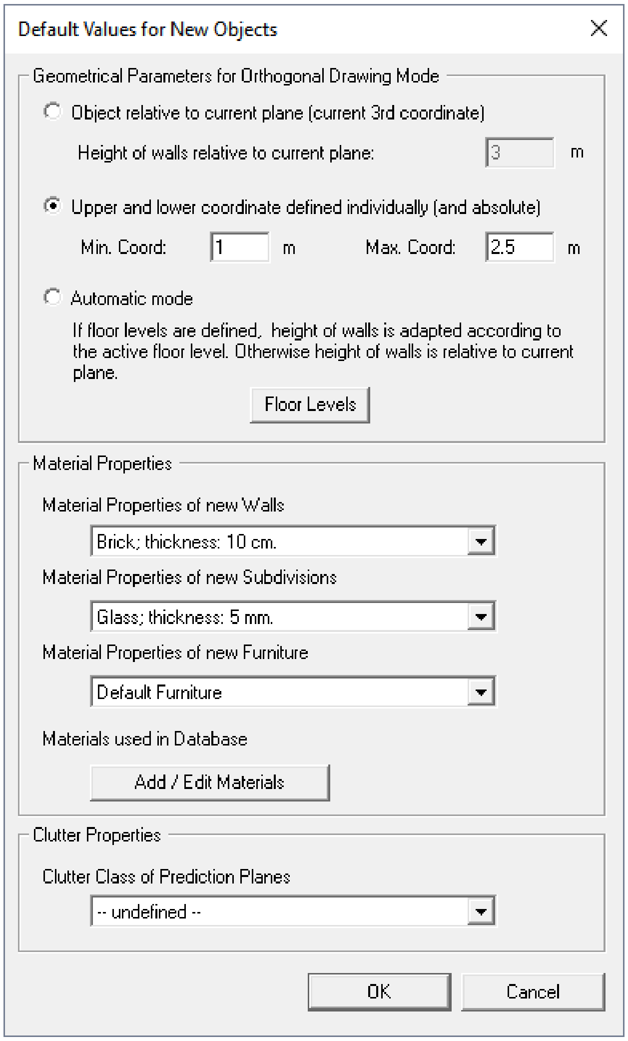


*Figure 15: The **Default Values for New Objects** dialog.*

5. Click **OK** to close the **Default Values for New Objects** dialog.

6. Create a window in the X/Y window.

> **Note:** Create several windows. An exact layout is not important for this example.

a) On the **Objects** toolbar, click the  **Add Objects Orthogonal** icon.

b) Click twice in the X/Y window to specify the start point of the window.

c) Click again to specify the end point of the window.

The **Insert Subdivision** dialog is displayed.

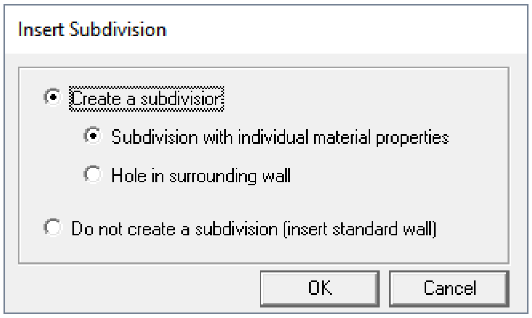


*Figure 16: The **Insert Subdivision** dialog.*

7. Click **OK** to insert the window and to close the dialog.

A glass window is created perpendicular to the XY plane with a height of 1.5 m.

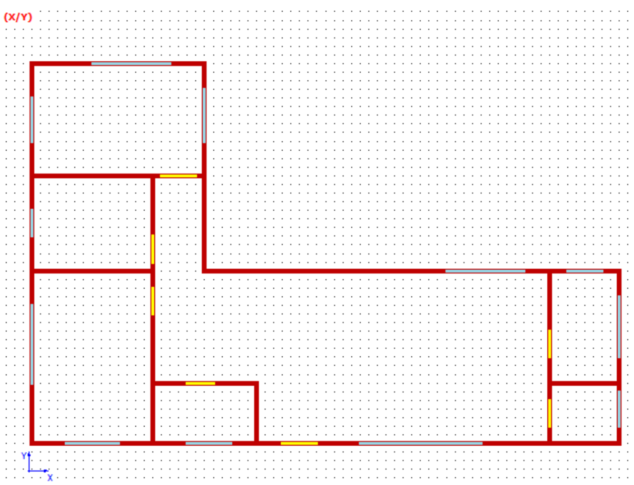


Figure 17: View of the model in the XY plane (top view) showing the outer and interior walls. The glass windows are indicated in light blue.

Drawing Glass Patio Doors

Define the glass patio doors in the building.

1. Verify that the **X/Y** window is active, or activate it by clicking in it.
   The **X/Y** symbol in the top-left of the window is red when the window is active.
2. On the **Edit** menu, click **Default Values**.
3. Specify the height of the glass patio doors.
   a) Under **Geometrical Parameters for Orthogonal Drawing Mode**, select **Upper and lower coordinate defined individually (and absolute)** field.
   b) In the **Min. Coord** field, enter a value of `0`.

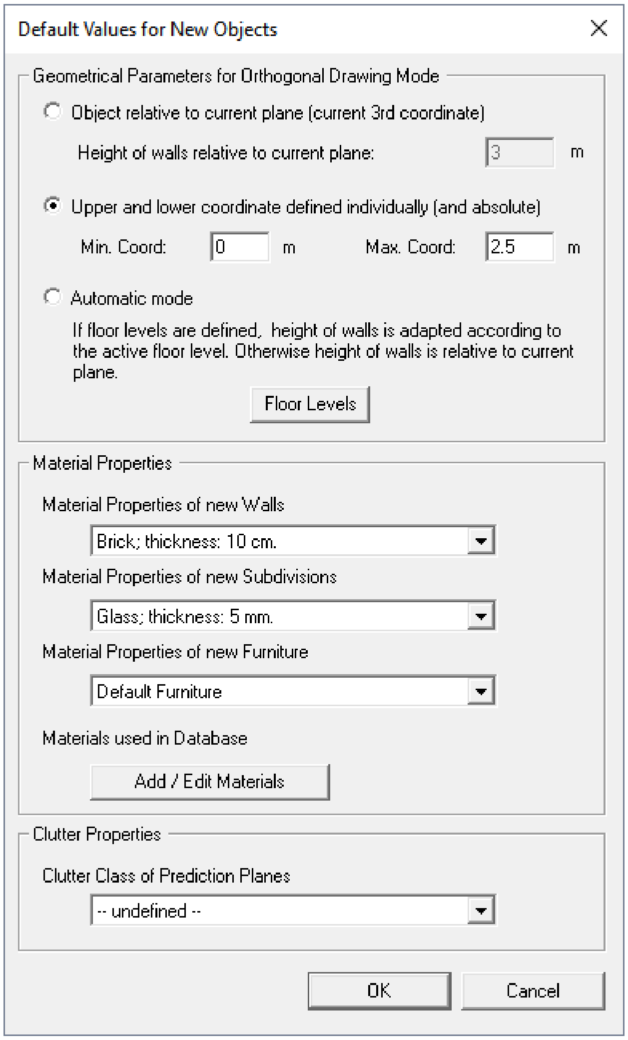


*Figure 18: The **Default Values for New Objects** dialog.*

4. Specify the material properties for the windows.

a) Under **Material Properties**, from the **Material Properties of new Subdivisions** drop-down list, select **Glass; thickness: 5 mm**.

5. Click **OK** to close the **Default Values for New Objects** dialog.

6. Create a glass patio door in the X/Y window.

> **Note:** An exact layout is not important for this example.

a) On the **Objects** toolbar, click the  **Add Objects Orthogonal** icon.

b) Click twice in the X/Y window to specify the start point of the glass patio door.

c) Click again to specify the end point of the glass patio door.

The **Insert Subdivision** dialog is displayed.

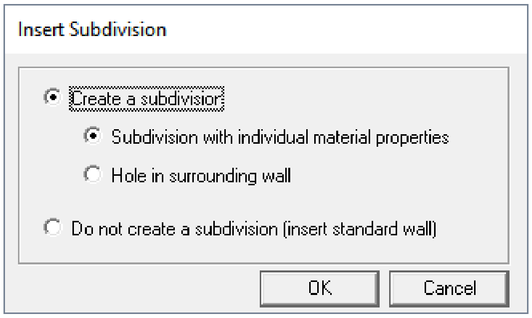


Figure 19: The ***Insert Subdivision*** *dialog.*

7. Click **OK** to insert the glass patio door and to close the dialog.

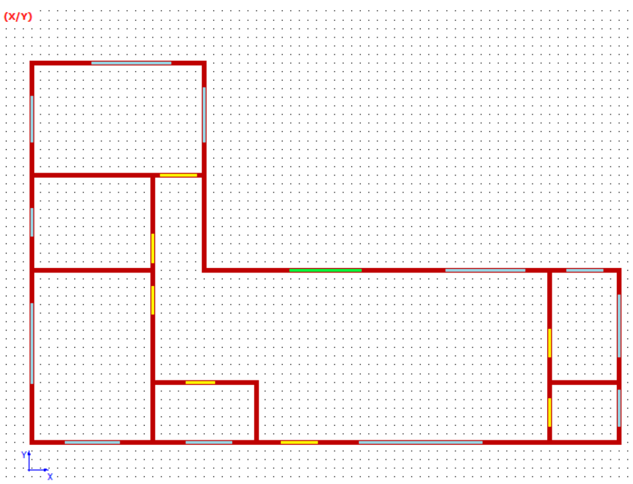


Figure 20: View of the model in the XY plane (top view) showing the outer and interior walls. For emphasis, the material color for glass was changed to green.

A glass patio door is created perpendicular to the XY plane with a height of 2.5 m.

Drawing a Floor

Define the floor of the building. The concrete floor should be large enough to be underneath the entire building, and includes an outdoor sitting area.

1. Verify that the **X/Y** window is active, or activate it by clicking in it.
   The **X/Y** symbol in the top-left of the window is red when the window is active.
2. Confirm that the third coordinate (Z value) is at 0 m using one of the following workflows:
   - On the **View** toolbar, click the **3rd Coordinate Settings** icon.
   - On the **Display** menu, click **Show 3rd Coord Dialog**.

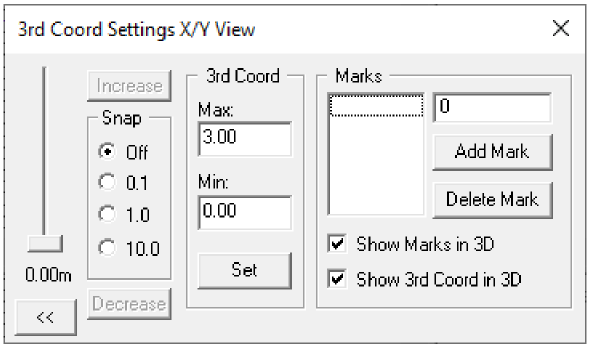


*Figure 21: The **3rd Coord Settings X/Y View** dialog.*

3. On the **Edit** menu, click **Default Values**.
4. Specify the material properties for the floor.
   a) Under **Material Properties**, from the **Material Properties of new Walls** drop-down list, select **Concrete; thickness: 20 cm**.
5. Click **OK** to close the **Default Values for New Objects** dialog.
6. Create the floor in the X/Y window using one of the following workflows:
   - On the **Objects** menu, click **Enter Basic Objects** > **Enter Rectangular Objects**.
   - On the **Objects** toolbar, click the **Add Rectangular Objects** icon.
   - Press F8 to use the keyboard shortcut.
7. Click twice in the 2D view to specify a corner.
8. Click again in the 2D view to specify the last corner.
9. Exit the draw mode using one of the following workflows:
   - On the **Objects** menu, click **Select Objects** > **Select Single Object (Mouse)**.
   - On the **Objects** toolbar, click the **Select Object** icon.
   - Press F10 to use the keyboard shortcut.

1.4.10 Adding an Angled Prediction Plane

Define an additional and arbitrary polygonal prediction plane.

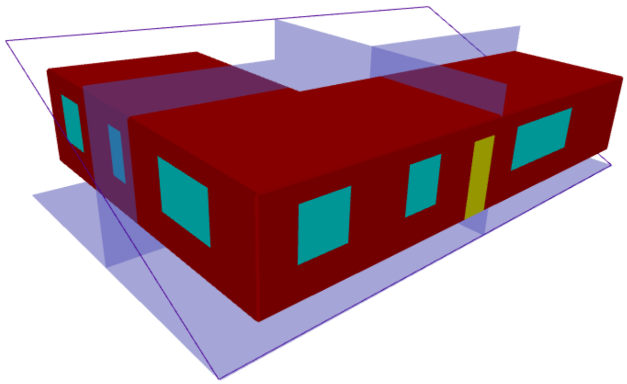


Figure 22: A 3D model of the building showing the additional prediction plane to be added to the model (indicated with a blue outline).

1. Create a polygon using one of the following workflows:
    - On the **Objects** menu, click **Enter Basic Objects** > **Enter Polygonal Object**.
    - On the **Objects** toolbar, click the **Add Polygonal Objects** icon.
    - Press F7 to use the keyboard shortcut.
2. Create the general shape of the prediction plane (in this example, a rectangle).

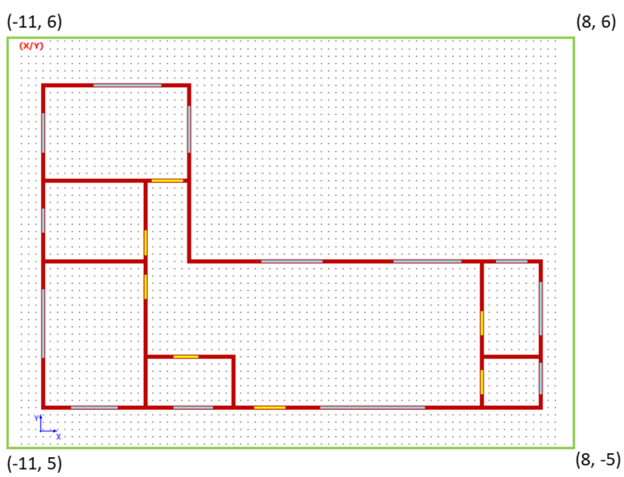


Figure 23: View of the model in the X/Y plane (top view). The general shape of the prediction plane is illustrated in green.

    a) Click twice to specify the first corner of the polygon.
    b) Click twice to specify corner 3 and corner 4.
    c) Right-click at the first corner to close the polygon.
3. Edit the coordinates of the prediction plane.
    a) Select the prediction plane by clicking on the outline of the polygon.

b) Right-click on the selected prediction plane and from the right-click context menu, click **Properties**.

c) On the **Object Properties** dialog, specify the precise coordinates:

- (-11, 6, 4)
- (8, 6, 4)
- (8, -5, -1)
- (-11, -5, -1)

4. Click **Change Type**.
   The **Wall Type** dialog is displayed.
5. Under **Selected Type**, from the drop-down list, select **Prediction Plane**.

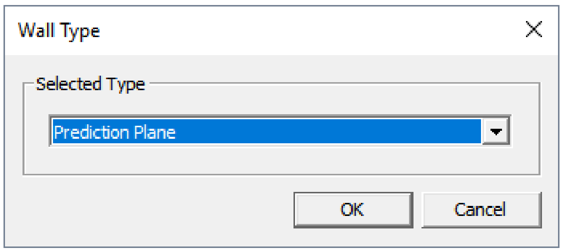


*Figure 24: The **Wall Type** dialog.*

6. Click **OK** to close the **Wall Type** dialog.
7. Click **OK** to close the **Object Properties** dialog.

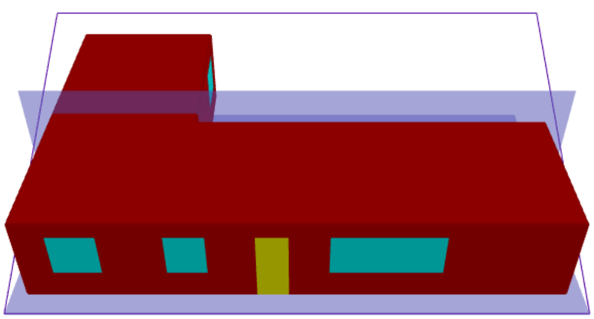


Figure 25: A 3D model of the building showing the angled prediction plane (indicated with a blue outline).

> **Note:** The new prediction plane must also be included in the simulation when setting up the project parameters in ProMan, see Step 5.

1.4.11 Saving the Indoor Database

Save the new indoor database to file.

1. On the **File** menu, click **Save Database As**.

2. Enter `rooms_1.idb` as the file name for the indoor database and click **Save**.

> **Note:** The `.idb` file extension stands for *indoor database binary*.

1.5 Introduction to Propagation Manager (ProMan)

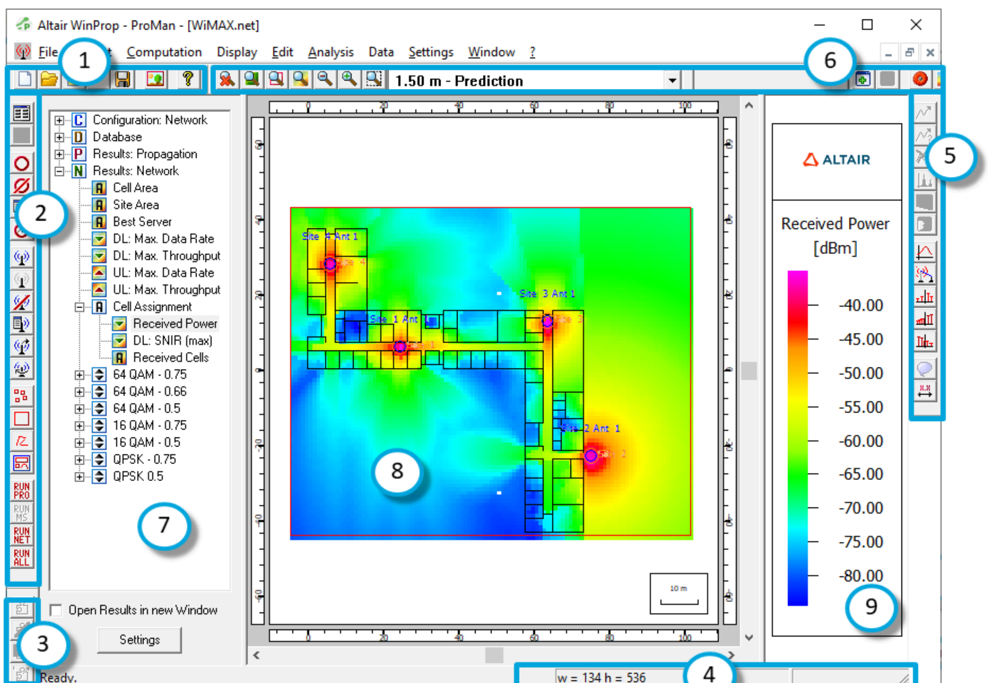
The ProMan (propagation) tool is designed to predict path loss accurately between transmitter and receiver. The ProMan (network) software offers network planning modules.

1.5.1 Launching ProMan

Launch ProMan in Microsoft Windows using the Feko Launcher utility (which includes WinProp and newFASANT).

1.5.2 User Interface Layout

View the main elements and terminology in the ProMan graphical user interface (GUI).



1. *Standard toolbar*

   The standard toolbar gives access to commonly used menu items including **New Project**, **Open Project**, **Open Result**, and **Save**.

2. *Project toolbar*

   The project toolbar gives access to tools related to editing project parameters, transmitters, sites, prediction points and launching simulations.

3. *Component toolbar*

   The component toolbar gives access to tools related to components, including add cable, add antenna, and add transceiver.

4. *Status bar*

   The Status bar is a small toolbar that gives quick access to absolute coordinates at the location of the mouse cursor in the 2D view.

5. *Utility toolbar*

   The utility toolbar gives quick access to, for example, ray display settings, line plot, and probability density function.

6. *Edit toolbar*

   The edit toolbar gives quick access to editing tools such as zooming to result, zooming to prediction area, enabling the 3D view and display settings.

7. *Tree view*

   The tree view is a panel that organizes the model into network configuration-specific items and propagation results.

8. *2D view/3D view*

   If the 2D view is enabled, the 2D view displays a top view of the model. If the 3D view is enabled, an isometric view of the model is displayed.

9. *Legend*

   The legend is displayed to the right of the 2D view or 3D view and is linked to the displayed data.

1.5.3 Creating a New Project

Load the indoor database that was created in WallMan.

1. On the **File** menu, click **New Project**.
   The **New Project** dialog is displayed.
2. Under **Scenario**, from the drop-down list, select **Indoor Scenarios (3D vector databases for arbitrary 3D scenarios)**.
3. In the **3D indoor building data (Vector database)** field, browse to `rooms_1.idb`.
4. Under **Polarimetric Analysis**, select **Full (limited to selection of scenarios and propagation models)**.

   full polarimetric analysis

   Angle-dependent polarization information is obtained from Feko .ffe file. This option is only for indoor and urban scenarios using standard ray tracing, intelligent ray tracing, and multi-wall model with Fresnel coefficients/UTD.

standard polarimetric analysis

The antenna pattern can come from a Feko .ffe field or other sources but may not contain polarization information. The polarization information is defined in ProMan, where selected polarization and cross polarization apply to all angles.

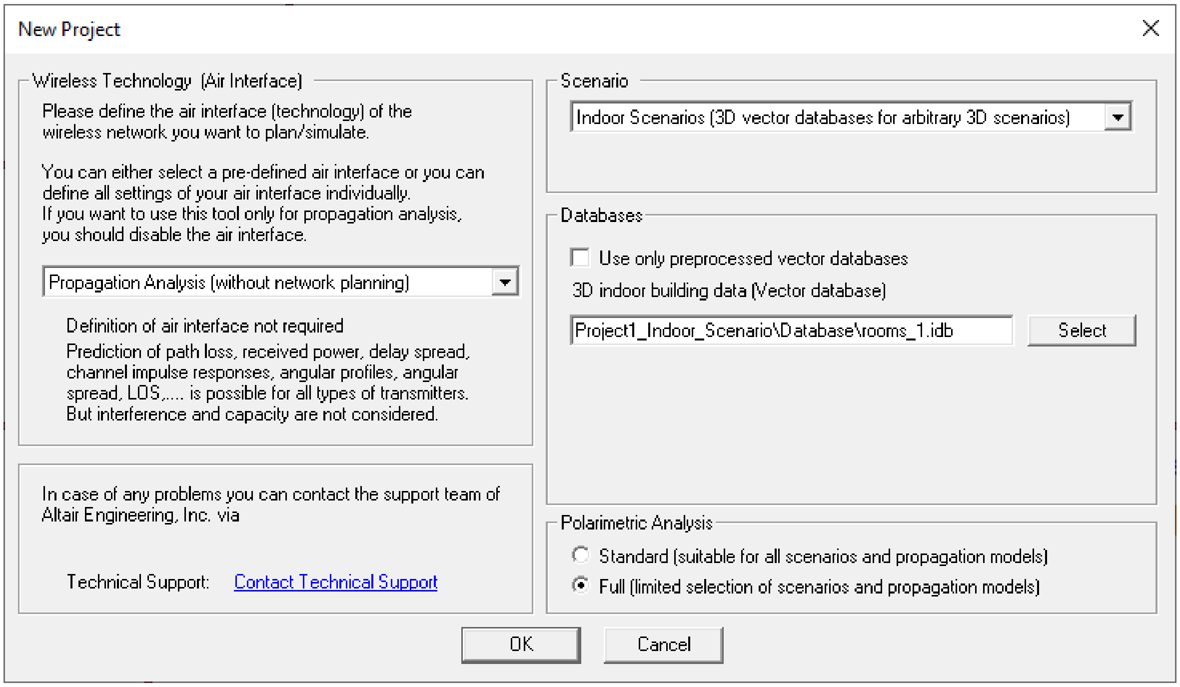


*Figure 26: The **New Project** dialog.*

5. Click **OK** to close the **New Project** dialog.
   The **Define Display Height** dialog is displayed.
6. In the **Height** field, enter a value of `1` m as this is the height of a typical table with a computer with Wi-Fi connection.
7. Click **OK** to define the display height and to close the dialog.
   A cross-section is displayed at Z = 1 m.

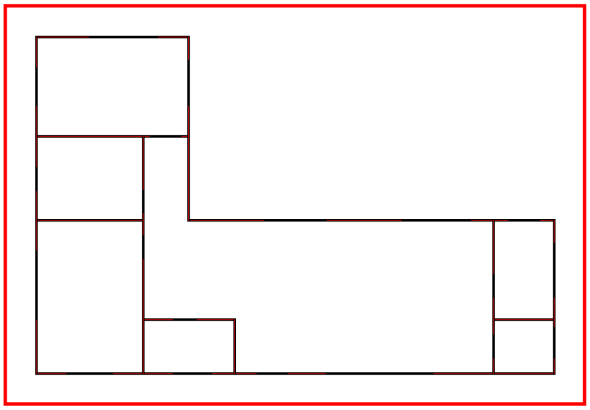


Figure 27: A cross-section of the model at Z = 1 m.

Note: The red rectangle indicates the extent of the computational domain.

1.5.4 Defining the Antenna Site and Antenna

For this example, a single antenna site and antenna are defined.

1. Specify the transmitter type and settings using one of the following workflows:
   - On the **Project** menu, click **Sites** > **Site: New**.
   - On the **Project** toolbar, click the **Set Site** icon.

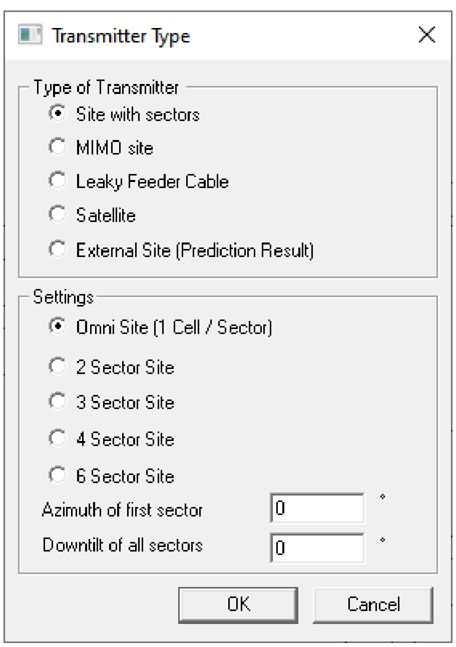


*Figure 28: The **Transmitter Type** dialog.*

2. Use the default settings.

   > **Note:** Use **Omni Site (1 Cell/Sector)** as only a single antenna is defined per site. This option does not imply an omnidirectional antenna.

3. Click **OK** to close the **Transmitter Type** dialog.
   In the 2D view, the mouse cursor is displayed as a circle to indicate that the **Set site** tool is enabled.
4. Click near point (X, Y) = (4, -1) in the 2D view to place the site.

   > **Tip:** The coordinates at the current mouse cursor are displayed in the Status bar.

   The **Site** dialog is displayed.
5. On the **Site** dialog, click on **Site 1** to select and click **Edit**.

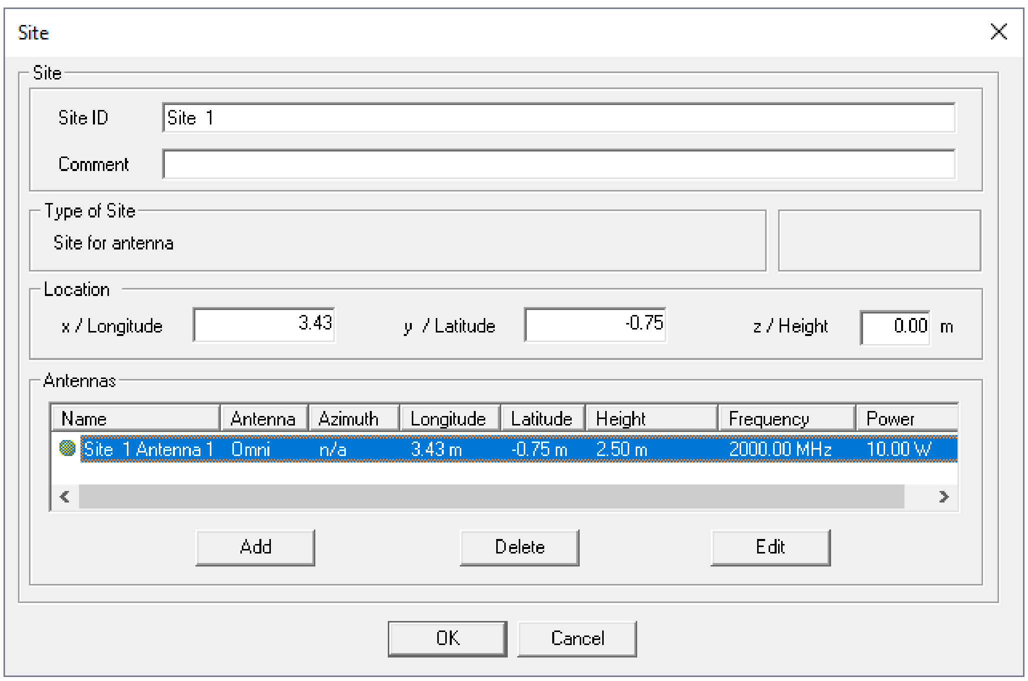


*Figure 29: The **Site** dialog.*

   The **Cell** dialog is displayed.
6. Specify the transmitter settings.
   a) Under **Transmitter Settings**, in the **Frequency (used for propagation)** field, enter a value of `2400` MHz.
   b) Under **Transmitter Settings**, in the **Tx Power** field, enter a value of `0.5` W.
7. Specify the location of the antenna.
   a) Under **Location of Antenna**, in the **x / Longitude** field, enter a value of `4` m.
   b) Under **Location of Antenna**, in the **y / Latitude** field, enter a value of `-1` m.
   c) Under **Location of Antenna**, in the **z / Height** field, enter a value of `2` m.
8. Specify the antenna pattern.

a) Under **Antenna Pattern**, click **Directional / Sector** antenna.

b) Browse to the file `router_FF3D.ffe` and click **Open**.

9. Click **OK** to close the **Cell** dialog.

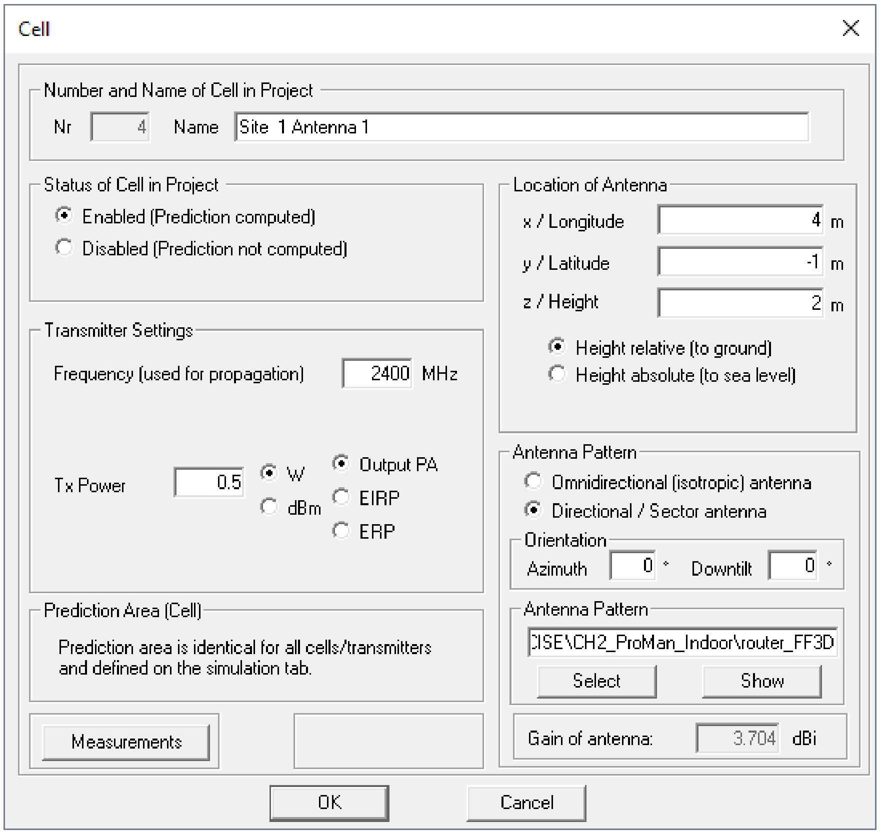


Figure 30: The ***Cell*** *dialog. Note that the maximum antenna gain is displayed in the* ***Gain of antenna*** *field.*

10. Click **OK** to close the **Site** dialog.

11. Disable the **Set site** tool by clicking again on the **Set Site** icon.

1.5.5 Main Computation Methods

The three main computation methods for indoor databases in ProMan are the 3D ray tracing (SRT) model, dominant path model (DPM), and the multi-wall model (COST 231).

- *3D ray tracing (SRT) model*

  This method is accurate but can be computationally expensive if many interactions are taken into account.

- *dominant path model (DPM)*

  This method is the right balance between accuracy and simulation time but not available with the fully polarimetric option.

- *multi-wall model (COST 231)*

  This method is fast but may be too pessimistic when a ray traverses multiple walls. Rays that diffract around corners are not considered.

1.5.6 Using the Multi-Wall Model (COST 231)

The indoor database is solved using the multi-wall model (COST 231).

Specifying the Prediction Resolution and Height

Define the resolution grid for the result matrices and the height at which the prediction results are computed.

1. Launch the **Edit Project Parameters** dialog using one of the following workflow:
   - On the **Project** menu, click **Edit Project Parameters**.
   - On the **Project** toolbar, click the **Edit Project Parameters** icon.
   - Press F3 to use the keyboard shortcut.
2. Click the **Simulation** tab.
3. Under **Resolution of prediction results**, in the **Resolution** field, enter a value of `0.05` m.
   The prediction result will be computed with a resolution (grid) of 0.05 m.
4. Under **Prediction Heights (relative to ground)**, in the **Heights** field, enter a value of `1` m.
   The prediction result will be computed at the height of 1m (height of a desk with a Wi-Fi router).
5. Under **Additional Prediction Planes**, select the **Prediction Planes defined in database** check box.

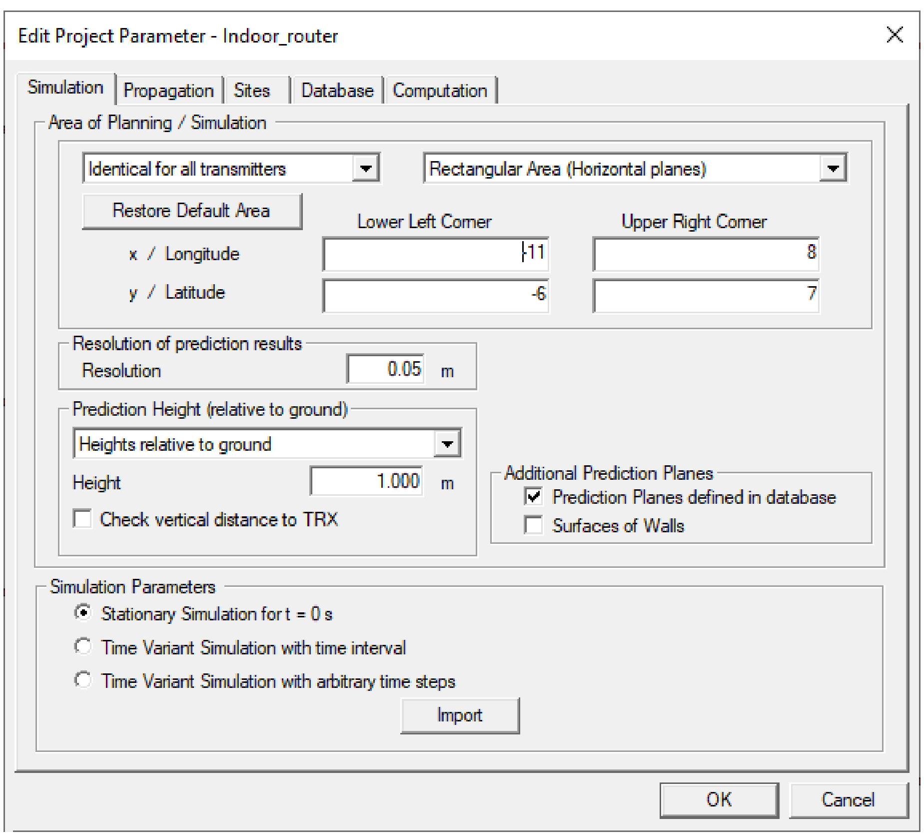


*Figure 31: The **Edit Project Parameters** dialog - **Simulation** tab.*

Note: Keep the dialog open to define additional project parameters.

Specifying the Output Folder for the Prediction Results

Specify the folder for the prediction results to be computed using the multi-wall model (COST 231).

1. Click the **Propagation** tab.
2. Specify the output folder for the results to be computed using the multi-wall model (COST 231).
   a) Under **Output Directory / Basic Filename for Propagation Results**, in the **Directory** field, change the default `PropName` to `Prop01_MW`.

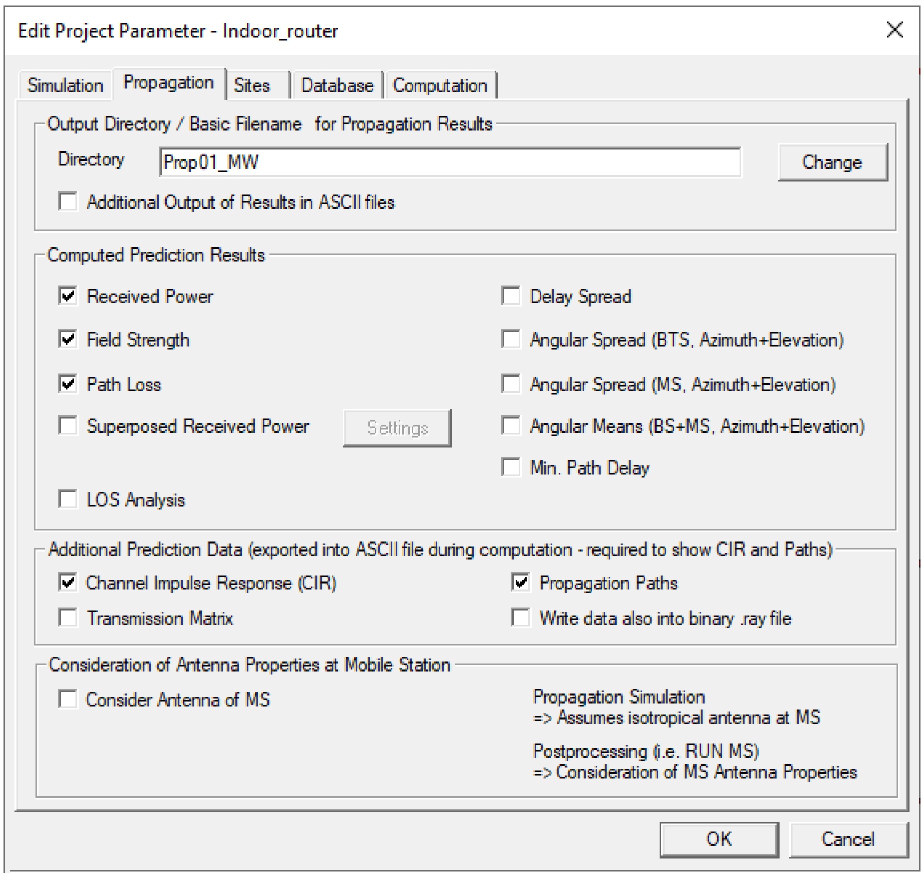


*Figure 32: The **Edit Project Parameters** dialog - **Propagation** tab.*

Note: Keep the dialog open to define additional project parameters.

Defining the Prediction Requests

Specify the predictions to be computed.

1. Under **Computed Prediction Results**, select the **Field strength** check box.

2. Under **Computed Prediction Results**, select the **Path loss** check box.
3. Under **Additional Prediction Data (exported into ASCII file during computation - required to show CIR and Paths)**, select the **Channel Impulse Response (CIR)** check box.

   > **Tip:** Select the **Consider Antenna of MS**[4] check box if you want to define a receiving antenna pattern to determine how much power would be received at every location by that mobile station.
   >
   > In the fully polarimetric case, this requires a ray-tracing method and requires the computation of the transmission matrix.

4. Under **Additional Prediction Data (exported into ASCII file during computation - required to show CIR and Paths)**, select the **Propagation Paths** check box.

> **Note:** Keep the dialog open to define additional project parameters.

Specifying the Computation Method

Select the multi-wall model (COST 231) as the computation method.

1. Click the **Computation** tab.
2. Under **Empirical Propagation Models**, click **Multi-Wall Model (COST 231)**.
3. Under **Computation of signal level along propagation path (valid for all propagation models)**, click **Fresnel Coefficients...**.

4. mobile station

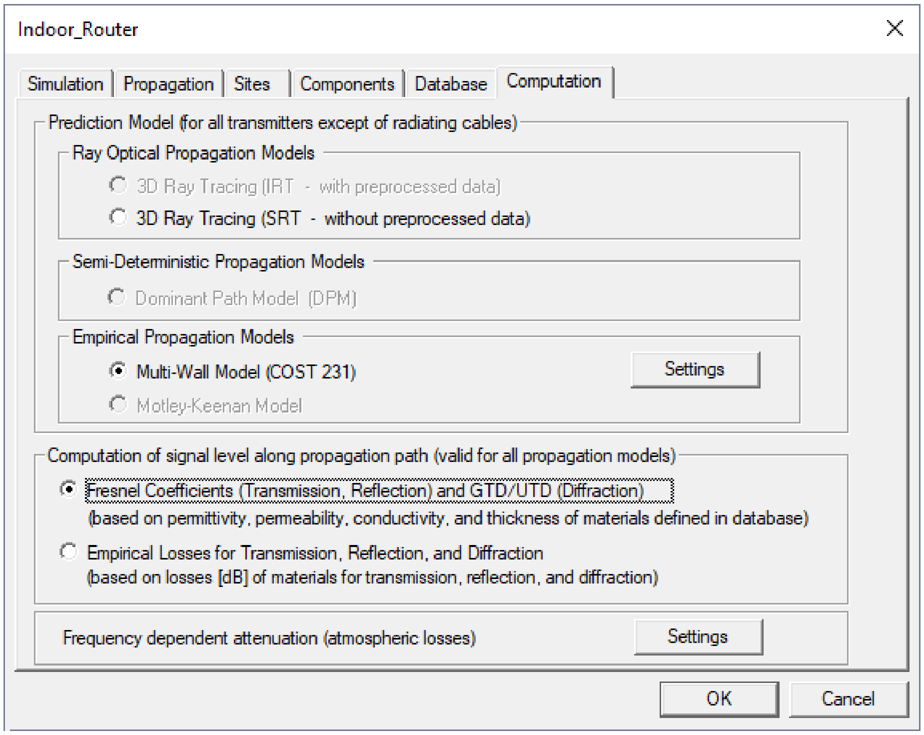


*Figure 33: The **Edit Project Parameters** dialog - **Computation** tab.*

> **Note:** We have imported an antenna pattern from Altair Feko with the complete angle-dependent polarization information (as opposed to a pattern that might only specify a dominant polarization direction and a cross-polarization level).
>
> To use this information in the interactions of the rays with the geometry, select Fresnel + GTD/UTD coefficients rather than empirical coefficients for transmission, reflection, and edge diffraction.

4. Click **OK** to close the **Edit Project Parameters** dialog.

Saving the Project

Save the new project to file.

1. On the **File** menu, click **Save Project As**.
2. Enter `Indoor_router.net` as the file name for the project and click **Save**.

Launching the Solver

Compute the propagation for the antenna to obtain the prediction results.

Launch the Solver using one of the following workflows:

- On the **Project** toolbar, click the RUN PRO **Computes propagation for all antennas** icon.

- On the **Computation** menu, click **Propagation: Compute All**.

The Solver is launched and the **Computation** dialog is displayed.

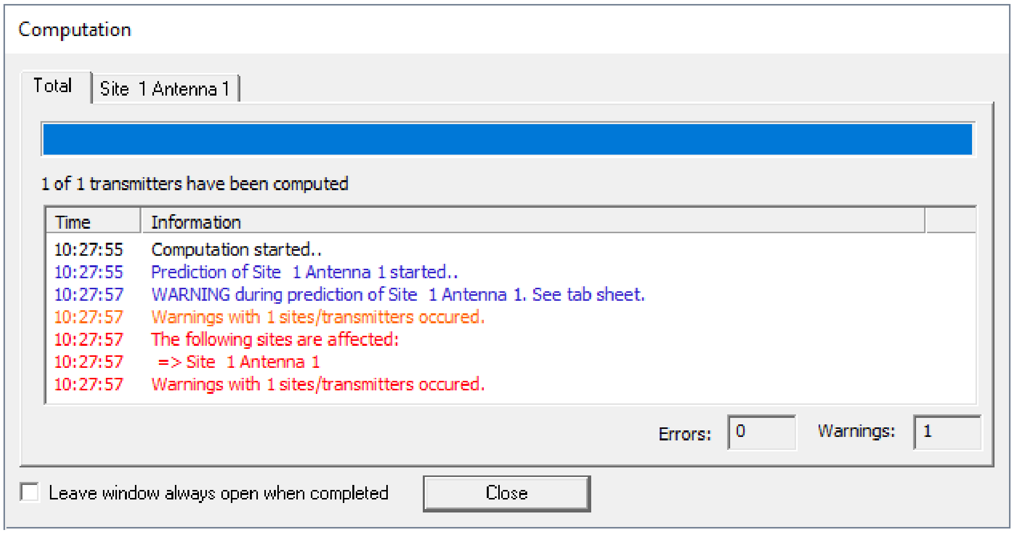


*Figure 34: The **Computation** dialog.*

> **Note:** For this example, several warnings are displayed. Ignore these warnings, as it only states that the imported pattern is a directivity pattern rather than a gain pattern.

Viewing the Prediction Results in 2D

Display the power prediction results in 2D using the multi-wall model (COST 231).

1. In the tree, expand **Results: Propagation** and click **Power**.

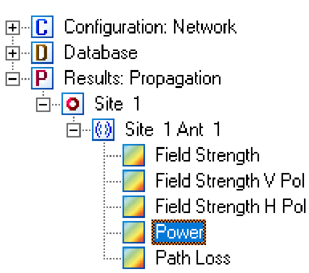


Figure 35: The tree in ProMan showing the results.

2. View the power prediction results in the 2D view.

> **Note:** Expect the results to take a minute or so to load.

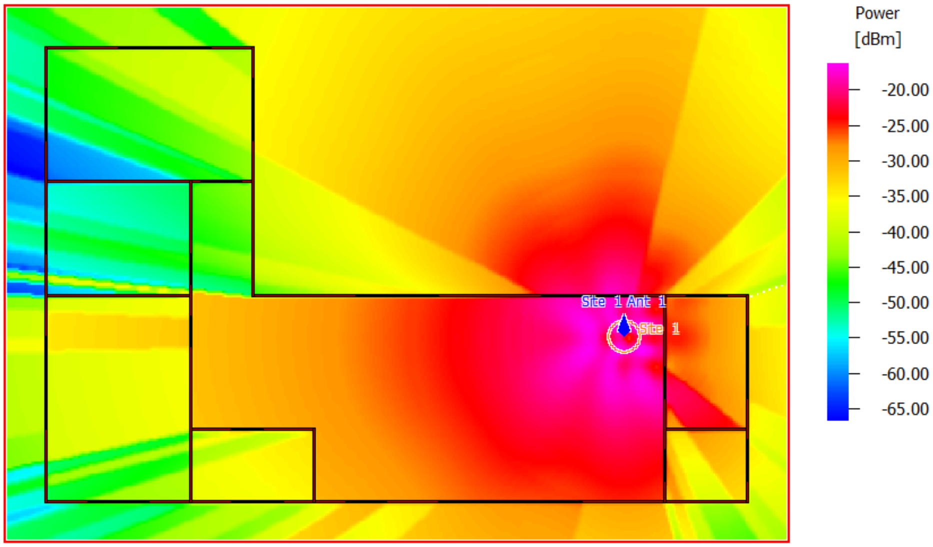


Figure 36: Prediction of received power, by a hypothetical isotropic antenna, using the multi-wall model (COST 231).

Note:

- Rays from the Wi-Fi router are straight.
- Distance and number of walls determine the field strength.

1.5.7 Using the 3D Ray Tracing (SRT) Model

The indoor database is solved using the 3D ray tracing (SRT) model.

Specifying the Output Folder for the Prediction Results

Specify the folder for the prediction results to be computed using the 3D ray tracing (SRT) model.

1. Launch the **Edit Project Parameters** dialog using one of the following workflow:
   - On the **Project** menu, click **Edit Project Parameters**.
   - On the **Project** toolbar, click the **Edit Project Parameters** icon.
   - Press F3 to use the keyboard shortcut.
2. Click the **Propagation** tab.
3. Specify the output folder for the results to be computed using the 3D ray tracing (SRT) model.
   a) Under **Output Directory / Basic Filename for Propagation Results**, in the **Directory** field, change `Prop01_MW` to `Prop01_SRT`.

> **Note:** Keep the dialog open to define additional project parameters.

Specifying the Computation Method

Select the 3D ray tracing (SRT) model as computation method.

1. Click the **Computation** tab.
2. Under **Ray Optical Propagation Models**, click **3D Ray Tracing (SRT - without preprocessed data)** as this the second computation method that is considered for this example.
3. Click **OK** to close the **Edit Project Parameters** dialog.

Launching the Solver

Compute the propagation for the antenna to obtain the prediction results.

Launch the Solver using one of the following workflows:

- On the **Project** toolbar, click the **Computes propagation for all antennas** icon.
- On the **Computation** menu, click **Propagation: Compute All**.

The Solver is launched and the **Computation** dialog is displayed.

> **Note:** For this example, several warnings are displayed. Ignore these warnings, as it only states that the imported pattern is a directivity pattern rather than a gain pattern.

Viewing the Prediction Results in 2D

Display the power results using the 3D ray tracing (SRT) model.

1. In the tree, expand **Results: Propagation** and click **Power**.
2. View the power prediction results in the 2D view.

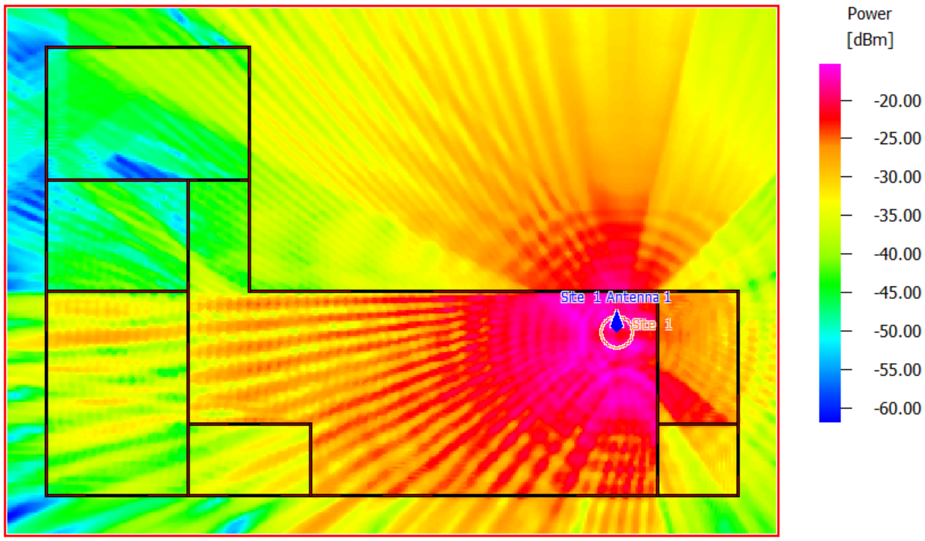


Figure 37: Prediction of received power using the 3D ray tracing (SRT) model.

> **Note:**
> - The effect of diffraction around a corner (indicated in red).
> - The deepest shadows are now less deep.
> - Fields have more ways to reach all locations.

The multi-wall model (COST 231) was too pessimistic in its prediction.

1.5.8 Viewing the Differences in Prediction Results

Display the difference between the two sets of prediction results obtained using the multi-wall model (COST 231) and the 3D ray tracing (SRT) model.

View the power results for the Wi-Fi router using the 3D ray tracing (SRT) model.

1. Subtract the data using one of the following workflows:
   - On the **Edit** menu, click **Subtract Data** > **Value (File, linear)**.
   - Press Alt+4 to use the keyboard shortcut.
2. Browse to the folder that contains the multi-wall model (COST 231) results as specified in Step 2.
3. Select the `Site 1 Ant 1 Power.fpp` file and click **Open**.

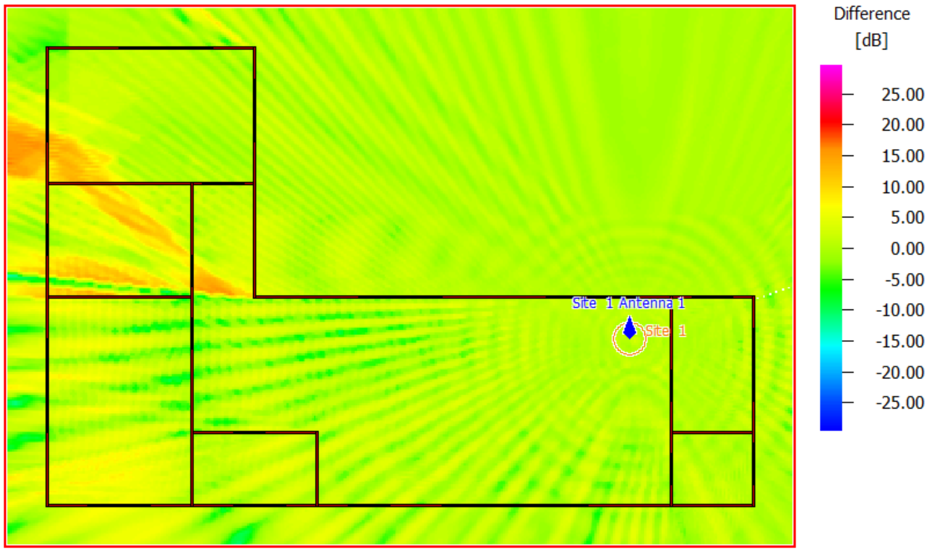


Figure 38: Difference between the predicted received power using the multi-wall model (COST 231) and 3D ray tracing (SRT) model.

> **Note:** Main difference between models are visible in the deep shadows (indicated by the red areas). Contributions through diffraction are significant.

The multi-wall model (COST 231) is too pessimistic in its prediction, but the 3D ray tracing (SRT) model is reliable.

1.5.9 Viewing the Prediction Results in 3D

In ProMan, the indoor database can be viewed in 3D to validate the physical structure and results.

1. View the model and results in 3D.

a) On the **Edit** toolbar, click the 3D **3D View** icon.

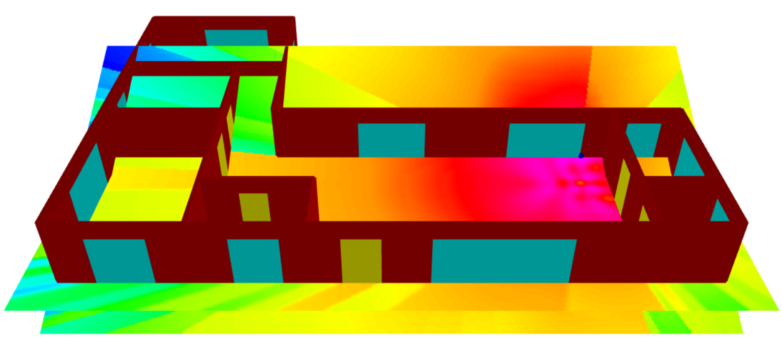


Figure 39: A 3D view of the model with power prediction results. The default prediction planes as well as the angled prediction plane are displayed.

2. View the results on the angled prediction plane.

a) On the **Settings** menu, click **Local Settings**.

b) On the **Display Settings** dialog, click the **Layout** tab.

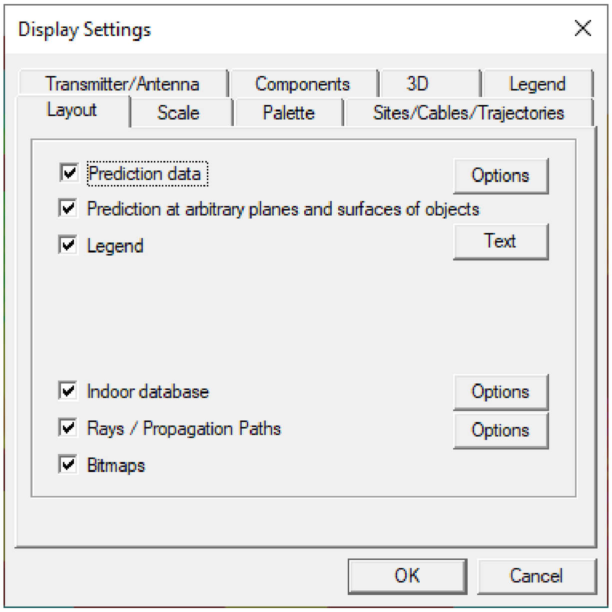


*Figure 40: The **Display Settings** dialog.*

c) Clear the **Prediction data** check box to disable the default prediction results and only show the results on the angled prediction plane.

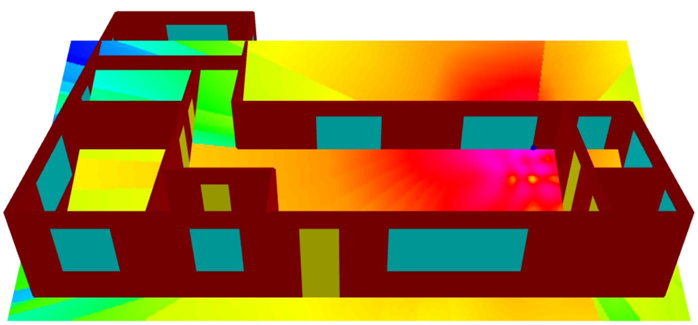


Figure 41: A 3D view of the model with power prediction results displayed only on the angled prediction plane.

3. Draw horizontal walls and objects to verify that the Wi-Fi router is below the ceiling.

a) On the **Settings** menu, click **Local Settings**.

b) On the **Display Settings** dialog, click the **Layout** tab.

c) In the **Indoor database** field, click **Options**.

d) On the **Display of Walls** dialog, under **3D Display**, select the **Draw horizontal walls/ objects** check box.

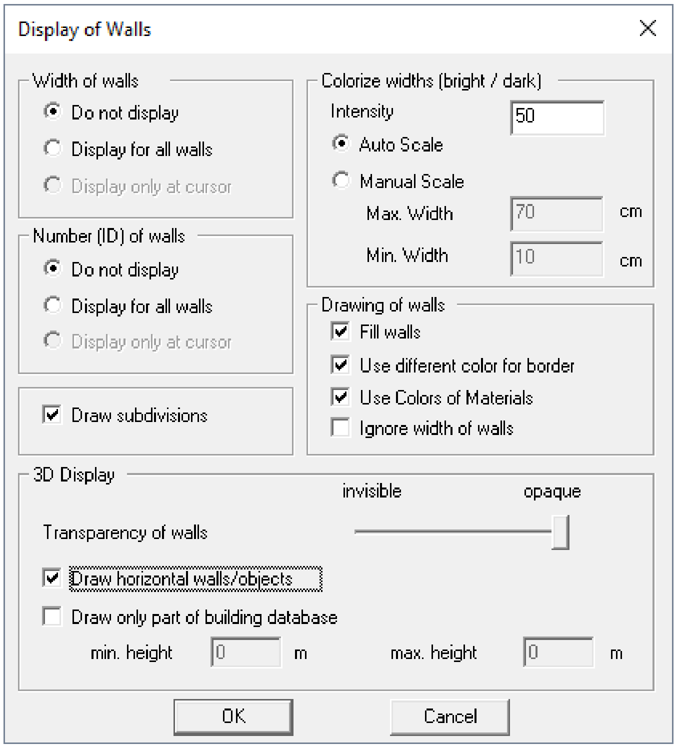


*Figure 42: The **Display of Walls** dialog.*

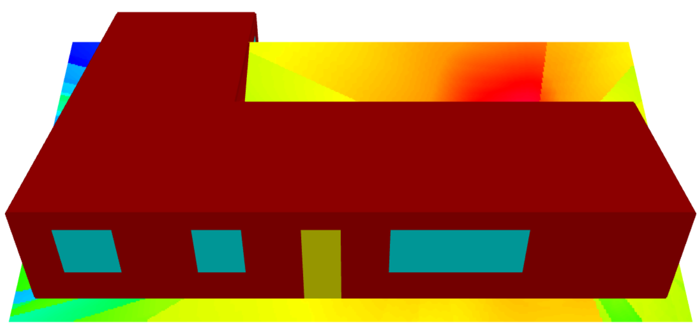


Figure 43: A 3D view of the model with power prediction results. on the angled prediction plane. Horizontal objects such as the floor and roof are visible.

4. Return to the 2D view of the model.

a) On the **Edit** toolbar, click the 3D **3D View** icon again to disable the 3D view.

1.5.10 Final Remarks

This example showed how to analyze a Wi-Fi router in a building, to create the 3D model (indoor database) using WallMan and to obtain coverage plots using ProMan.

Many concepts were introduced in this example that apply to models commonly created in WallMan and ProMan.

Indoor Cell-Phone Reception 2

This example considers the application of analyzing the indoor cell-phone reception, set in an urban environment.

This chapter covers the following:

2.1 Example Overview

This example considers the application of analyzing cell phone reception inside a building, set in an urban environment. The urban environment includes buildings and vegetation.

The 3D model of the urban environment is created in WallMan using an imported aerial photograph, tracing the building and assigning a height to the buildings. A model of a building, as created in Example 1, is imported onto the urban environment.

The antenna pattern was obtained using Altair Feko, but the steps on how to use Feko to obtain the antenna pattern are not in the scope of this example.

Coverage plots are produced using ProMan to determine the cell phone reception inside a building which is set in an urban environment. Two different propagation models are used, namely: dominant path model and COST 231 - extended Walfisch-Ikegami model.

Note:

This example does not specify the exact coordinates where to add buildings and vegetation in the urban environment or where to place the building, but instead, it highlights the steps to create these structures in WallMan.

You are encouraged to create your own urban environment and structures using WallMan.

2.2 Topics Discussed in Example

Before starting this example, check if the topics discussed in this example are relevant to the intended application and experience level.

The topics discussed in this example are:

- WallMan
  - Launch WallMan.
  - Import an aerial photograph to create the urban environment.
  - Trace the buildings on the aerial photograph and assign a height to the buildings.
  - Add vegetation to the urban environment.
  - Import the indoor database (3D model of the building) onto the urban environment.
- ProMan
  - Launch ProMan.
  - Specify the computation method.
  - Launch the Solver.
  - View the prediction results.

> **Note:** Follow the example steps in the order they are presented as each step uses its predecessor as a starting point.

> **Tip:** Find the completed model in the Altair installation directory, for example:
>
> `Altair\2025.1\help\winprop\examples\GetStarted_models\Project2_Hybrid_Urban_Indoor_Scenario`.

2.3 Example Prerequisites

Before starting this example, ensure that the system satisfies the minimum requirements.

The requirements for this example are:

- Feko 2025.1[5] or later should be installed.

5. WinProp is included as part of the Feko installation.

2.4 Exporting the Antenna Pattern in Feko

An antenna pattern is exported to a `.ffe` file using POSTFEKO.

In POSTFEKO, export the antenna pattern to `farfield_gain_3d.ffe` file[6].

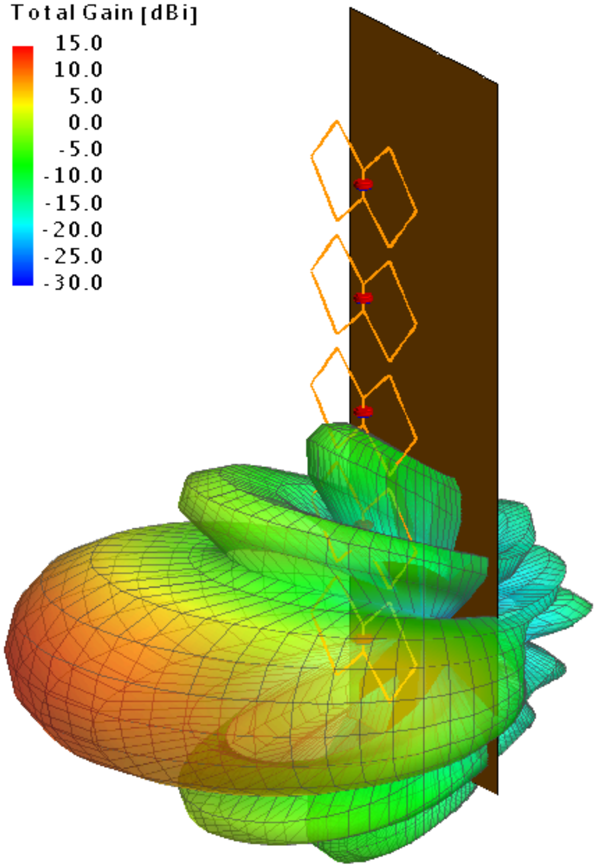


Figure 44: The antenna pattern (directivity) as displayed in POSTFEKO.

> **Note:** The antenna pattern represents a base-station sector pattern, broad in the azimuth direction and relatively narrow in the elevation direction.

6. View the Feko User Guide for more information.

2.5 Creating the Geometry Database in WallMan

Create a hybrid urban/indoor geometry database in WallMan.

The workflow for creating a hybrid urban/indoor geometry database for this example:

1. Create an urban database by importing an aerial photograph. Draw buildings and vegetation by tracing the image and specifying a height for the objects.
2. Import the indoor database (building) into the urban database.

2.5.1 Launching WallMan

Launch WallMan in Microsoft Windows using the Feko and WinProp Launcher utility.

2.5.2 Creating a New Hybrid Urban/Indoor Database

Define a new urban building database.

1. Create a new database using one of the following workflows:
    - On the **File** menu, click **New Database**.
    - On the **Standard** toolbar, click the **New Database** icon.
    - Press Ctrl+N to use the keyboard shortcut.
2. Under **Type of new database**, click **Urban building database**.
3. Under **Mode of operation**, click **Draw with bitmap in background**.
4. Under **Material catalogue**, browse to `GlobalMaterialCatalogue.mcb`[7].

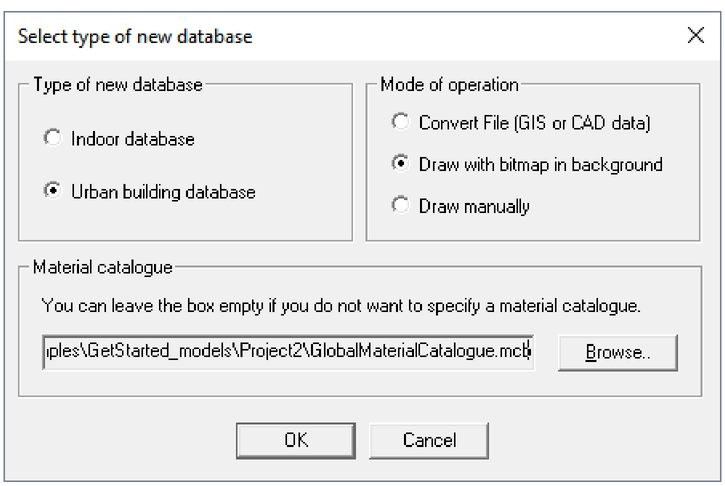


*Figure 45: The **Select type of new database** dialog.*

7. `Project2_Hybrid_Urban_Indoor_Scenario\Database\GlobalMaterialCatalogue.mcb`

5. Click **OK** to close the **Select type of new database** dialog.
   The **Coordinate System** dialog is displayed.

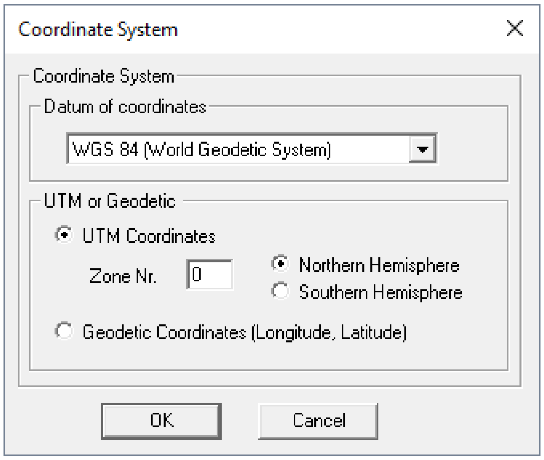


*Figure 46: The **Coordinate System** dialog.*

6. Under **Datum of coordinates**, keep the default option, **WGS 84 (World Geodetic System)**.[8]
7. Under **UTM or Geodetic**, in the **Zone Nr.** field, enter an integer value of `11`.[9]
8. Click **OK** to close the **Coordinate System** dialog.
   The **Default Values for New Buildings** dialog is displayed.

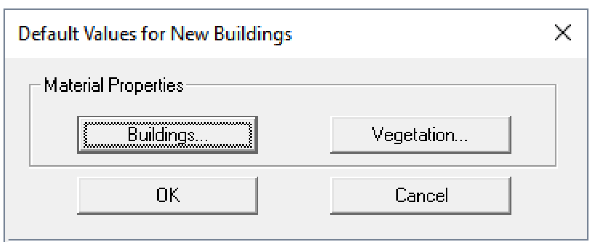


*Figure 47: The **Default Values for New Buildings** dialog.*

2.5.3 Specifying Default Materials for New Objects

Define the default materials for new buildings and vegetation.

1. Specify the default material for new buildings.
   a) Click **Buildings** and the **Material** dialog is displayed.
   b) Under **Select Material**, from the drop-down list, select **10: Concrete; thickness: 20 cm**.

8. This option is required for geo-referencing and not relevant to this example.
9. The Universal Transverse Mercator (UTM) system describes a position on a map using a system of coordinates. For this example you can enter any zone number of your choice.

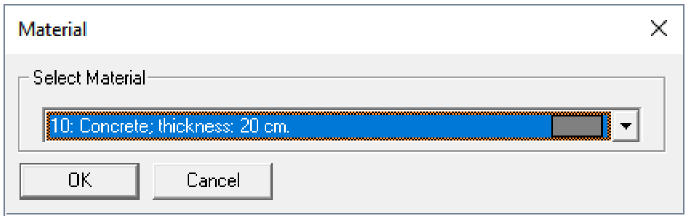


*Figure 48: The **Material** dialog.*

   c) Click **OK** to close the **Material** dialog.

2. Specify the default material for new vegetation.
   a) Click **Vegetation** and the **Material** dialog is displayed.
   b) Under **Select Material**, from the drop-down list, select **73: Default Vegetation**.

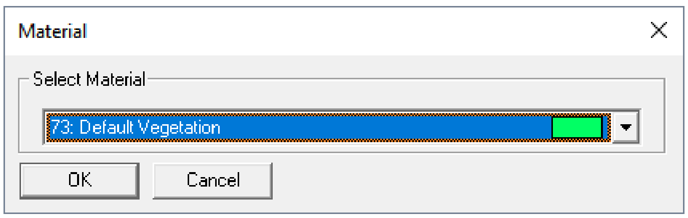


*Figure 49: The **Material** dialog.*

   c) Click **OK** to close the **Material** dialog.

3. Click **OK** to close the **Default Values for New Buildings** dialog.
The **Image configuration** dialog is displayed.

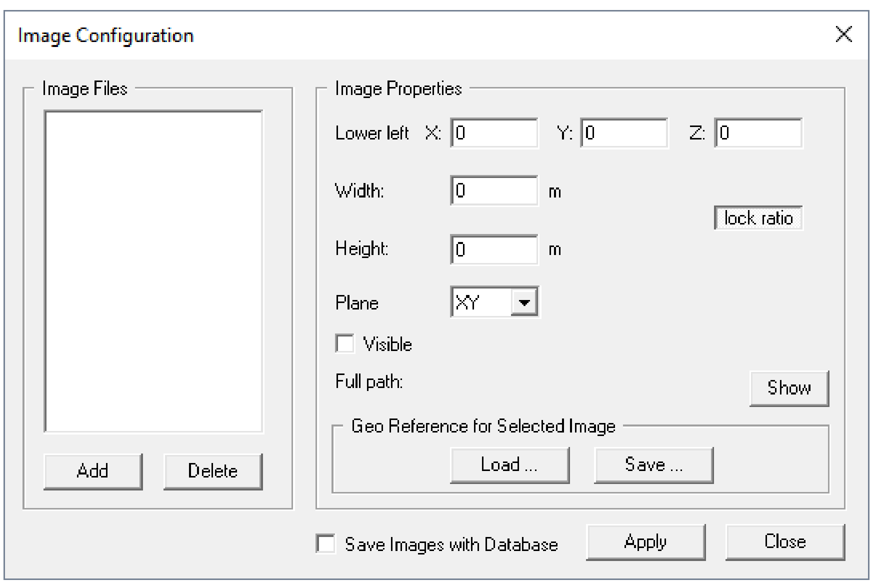


*Figure 50: The **Image Configuration** dialog.*

> **Note:** Keep the **Image configuration** dialog open.

2.5.4 Urban Database

Create an urban environment for the hybrid urban/indoor database which includes the buildings and vegetation.

Importing an Aerial Photograph

Import an image representing an aerial photograph of an office park.

1. Under **Image Files**, click **Add** to browse to `UrbanArea.jpg`[10] and click **Open**.
2. Under **Image Properties**, in the **Width** field, enter a value of `350` m.
3. Click **Apply** and then click **Close**.

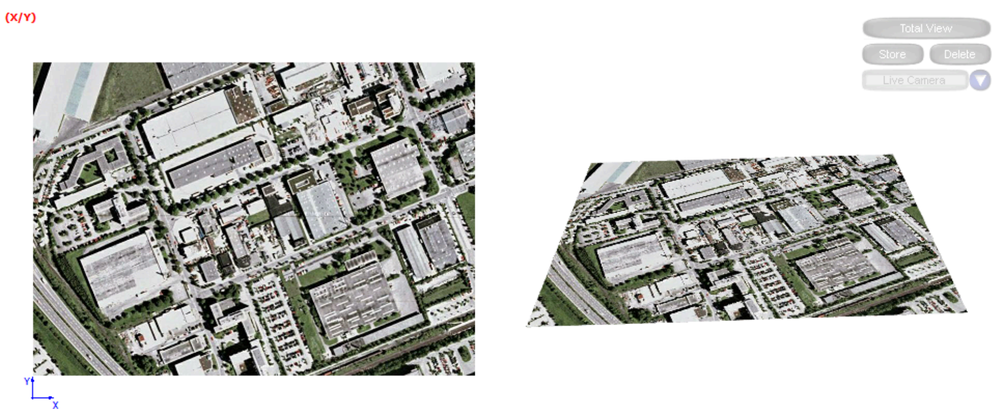


Figure 51: The aerial photograph is displayed in the X/Y plane (on the left) and 3D view (to the right).

Scaling the Imported Aerial Photograph

Scale the image by drawing a line with a known length on the image.

For the imported aerial photograph, we know that a certain building is 20 m wide.

10. `Altair\2025.1\help\winprop\examples\GetStarted_models\Project2_Hybrid_Urban_Indoor_Scenario\Database\UrbanArea.jpg`

Figure 52: The red arrow indicates the building width of 20 m.

1. On the **Edit** menu, click **Scale All Objects**.
2. Under **Fixpoint**, click **Center of all Objects**.

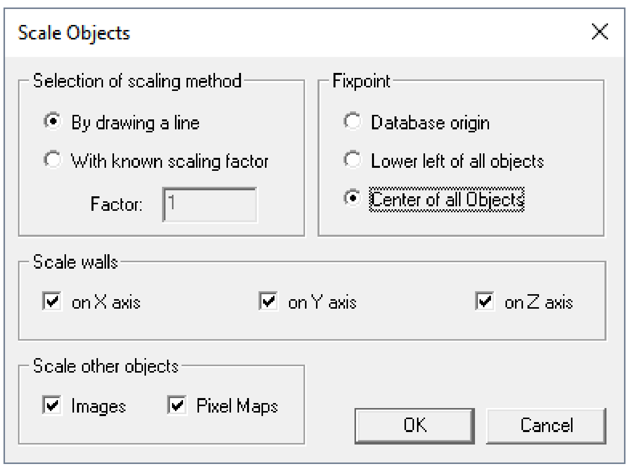


*Figure 53: The **Scale Objects** dialog.*

3. Click **OK** to close the **Scale Objects** dialog.
   The `Please draw a line now...` message is displayed.

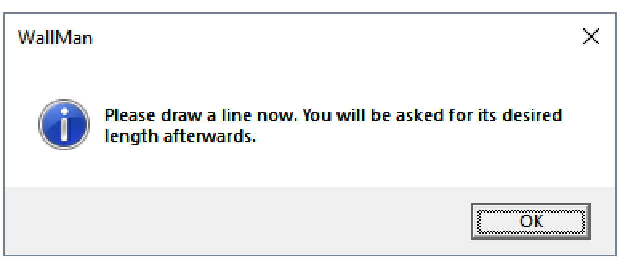


Figure 54: A WallMan information dialog is displayed.

4. Click **OK** to close the `Please draw a line now...` message.
5. Click twice in the X/Y plane to specify the start point of the line.

> **Note:** A black line is drawn. The end point is indicated with a "+" at the mouse cursor.

6. Click again to specify the end point of the line (this is the end point of the red arrow in Figure 52). The **Scale** dialog is displayed.

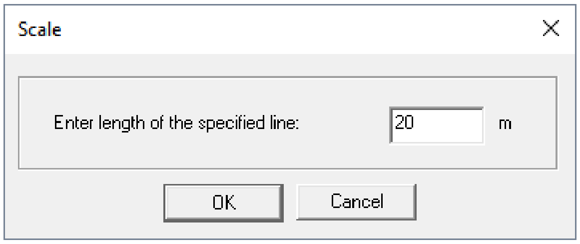


*Figure 55: The **Scale** dialog.*

7. In the **Enter length of the specified line** field, enter a value of `20` m.
8. Click **OK** to close the **Scale** dialog.
The `The entire database will be resized...` message is displayed.

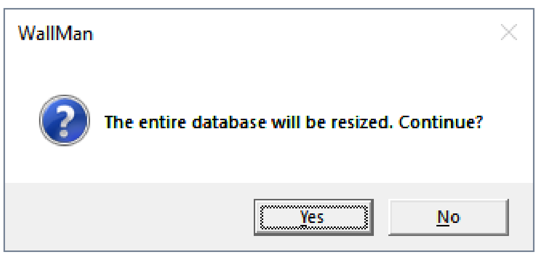


Figure 56: A WallMan information dialog is displayed.

9. Click **Yes** on the `The entire database will be resized...` message to resize the database.

The imported aerial photograph is scaled.

Adding Marker Points to Geo-Reference the Image

Use marker points to position database objects (geo-referencing) relative to one another.

> **Note:** Marker points are generally used when drawing multiple and complex buildings relative to one another. It is not required for this example, but the steps are highlighted.

1. Add a marker point using one of the following workflows:
   - On the **Edit** menu, click **Edit** > **Marker points**.
   - On the **View** toolbar, click the icon.
2. Click in the X/Y window.
A marker point is placed on the image at the location of the mouse click. The marker point is indicated by a blue crosshair.

3. Activate the marker point by clicking again on the marker.
   The marker point is now indicated by a red crosshair.
4. Right-click on the red crosshair and from the right-click context menu, click **Assign Reference**.

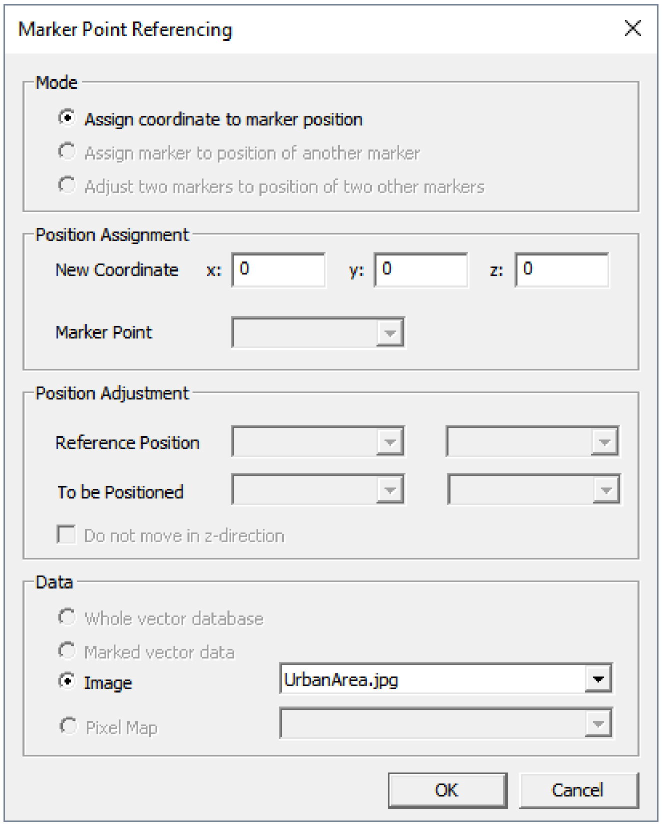


*Figure 57: The **Marker Point Referencing** dialog.*

5. Under **Position Assignment**, in the **New Coordinate** field, enter the coordinates of the marker.
6. Click **OK** to close the **Marker Point Referencing** dialog.

Drawing Buildings

Trace building outlines on the imported aerial photograph to draw buildings.

1. Trace the building in the X/Y window using one of the following workflows:
   - On the **Objects** menu, click **Enter Basic Objects** > **Enter Polygonal Object**.
   - On the **Objects** toolbar, click the **Add Polygonal Objects** icon.
   - Press F7 to use the keyboard shortcut.
2. Click twice to specify the start point of the building.
3. Trace the building by clicking on the corners of the building.

Tip: Press Esc to exit the creation of the current polygon.

4. Right-click at the start point to close the polygon.
5. Repeat Step 2 to Step 4 and trace multiple buildings.

Figure 58: Drawn buildings are indicated in grey.

6. Exit the draw mode using one of the following workflows:
   - On the **Objects** menu, click **Select Objects** > **Select Single Object (Mouse)**.
   - On the **Objects** toolbar, click the  **Select Object** icon.
   - Press F10 to use the keyboard shortcut.
7. Select the building by clicking on the outline of the building.
   A selected object is indicated in red.

Figure 59: A selected building is indicated in red.

8. Right-click on the selected building and from the right-click context menu, click **Properties**. The **Object Properties** dialog is displayed.

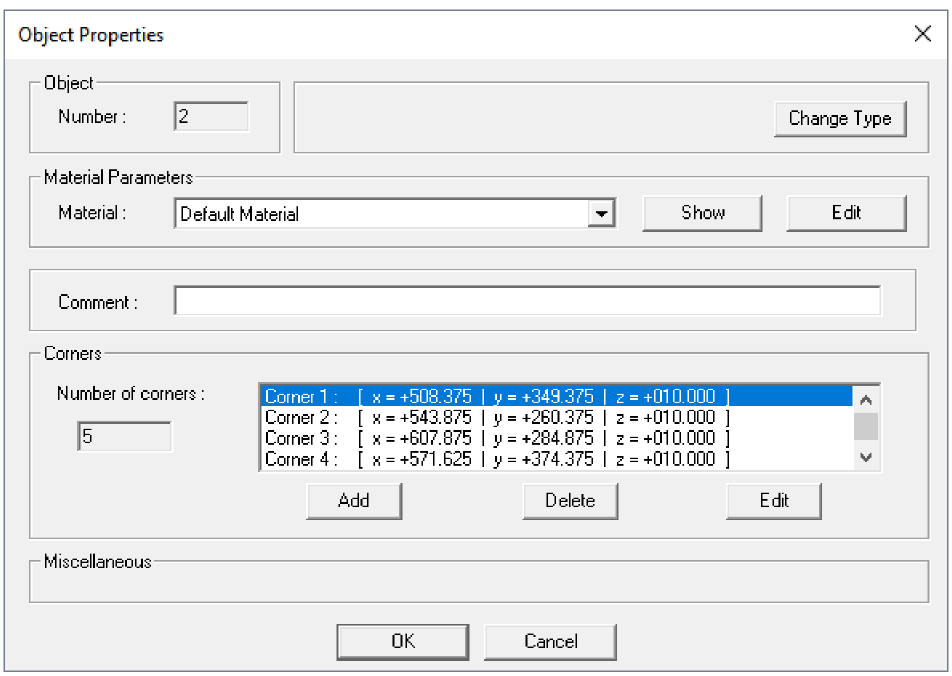


*Figure 60: The **Object Properties** dialog.*

9. Under **Corners**, select a corner and click **Edit** to modify the height of the buildings.

> **Note:** You can modify the height of any corner to change the height of the building.

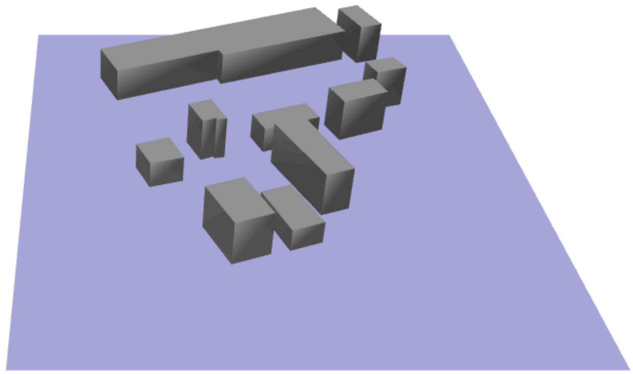


Figure 61: The 3D view of the buildings after their heights were modified. The aerial photograph was hidden for demonstrative purposes.

10. Click **OK** to close the **Enter Coordinates** dialog.
11. Save the outdoor database.
    a) On the **File** menu, click **Save Database As**.
    b) Enter `Office_Park_partial.odb` as the file name for the outdoor database and click **Save**.

    > **Note:** The `.odb` file extension stands for *outdoor database binary*.

Drawing Vegetation

Trace tree outlines on the imported aerial photograph to draw vegetation.

1. Enable the drawing of vegetation in the X/Y window using one of the following workflows:
   - On the **Objects** menu, click **Enter vegetation**.
   - On the **Objects** toolbar, click the **Enter vegetation** icon.
2. Enable the drawing of polygonal objects in the X/Y window using one of the following workflows:
   - On the **Objects** menu, click **Enter Basic Objects** > **Enter Polygonal Object**.
   - On the **Objects** toolbar, click the **Add Polygonal Objects** icon.
   - Press F7 to use the keyboard shortcut.
3. On the **Objects** toolbar, click the **Add Polygonal Objects** icon.
4. Click to specify the start point of the vegetation.
5. Trace the vegetation by clicking on the corners of the trees.
6. Right-click at the start point to close the polygon.
7. Repeat Step 4 to Step 6 and trace vegetation.

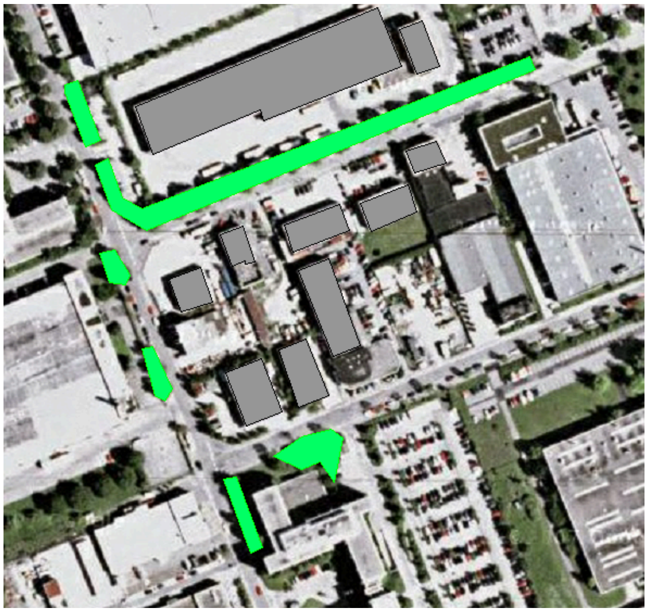


Figure 62: Drawn vegetation is indicated in green.

8. Exit the draw mode using one of the following workflows:
   - On the **Objects** menu, click **Select Objects** > **Select Single Object (Mouse)**.
   - On the **Objects** toolbar, click the **Select Object** icon.
   - Press F10 to use the keyboard shortcut.
9. Select the vegetation by clicking on the outline of the vegetation.
   A selected object is indicated in red.
10. Right-click on the selected vegetation and from the right-click context menu, click **Properties**.
    The **Object Properties** dialog is displayed.

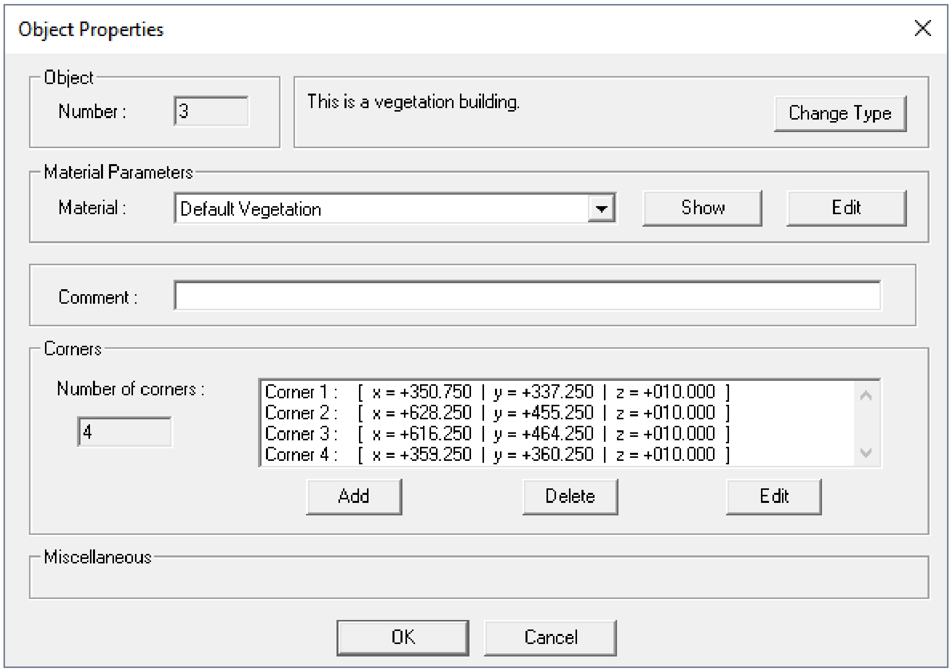


*Figure 63: The **Object Properties** dialog.*

11. Under **Corners**, select a corner and click **Edit** to modify the height of the vegetation.

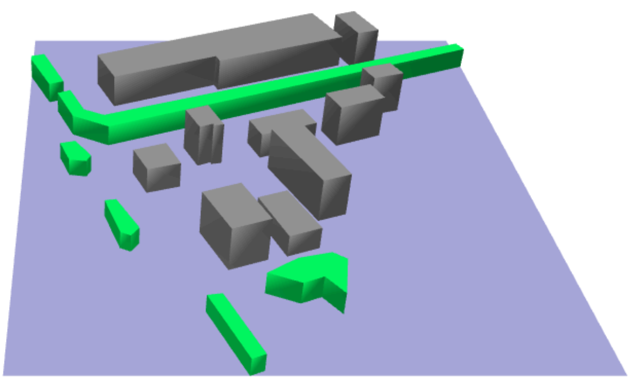


Figure 64: The 3D view of the buildings after their heights were modified. The aerial photograph was hidden for demonstrative purposes.

12. Click **OK** to close the **Object Properties** dialog.
13. Save the outdoor database.
    a) On the **File** menu, click **Save Database As**.
    b) Enter `Office_Park_partialwithvegetation.odb` as the file name for the outdoor database and click **Save**.

2.5.5 Indoor Database

Import and place the indoor geometry (building) onto the hybrid urban/indoor database.

Adding an Indoor Database

Insert an indoor database of a building on the imported aerial photograph.

The database created thus far is now ready for a standard urban simulation. However, we want to add an indoor database near the bottom of the image. Using a hybrid urban/indoor database, the urban database is solved using high simulation speed while the indoor database is solved using high accuracy.

1. Import an indoor database (building) using one of the following workflows:
   - On the **Objects** menu, click the **Import Indoor Database**.
   - Press Alt+F6 to use the keyboard shortcut.
2. Browse to the location of the file `rooms_1.idb` that was created in Example 1 and click **Open**.
   The **CNP**[11] **Building** dialog is displayed.

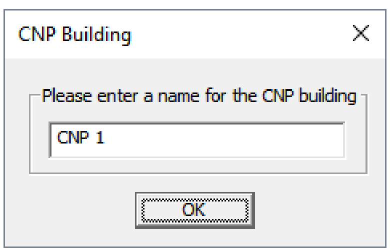


*Figure 65: The **CNP Building** dialog.*

3. Click **OK** to close the **CNP Building** dialog.
   The `Database to be imported must contain...` message is displayed.

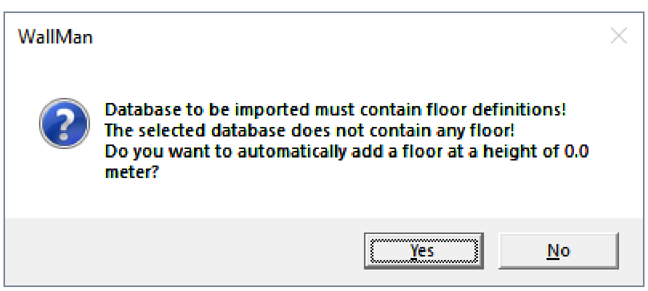


Figure 66: The `Database to be imported must contain...` message.

4. Click **Yes** to continue.
   The `The imported database contains...` message is displayed.

11. Combined network planning (CNP) is the model that allows for the combination of urban and indoor predictions.

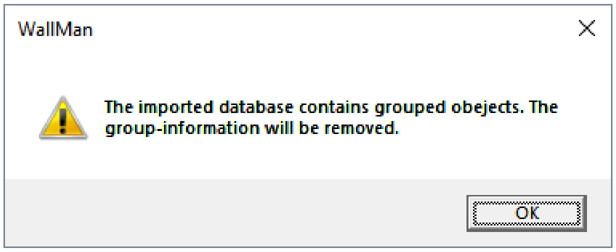


Figure 67: The `The imported database contains...` *message.*

5. Click **OK** to close the message.
   The `The imported building is now in the clipboard...` message is displayed.

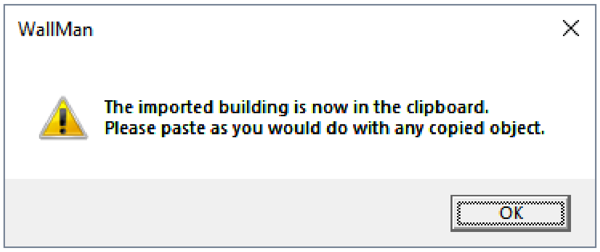


Figure 68: The `The imported building is now in the clipboard...` *message.*

6. Click **OK** to close the message.
7. Click to place the indoor database on the imported aerial photograph.

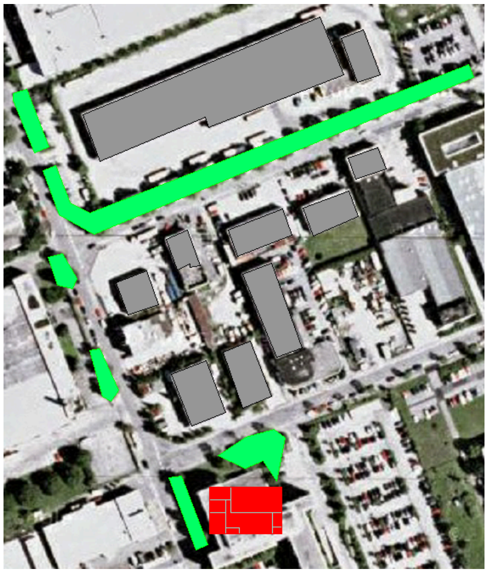


Figure 69: The indoor database is placed onto the urban environment.

Rotating the Indoor Database

Place the indoor database at the correct location by rotating the building.

1. Select the indoor database by clicking with the mouse on the outline of the indoor database.
   A selected object is indicated in red.
2. On the **Objects** menu, click **Rotate selected objects**.
   The **Rotate Objects** dialog is displayed.

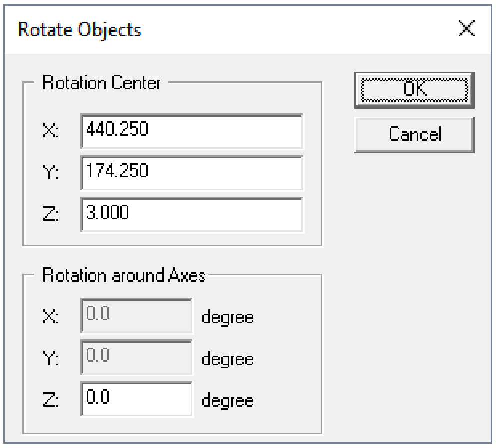


*Figure 70: The **Rotate Objects** dialog.*

3. Under **Rotation around Axes**, in the **Z** field, enter a value to rotate the indoor database around the Z axis.
4. Click **OK** to close the **Rotate Objects** dialog.

The indoor database is rotated.

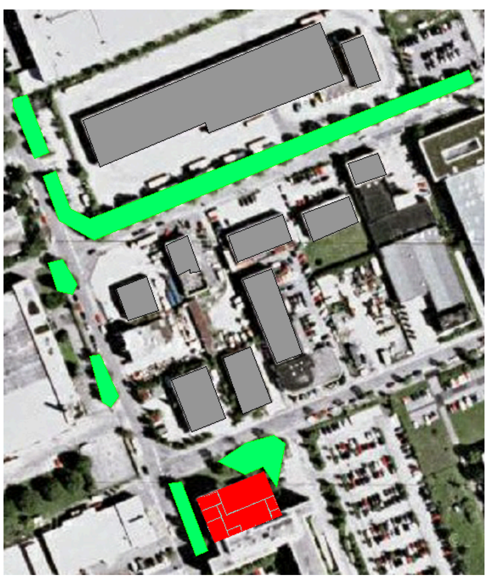


Figure 71: The indoor database is rotated to fit between the vegetation (in green).

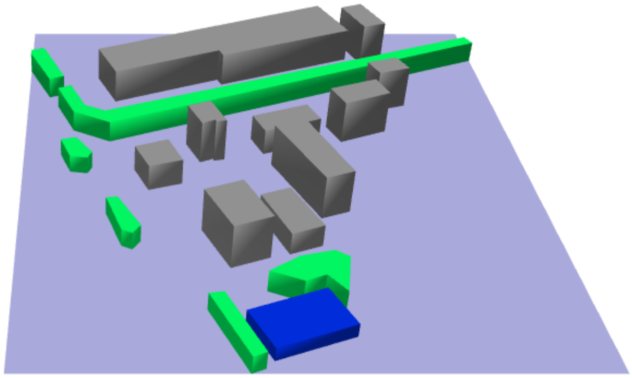


Figure 72: 3D view of the buildings, vegetation, and indoor database. The aerial photograph was hidden for demonstrative purposes.

2.5.6 Saving the Hybrid Urban/Indoor Database

Save the new hybrid urban/indoor database to file.

1. On the **File** menu, click **Save Database As**.
2. Enter `Office_Park.odb`[12] as the file name for the completed hybrid urban/indoor database and click **Save**.
3. On the **File** menu, click **OK** to exit WallMan.

12. `Project2_Indoor_Urban_Scenario\Database\Office_Park.odb`

2.6 Setting Up the Simulation in ProMan

Set up the propagation simulation parameters. Solve the hybrid urban/indoor database and inspect the indoor reception.

The hybrid urban/indoor database is solved using the dominant path model and COST 231 - extended Walfisch-Ikegami model.

2.6.1 Launching ProMan

Launch ProMan in Microsoft Windows using the Feko Launcher utility (which includes WinProp and newFASANT).

2.6.2 Creating a New Project

Load the hybrid urban/indoor building database that was created in WallMan.

1. On the **File** menu, click **New Project**.
   The **New Project** dialog is displayed.

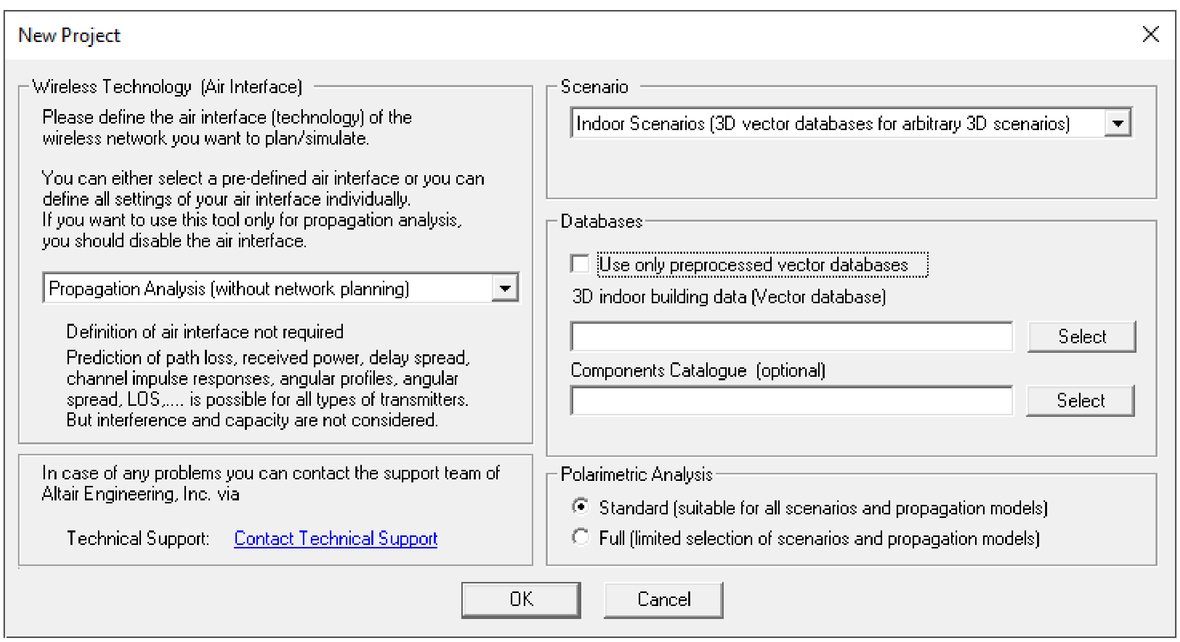


*Figure 73: The **New Project** dialog.*

2. Under **Scenario**, from the drop-down list, select **Urban Scenario (vector data for urban buildings and pixel topo data)**.

3. Under **Databases**, in the **3D building data (Vector database)** field, browse to `Office_Park.odb`[13].
4. Under **Polarimetric Analysis**, select **Standard (suitable for all scenarios and propagation models)**.
5. Click **OK** to close the **New Project** dialog.
6. Browse to the location of the file, `UrbanArea.jpg`[14] and click **Open.**
   The **Define Display Height** dialog is displayed.

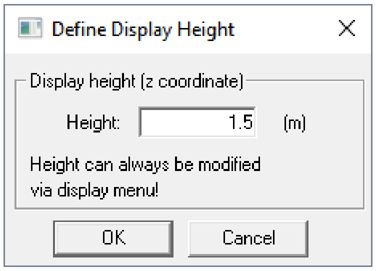


*Figure 74: The **Define display Height** dialog.*

7. In the **Height** field, use the default value of `1.5` m.

> **Note:** This value is used only to specify the display height. This value has no impact on the height at which the prediction results are calculated.

8. Click **OK** to close the **Define Display Height** dialog.
   The office park is displayed.

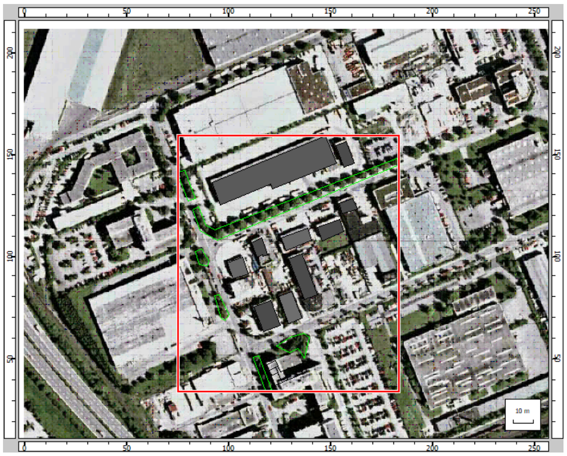


Figure 75: A top view of the office park.

> **Note:** The red rectangle indicates the extent of the computational domain.

13. `Project2_Hybrid_Urban_Indoor_Scenario\Database\Office_Park.odb`
14. `Project2_Hybrid_Urban_Indoor_Scenario\Database\UrbanArea.jpg`

2.6.3 Defining the Antenna Site and Antennas

For this example, a single antenna site with three antennas is defined.

The height of the building where the antennas are to be placed is 5 m. The height of the antenna mast is 4 m with the result that the antenna will be located at the 9 m.

1. Specify the transmitter type and settings using one of the following workflows:
   - On the **Project** menu, click **Sites** > **Site: New**.
   - On the **Project** toolbar, click the **Set Site** icon.
2. Under **Settings**, click **3 Sector Site**.

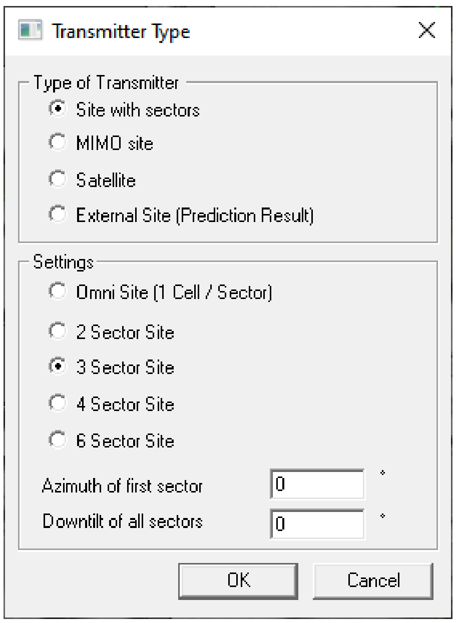


*Figure 76: The **Transmitter Type** dialog.*

3. Click **OK** to close the **Transmitter Type** dialog.
   The mouse cursor is displayed as a circle to indicate that the **Set site** tool is enabled.
4. Click near point (X, Y) = (143.88, 187.90) in the 2D view to place the site (the location of the antenna site is indicated by an orange circle).

Figure 77: A partial view of the 2D view. Place the antenna site at the location of the orange dot.

> **Note:** The exact coordinates is not important for this example, but the above coordinate is used in the steps that follow.

> **Tip:** The coordinates at the current mouse cursor are displayed in the Status bar.

The **Site** dialog is displayed.

5. In the **z / Height** field, enter a value of `5` m.
6. Click on **Site 1 Antenna 1** to select and click **Edit**.
   The **Cell** dialog is displayed for antenna 1.
7. Under **Transmitter Settings**, in the **Frequency (used for propagation)** field, enter a value of `1800` MHz.
8. Under **Location of Antenna**, in the **z / Height** field, enter a value of `9` m.
9. Under **Antenna Pattern**, click **Directional / Sector antenna**.
10. Under **Antenna Pattern**, click **Select** to browse to the file `farfield_gain_3d.ffe`[15].

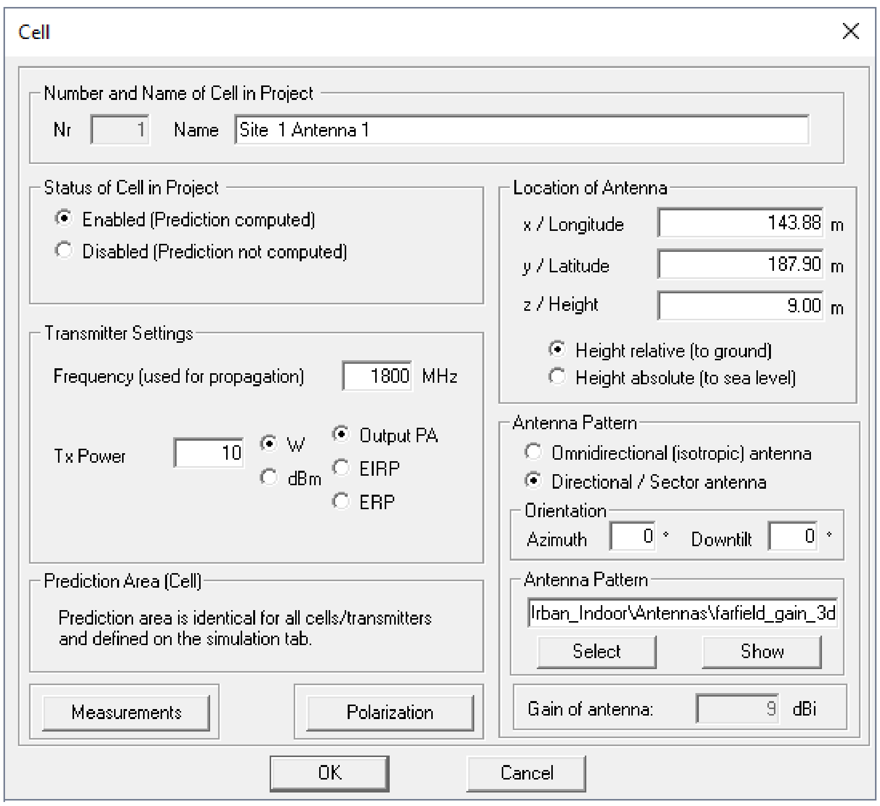


*Figure 78: The **Cell** dialog for antenna 1.*

11. Click **OK** to close the **Cell** dialog.
12. Repeat Step 6 to Step 10 to define antenna 2.
13. Repeat Step 6 to Step 10 to define antenna 3.

15. `Project2_Hybrid_Urban_Indoor_Scenario\Antennas\farfield_gain_3d.ffe`

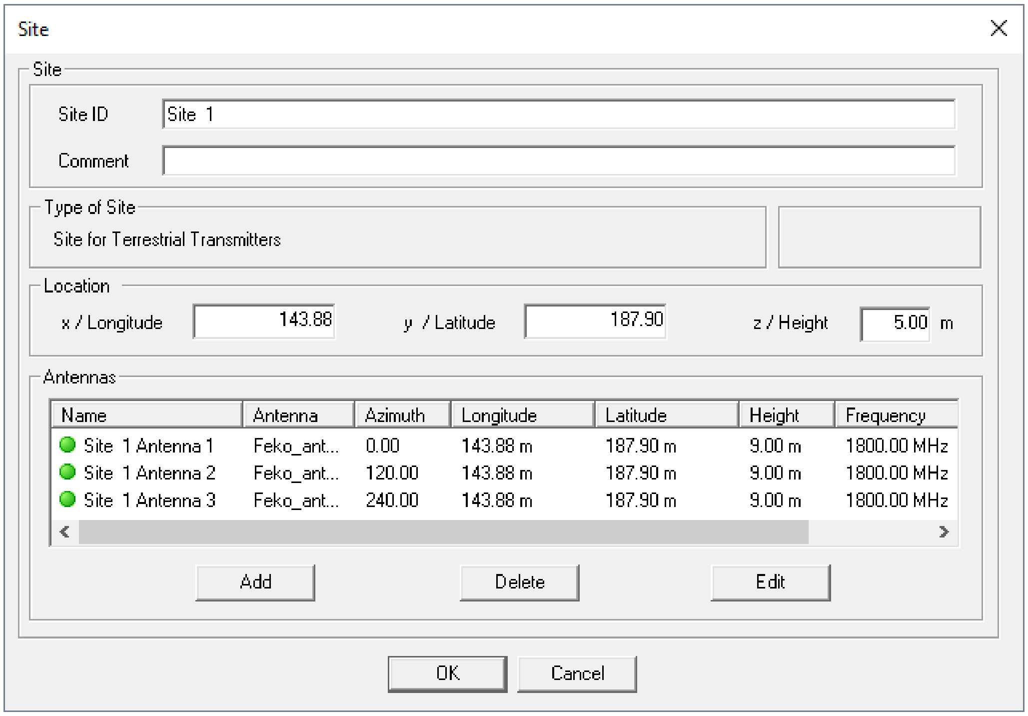


*Figure 79: The **Site** dialog.*

14. Click **OK** to close the **Site** dialog.

15. Disable the **Set site** tool by clicking again on the  **Set Site** icon.

2.6.4 Using the Dominant Path Model (DPM)

The hybrid urban/indoor database is solved using the dominant path model.

Specifying the Area of Simulation

Increase the extent of the computational domain.

View Figure 77 and observe that the default extent of the computational domain (indicated by the red rectangle) does not include the antenna site. Modify the computational domain to include antenna site.

1. Launch the **Edit Project Parameters** dialog using one of the following workflow:
   - On the **Project** menu, click **Edit Project Parameters**.
   - On the **Project** toolbar, click the **Edit Project Parameters** icon.
   - Press F3 to use the keyboard shortcut.
2. Click the **Simulation** tab.
3. Specify the lower left corner.
   a) In the **x / Longitude** field, in the **Lower Left Corner** column, enter a value of `50`.
   b) In the **y / Latitude** field, in the **Lower Left Corner** column, enter a value of `10`.
4. Specify the upper right corner.
   a) In the **x / Longitude** field, in the **Upper Right Corner** column, enter a value of `210`.
   b) In the **y / Latitude** field, in the **Upper Right Corner** column, enter a value of `200`.

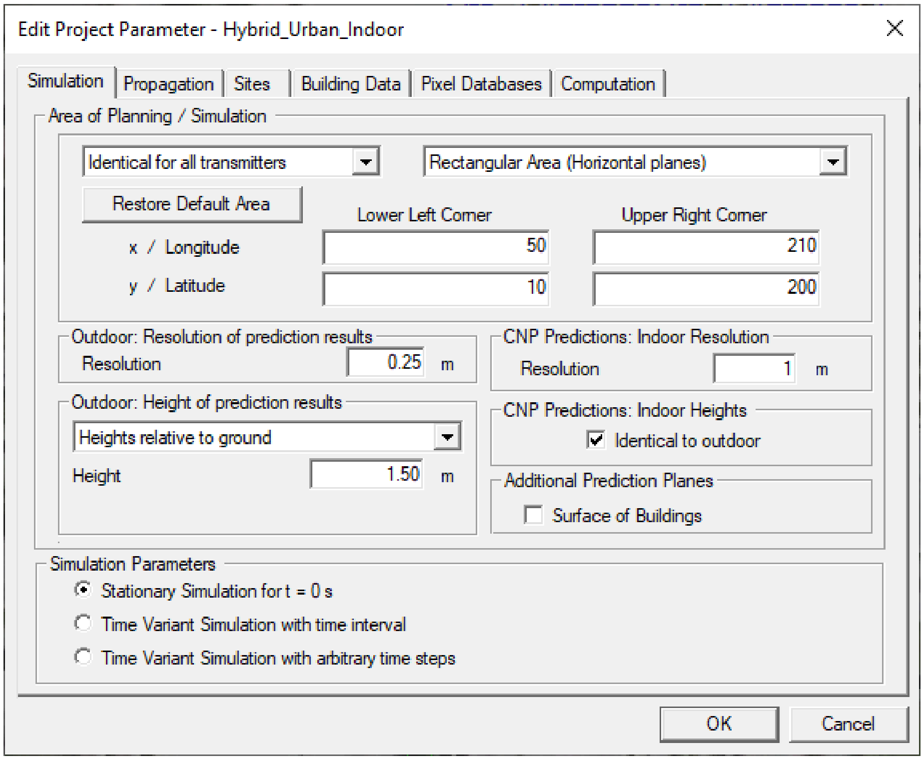


*Figure 80: The **Edit Project Parameters** dialog - **Simulation** tab.*

Note: Keep the dialog open to define additional project parameters.

Specifying the Prediction Resolution and Height

Define the resolution grid and the height where the prediction results are to be calculated.

1. Under **Resolution of prediction results**, in the **Resolution** field, enter a value of `0.25` m.
   The prediction results will be computed with a resolution (grid) of 0.25 m.
2. Under **Prediction Height (relative to ground)**, in the **Height** field, enter a value of `1.5` m.

   Tip: Multiple prediction heights can be specified by entering space-separated values.
   For example: `1.5 2 2.5`

Note: Keep the dialog open to define additional project parameters.

Specifying the Output Folder for the Prediction Results

Specify the folder for the prediction results to be computed using the dominant path model (DPM).

1. Click the **Propagation** tab.

2. Specify the output folder for the results to be computed using the dominant path model.
   a) Under **Output Directory / Basic Filename for Propagation Results**, in the **Directory** field, change the default `PropName` to `Prop02_DPM`.

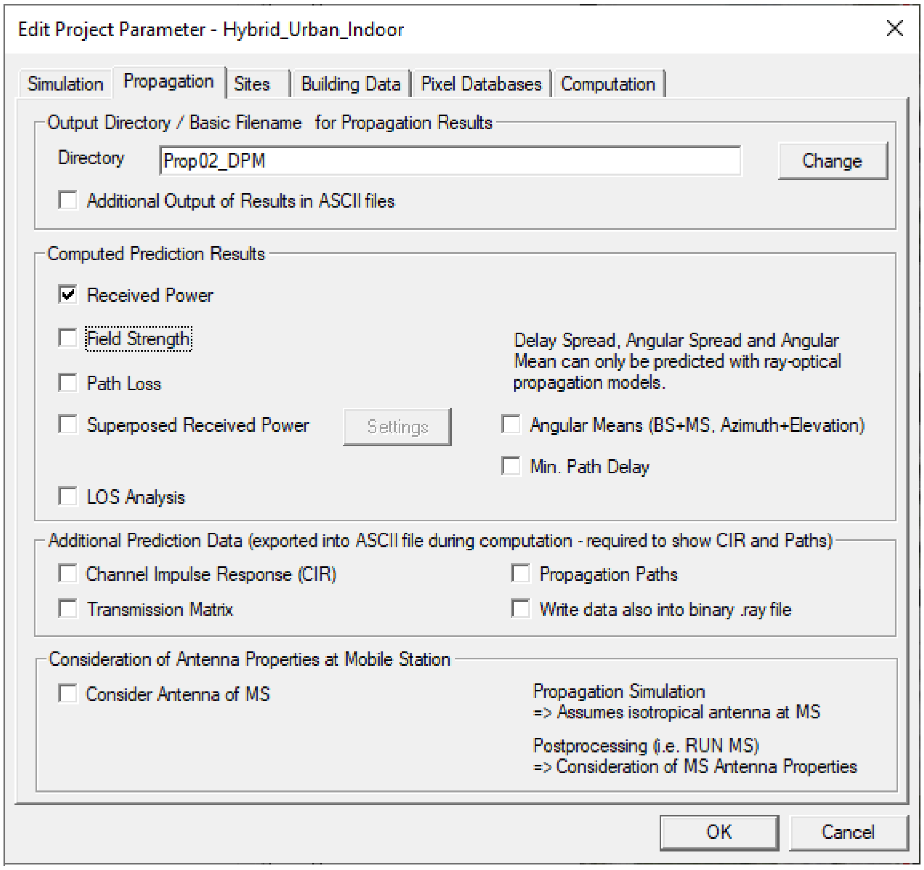


Figure 81: The ***Edit Project Parameters*** *dialog -* ***Propagation*** *tab.*

> **Note:** Keep the dialog open to define additional project parameters.

Defining the Prediction Requests

Specify the predictions to be computed.

Under **Computed Prediction Results**, select the **Field strength** check box.

> **Note:** Keep the dialog open to define additional project parameters.

Specifying the Computation Method

Select the dominant path model (DPM) as computation method.

1. Click the **Computation** tab.

2. Under **Prediction model (Urban)**, click **Dominant Path Model**.
3. Under **Indoor Prediction**, select the **CNP Indoor prediction (including indoor walls (only if available))** check box.

> **Note:** This option applies to hybrid (urban/indoor) simulations.

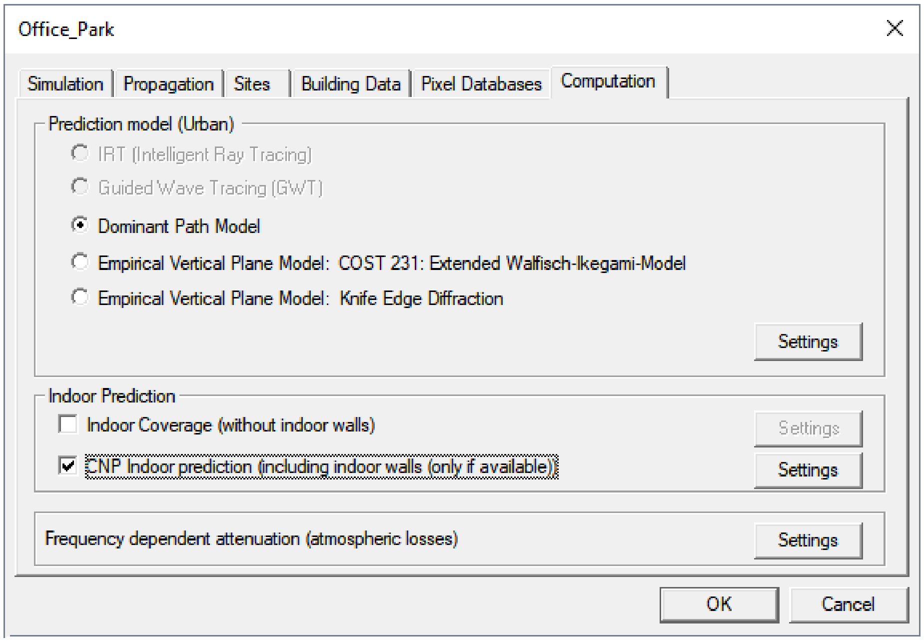


*Figure 82: The **Edit Project Parameters** dialog - **Computation** tab.*

4. Click **OK** to close the **Edit Project Parameters** dialog.

Saving the Project

Save the new project to file.

1. On the **File** menu, click **Save Project As**.
2. Enter `Hybrid_Urban_Indoor.net` as the file name for the project and click **Save**.

> **Tip:** To export the project along with its antenna pattern and geometry database to an archive using relative file paths, click **File** > **Export** > **Export Project as ZIP archive**.[16]

16. This allows you to exchange project files between different machines and users.

Launching the Solver

Compute the propagation for all antennas to obtain the prediction results.

Launch the Solver using one of the following workflows:

- On the **Project** toolbar, click the **Computes propagation for all antennas** icon.
- On the **Computation** menu, click **Propagation: Compute All**.
- Press F5 to use the keyboard shortcut.

The Solver is launched, and the **Computation** dialog is displayed.

> **Note:** For this example, several warnings are displayed. Ignore these warnings, as it only states that the imported pattern is a directivity pattern rather than a gain pattern.

Viewing the Prediction Results

Display the power results using the dominant path model.

1. View the power using the dominant path model in the urban environment.
   a) In the tree, expand **Results: Propagation** to view site 1.
   b) In the tree, expand **Site 1** to view the three antennas.
   c) In the tree, expand **Site 1 Antenna 3** to view the **Field Strength** and **Power** entries.
   d) In the tree, click **Power** to view the results.

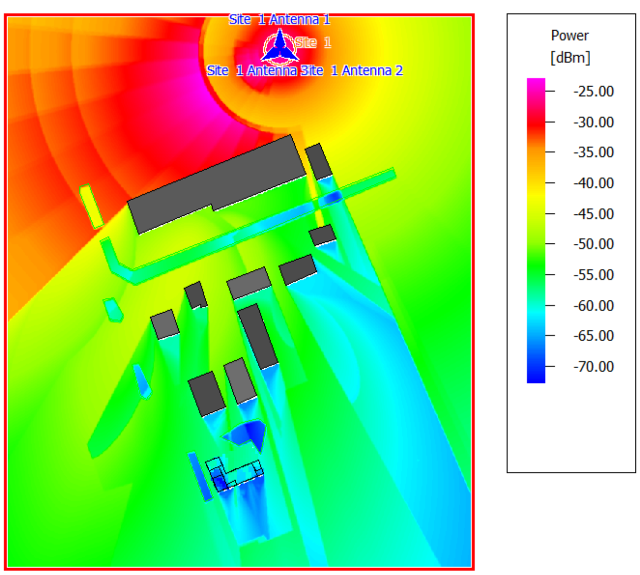


Figure 83: Power calculated using the dominant path model (DPM).

2. View the power for the indoor database.
   a) Zoom in on the indoor database.

b) Right-click on the legend and from the right-click context menu, click **Thresholds** > **Manual**.
c) In the **Max** field, enter a value of –50 dBm.
d) In the **Min** field. enter a value of –90 dBm.

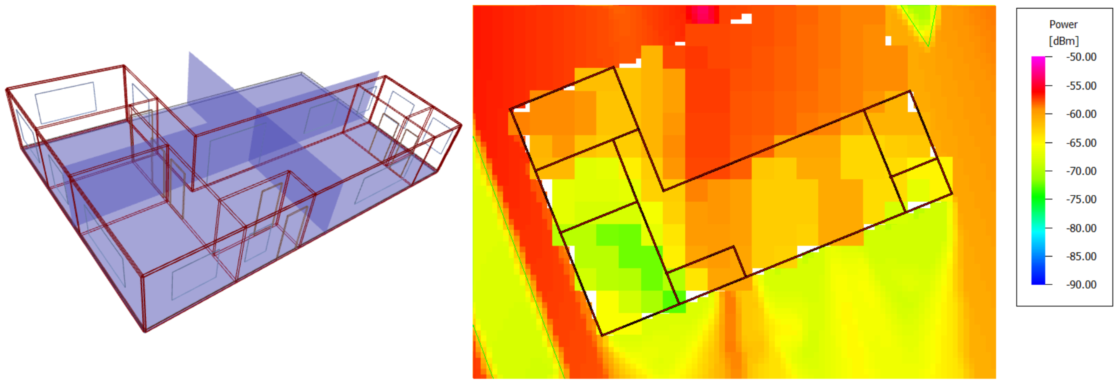


Figure 84: Power calculated using the dominant path model (DPM) for the indoor database.

2.6.5 Using COST 231: Extended Walfisch-Ikegami Model

The hybrid urban/indoor database is solved using the COST 231 - extended Walfisch-Ikegami model.

This method is suited for high transmitters in urban scenarios when the dominant path is expected to be in the vertical plane over rooftops.

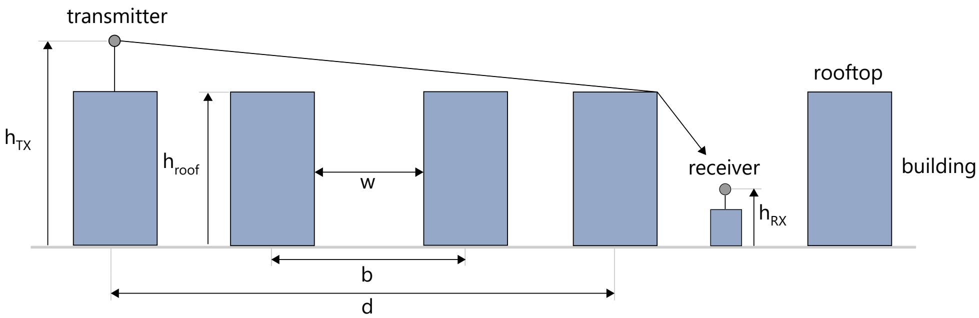


Figure 85: Urban propagation scenario using the COST 231 Walfisch-Ikegami Model.

In this case, the transmitter is not very high, so we expect lower accuracy. Also, any time the dominant path is not purely in the vertical plane, this method will under-estimate the received fields, but it will be faster in comparison to the dominant path model.

Specifying the Output Folder for the Prediction Results

Specify the folder for the prediction results to be computed using the COST 231 - extended Walfisch-Ikegami model.

1. Launch the **Edit Project Parameters** dialog using one of the following workflow:
   - On the **Project** menu, click **Edit Project Parameters**.
   - On the **Project** toolbar, click the **Edit Project Parameters** icon.
   - Press F3 to use the keyboard shortcut.
2. Click the **Propagation** tab.
3. Specify the output folder for the results to be computed using the dominant path model.
   a) Under **Output Directory / Basic Filename for Propagation Results**, in the **Directory** field, rename `Prop02_DPM` to `Prop02_COST231`.

> **Note:** Keep the dialog open to define additional project parameters.

Specifying the Computation Method

Select the COST 231 - extended Walfisch-Ikegami model as computation method.

1. Click the **Computation** tab.
2. Under **Prediction model (Urban)**, click **Empirical Vertical Plane Model: COST 231: Extended Walfisch-Ikegami-Model**.

3. Click **OK** to close the **Edit Project Parameters** dialog.

Launching the Solver

Compute the propagation for all antennas to obtain the prediction results.

Launch the Solver using one of the following workflows:

- On the **Project** toolbar, click the **Computes propagation for all antennas** icon.
- On the **Computation** menu, click **Propagation: Compute All**.
- Press F5 to use the keyboard shortcut.

The Solver is launched, and the **Computation** dialog is displayed.

> **Note:** For this example, several warnings are displayed. Ignore these warnings, as it only states that the imported pattern is a directivity pattern rather than a gain pattern.

Viewing the Prediction Results

Display the field strength results using the COST 231 - extended Walfisch-Ikegami model.

1. View the field strength using the COST 231 - extended Walfisch-Ikegami model in the urban environment.
    a) In the tree, expand **Results: Propagation** to view site 1.
    b) In the tree, expand **Site 1** to view the three antennas.
    c) In the tree, expand **Site 1 Antenna 3** to view the **Field Strength** and **Power** entries.
    d) In the tree, click **Power** to view the results.
    e) Right-click on the legend and from the right-click context menu, click **Thresholds** > **Auto defined**.

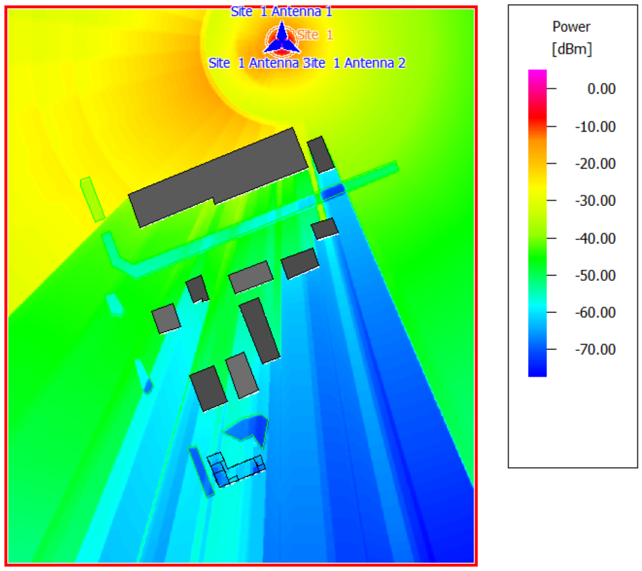


Figure 86: Power calculated using the COST 231 - extended Walfisch-Ikegami model.

2. View the power for the indoor database.
   a) Zoom in on the indoor database.
   b) Right-click on the legend and from the right-click context menu, click **Thresholds** > **Manual**.
   c) In the **Max** field, enter a value of –`50` dBm.
   d) In the **Min** field. enter a value of –`90` dBm.

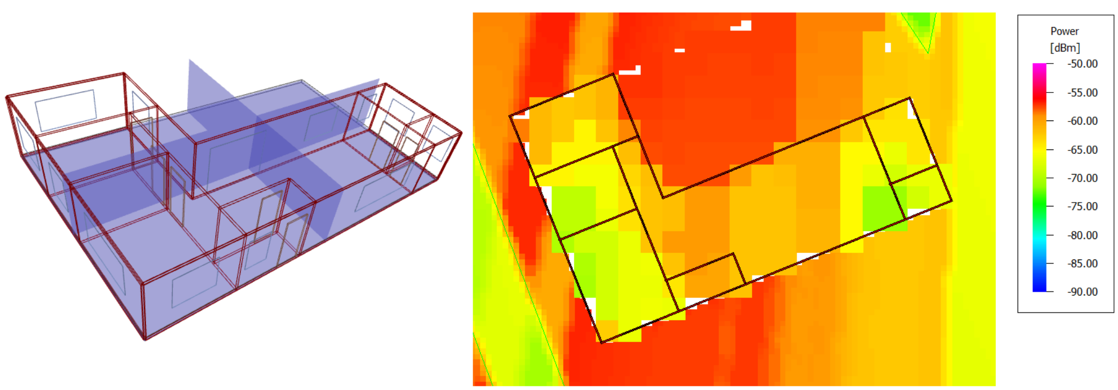


Figure 87: Power calculated using the COST 231 - extended Walfisch-Ikegami model for the indoor database.

> **Note:**
> - Propagation is along straight lines only (always in the vertical plane between transmitter and point of interest).
> - The power is lower than with the dominant path model.
> - Effects of windows and doors are visible.

2.6.6 Final Remarks

This example showed how to analyze the cell-phone reception in a building, to create the hybrid urban/indoor database using WallMan and to obtain coverage plots using ProMan.

Many concepts were introduced in this example that apply to models commonly created in WallMan and ProMan.

Base Stations in a City

3

This example considers the application of analyzing base stations in a city, set in an urban environment.

This chapter covers the following:

3.1 Example Overview

This example considers the application of analyzing base stations in a city.

The antenna pattern was obtained using Altair Feko, but the steps on how to use Feko to obtain the antenna pattern are not in the scope of this example.

An urban database is imported from a `.dxf` and converted to a WinProp format. The urban database is modified, a tower and vegetation are added.

Coverage plots are produced using ProMan to determine the cell phone reception inside a building which is set in an urban environment. Two different propagation models are used, namely: dominant path model and COST 231 - extended Walfisch-Ikegami model.

> **Note:**
>
> This example does not specify the exact coordinates where to add buildings and vegetation in the urban environment, but instead, it highlights the steps to create these structures in WallMan.
>
> You are encouraged to create your own urban environment and structures using WallMan.

3.2 Topics Discussed in Example

Before starting this example, check if the topics discussed in this example are relevant to the intended application and experience level.

The topics discussed in this example are:

- WallMan
    - Launch WallMan.
    - Import an urban database from a .dxf and convert to a WinProp format.
    - Modify a building in the urban database.
    - Add a tower to a standard building.
    - Add vegetation to the urban environment.
    - Save the urban database.
- ProMan
    - Launch ProMan.
    - Specify the antenna sites, orientations and properties.
    - Specify the simulation parameters.
    - Specify the computation method.
    - Save the project.
    - Launch the Solver.
    - View the prediction results.

> **Note:** Follow the example steps in the order they are presented as each step uses its predecessor as a starting point.

> **Tip:** Find the completed model in the Altair installation directory, for example:
> `Altair\2025.1\help\winprop\examples\GetStarted_models\Project3_Urban_Scenario`.

3.3 Example Prerequisites

Before starting this example, ensure that the system satisfies the minimum requirements.

The requirements for this example are:

- Feko 2025.1[17] or later should be installed.

17. WinProp is included as part of the Feko installation.

3.4 Exporting the Antenna Pattern in Feko

An antenna pattern is exported to a `.ffe` file using POSTFEKO.

In POSTFEKO, export the antenna pattern to `farfield_gain_3d.ffe` file[18].

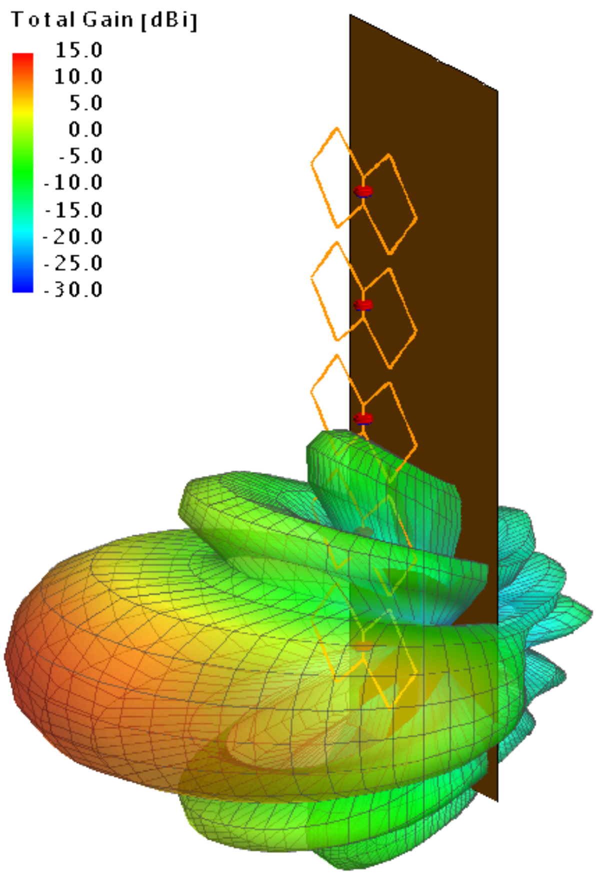


Figure 88: The antenna pattern (directivity) as displayed in POSTFEKO.

> **Note:** The antenna pattern represents a base-station sector pattern, broad in the azimuth direction and relatively narrow in the elevation direction.

18. View the Feko User Guide for more information.

3.5 Creating the Geometry Database in WallMan

Create an urban geometry database in WallMan.

The workflow for creating an urban geometry database for this example:

1. Import an urban database from a `.dxf` file and convert to a WinProp format.
2. Select and modify buildings.
3. Add a tower and vegetation.

3.5.1 Launching WallMan

Launch WallMan in Microsoft Windows using the Feko and WinProp Launcher utility.

3.5.2 Importing Geometry from a .DXF File

Import geometry representing a city from a `.dxf` file. Convert the geometry to a WinProp format.

1. Convert the urban database using one of the following workflows:
   - On the **File** menu, click **Convert Urban Database** > **Vector Database**.
   - Press Ctrl+D to use the keyboard shortcut.
2. Under **Format of source file**, in the **Selection of import filter** drop-down list, select **AutoCAD (*.dwg, *.dxf)**.

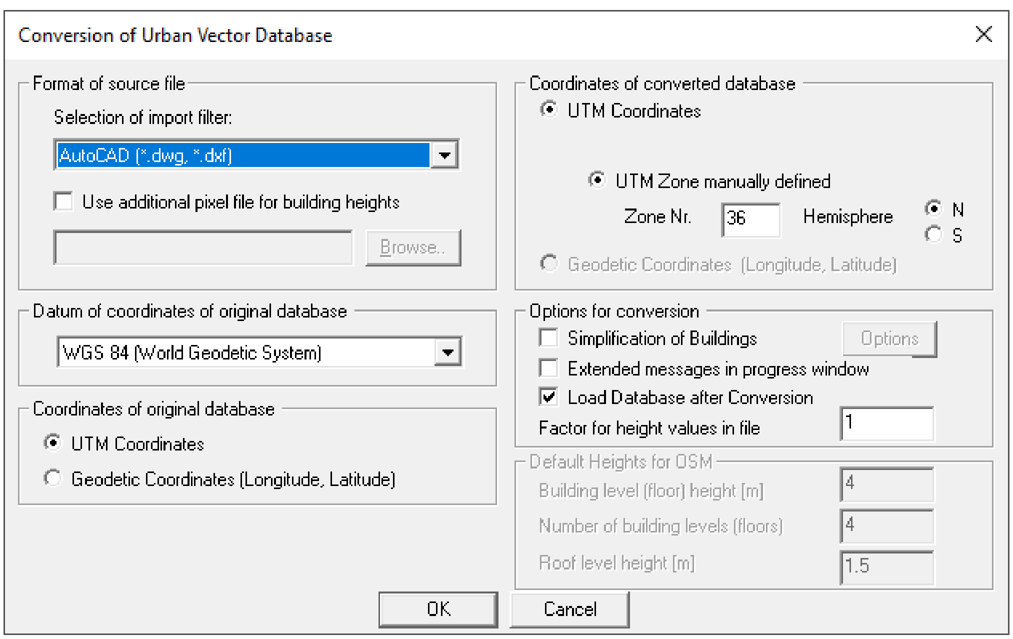


*Figure 89: The **Conversion of Urban Vector Database** dialog.*

3. Keep the default settings on the dialog.

4. Click **OK** to close the **Conversion of Urban Database** dialog.
5. Browse to the location of the file, `Frankfurt_modified.dxf`[19] and click **Open**.
6. Specify the file name as `Frankfurt.odb`[19] and click **Save**.
   The **AutoCAD Conversion Settings** dialog is displayed.

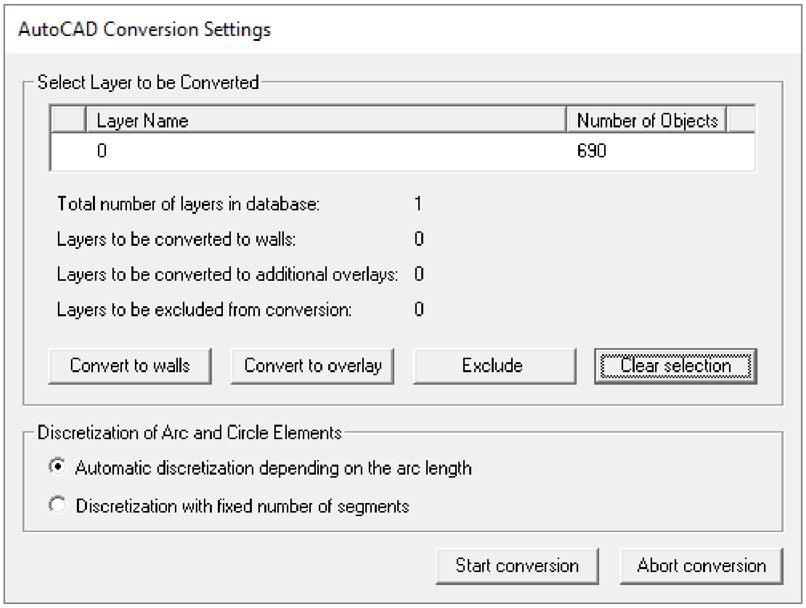
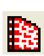


*Figure 90: The **AutoCAD Conversion Settings** dialog.*

7. In the **LayerName** column (second column), select layer **0**.
   For this example, there is only a single layer.
8. Under **Select Layer to be Converted**, click **Convert to walls**.
   The  icon is displayed in column 1 for layer 0.

19. `Project3_Urban_Scenario\Database\Frankfurt_modified.dxf`

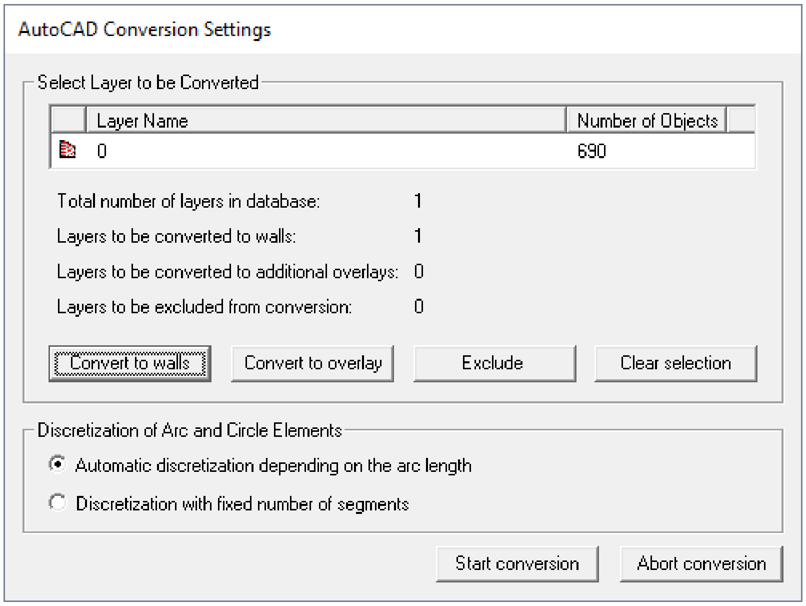


*Figure 91: The **AutoCAD Conversion Settings** dialog with layer 0 converted to walls.*

9. Click **Start conversion** to convert to WinProp format.
The **2D object found** dialog is displayed.

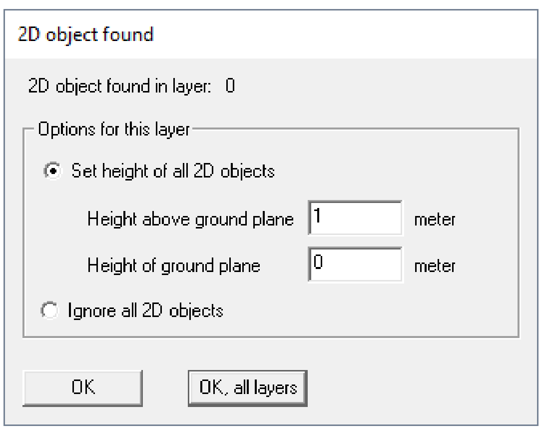


*Figure 92: The **2D object found** dialog.*

> **Note:** The `.dxf` file for this example only contains 3D objects (no 2D objects).

10. Click **Ignore all 2D objects**.

> **Note:** The option to extrude 2D objects to 3D is not applicable to this example as the file only contains 3D objects.

11. Click **OK** to close the **2D object found** dialog.
The `Conversion of database finished...` message is displayed.

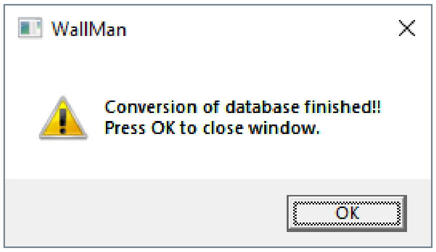


*Figure 93: The **Conversion of database finished...** message.*

12. Click **OK** to close the message.

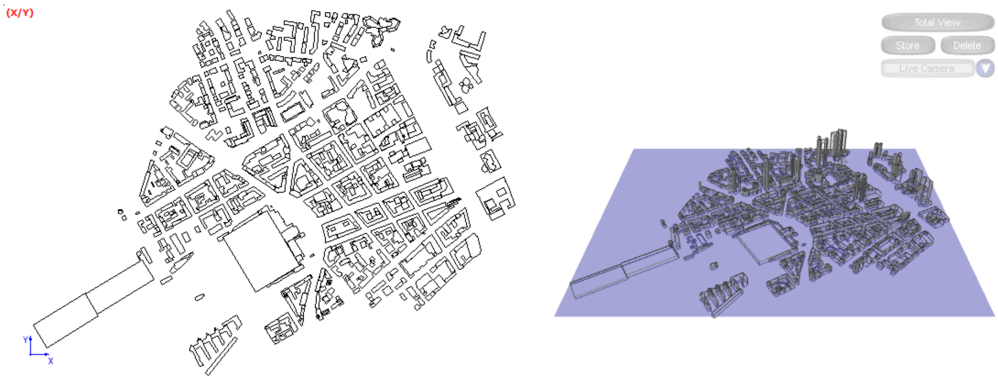


Figure 94: Top view of Frankfurt (on the left) and 3D view (to the right).

The urban database is converted and saved as an outdoor database binary (`.odb`) file.

3.5.3 Display Settings

Change the display settings of objects to validate the model visually.

On the **Settings** menu, click **Local settings** to launch the **Settings** dialog.

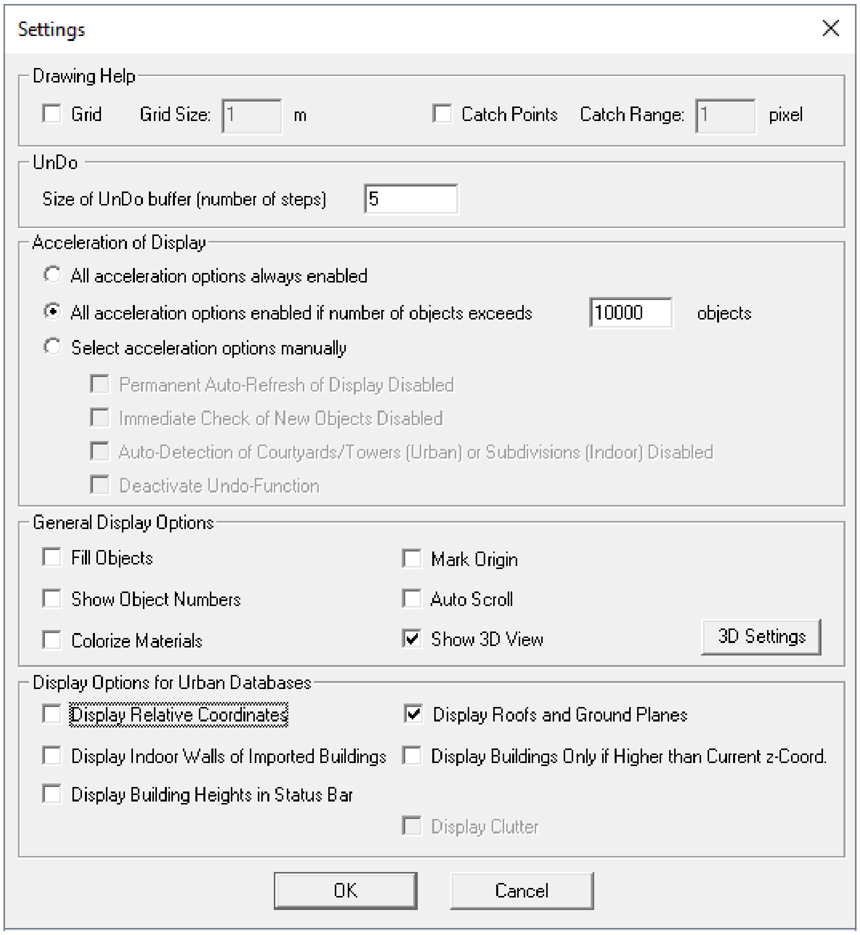


*Figure 95: The **Settings** dialog.*

Fill Objects

This option allows you to visualize the model as a 3D solid and reduce visual complexity.

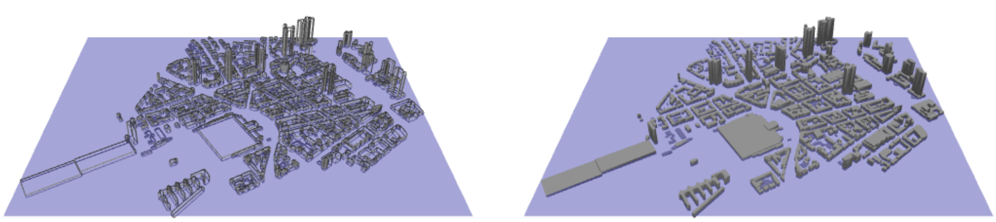


Figure 96: A model without fill (on the left) and a model with fill (to the right).

Display Building Heights in Status Bar

This option allows you to validate the model by viewing the height of an object. In the X/Y view hover with the mouse over a building to view the height of the building in the Status bar.

3.5.4 Modifying the Height of a Building

Change or correct the height of a building

1. Select a building by clicking on the outline of the building.
   A selected object is indicated in red.

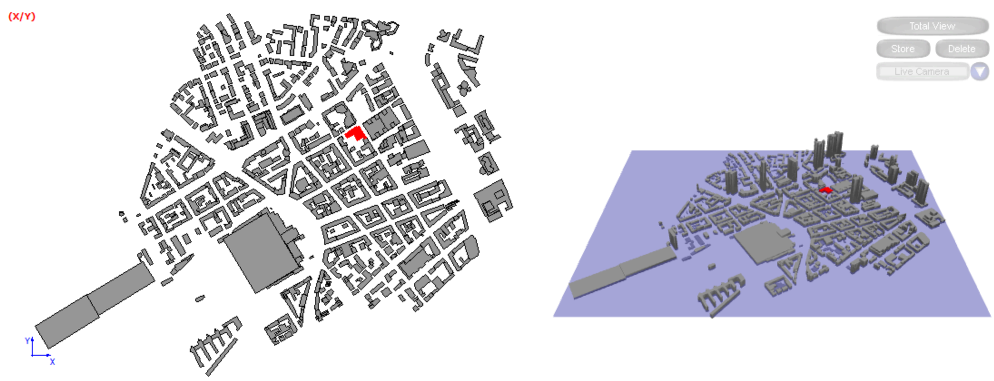


Figure 97: A selected building is indicated in red. Top view of Frankfurt (on the left) and 3D view (to the right).

2. Right-click on the selected building and from the right-click context menu, click **Properties**.
   The **Object Properties** dialog is displayed.

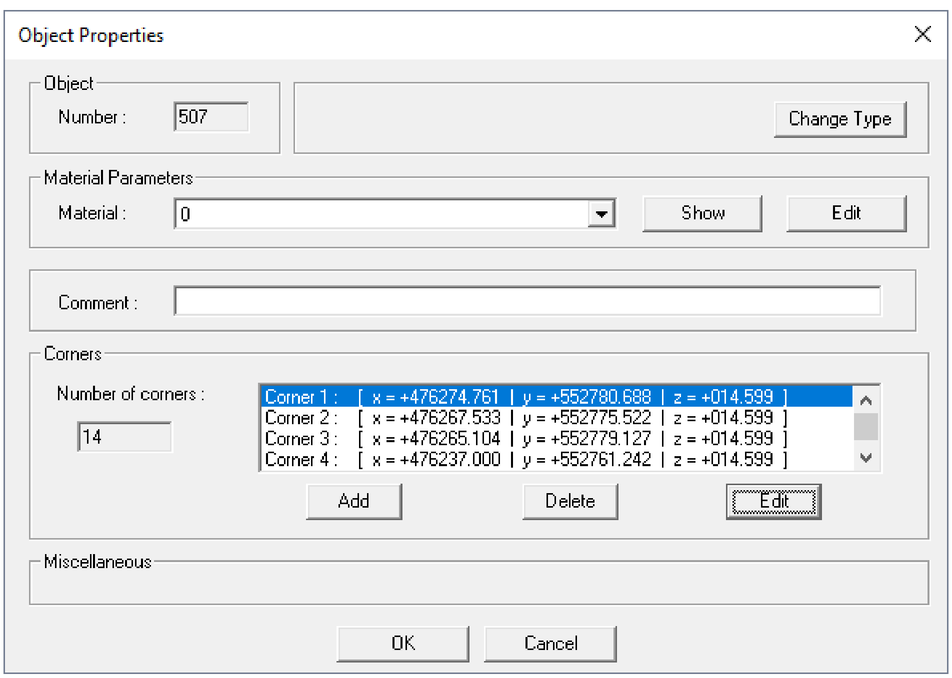


*Figure 98: The **Object Properties** dialog.*

3. Verify the building type of the selected building.
   a) Next to **Object,** click **Change Type**.

b) Under **Selected Type**, verify that **Standard Building**[20] is selected.

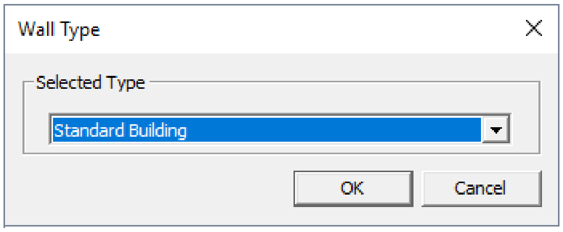


*Figure 99: The **Wall Type** dialog.*

c) Click **OK** to close the **Wall Type** dialog.

4. Under **Corners**, select a corner and click **Edit** to modify the height of the building. The **Enter Coordinates** dialog is displayed.

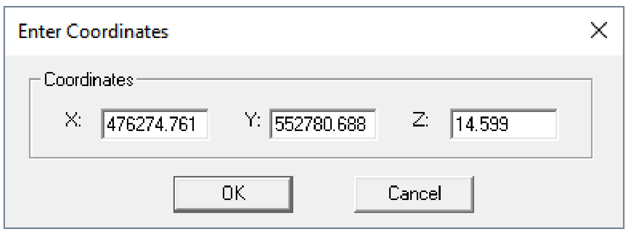


*Figure 100: The **Enter Coordinates** dialog.*

5. In the **Z** field, enter a new height for the building.
6. Click **OK** to close the **Enter Coordinates** dialog.
7. Click **OK** to close the **Object Properties** dialog.

The height of the selected building is updated.

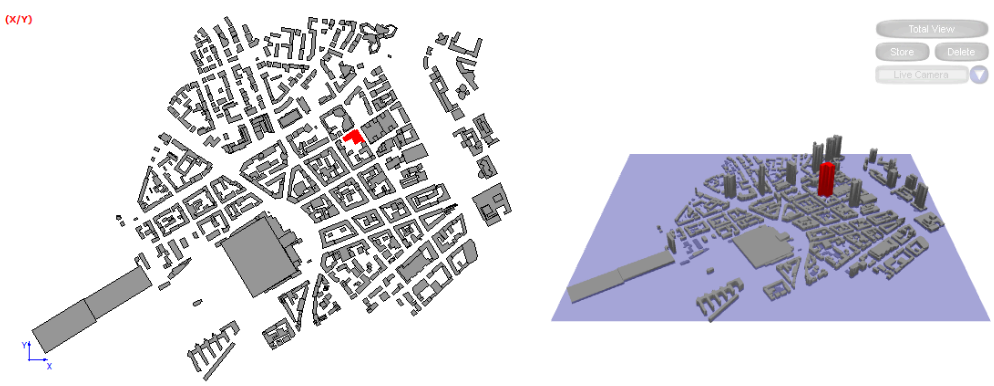


Figure 101: The height of the selected building is increased.

20. Other building types also supported are: horizontal plates, courtyards and towers, vegetation block and virtual buildings, see the WinProp User Guide for more information.

3.5.5 Modifying the Shape of a Building

Change or correct the shape of a building.

1. Select a building by clicking on the outline of the building.
   A selected object is indicated in red.
2. Click with the mouse on a corner of the selected building and drag to the required coordinate.
   An arrow is displayed at the location of the mouse cursor while modifying the shape.

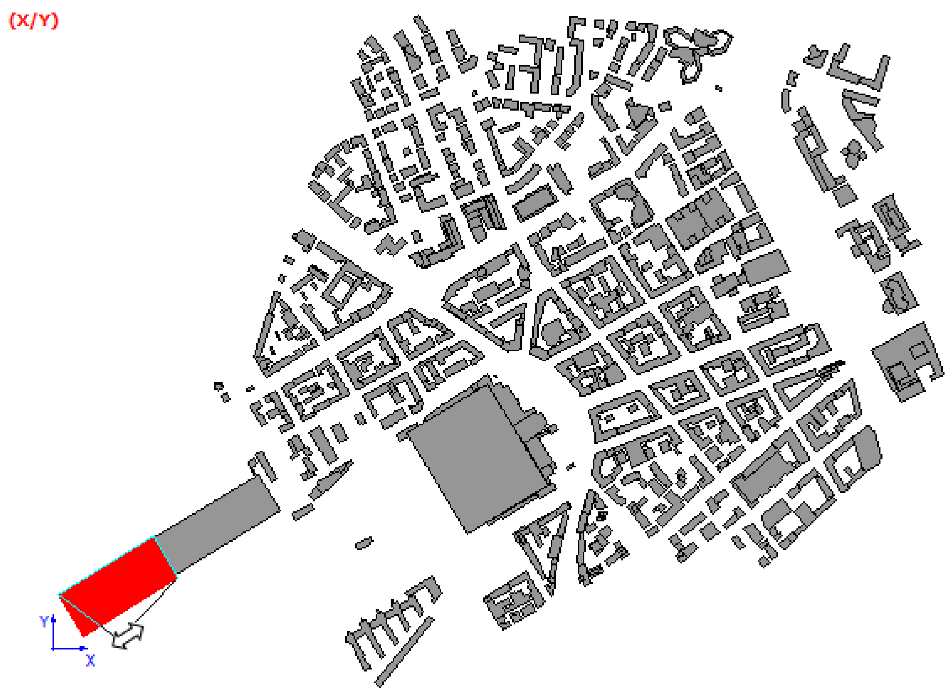


Figure 102: A corner of the selected building (in red) is modified.

The building is updated to include the modification to the corner point.

3.5.6 Courtyards and Towers

A courtyard or tower is a special type of building that allows you to create complex building structures.

A standard building is defined using corners where you specify the X, Y, and Z coordinates for each corner. The height of the building is determined by the value of the Z coordinate. If you change the Z value of one corner, the height of the entire building changes.

> **Note:** A standard building defined completely inside another standard building is ignored.

A courtyard/tower is a special building type where you define the courtyard/tower inside a standard building. Although this results in overlapping structures, a courtyard/tower object has a higher priority and will not lead to validation errors. Towers and courtyards are indicated in yellow (when unselected) in the X/Y view and 3D view.

The difference between a courtyard and tower is:

- Courtyard: The height of the courtyard is less than the height of the standard building that contains it.

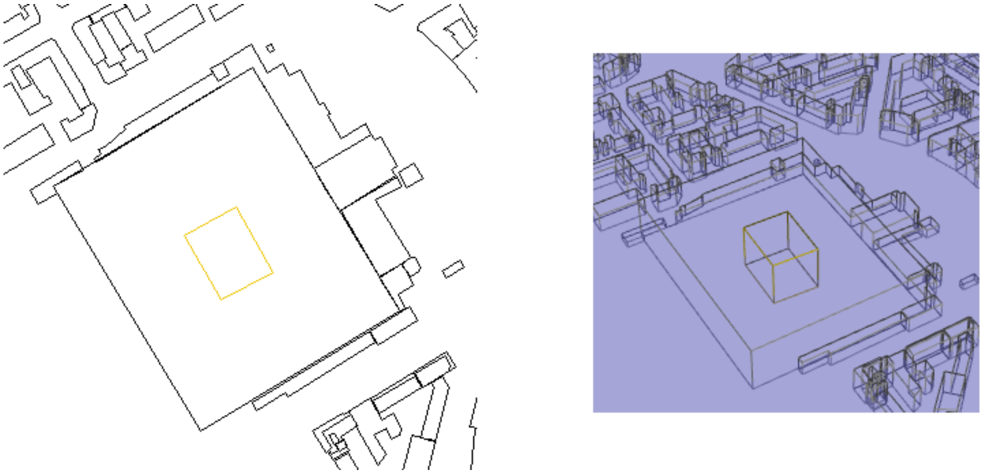


*Figure 103: Top view of the courtyard (on the left) and 3D view (to the right). The **Fill Objects** display setting was disabled for demonstrative purposes.*

- Tower: The height of the tower is greater than the height of the standard building that contains it.

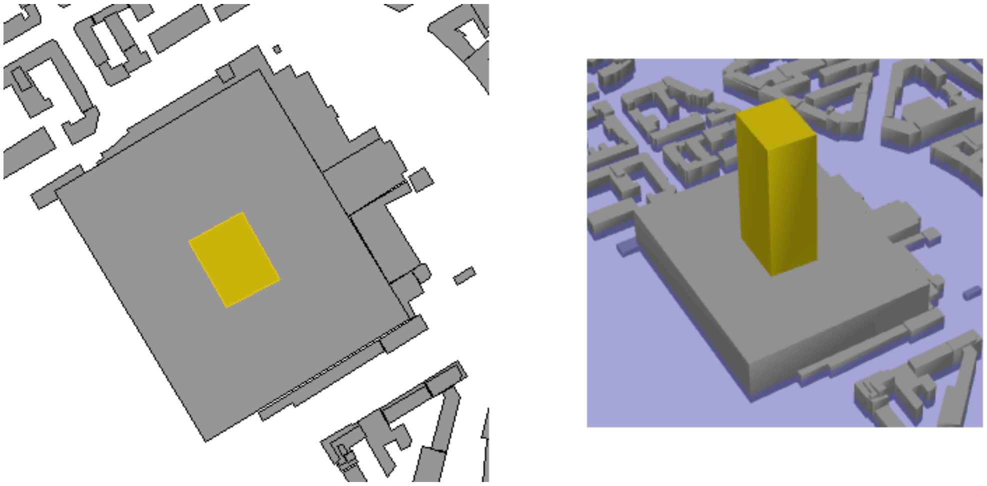


Figure 104: Top view of the tower (on the left) and 3D view (to the right).

> **Note:** Courtyards are not visible when the **Fill object**[21] display setting is enabled but are still part of the geometry and included in the simulation.

21. See the display settings in Display Settings on how to disable.

Adding a Courtyard

Add a rectangular courtyard to the city.

1. Draw a tower in the X/Y window using one of the following workflows:
   - On the **Objects** menu, click **Enter Basic Objects** > **Enter Polygonal Object**.
   - On the **Objects** toolbar, click the **Add Polygonal Objects** icon.
   - Press F7 to use the keyboard shortcut.
2. Click twice to specify the start point of the courtyard.
3. Create the courtyard by clicking on the corners of the courtyard.

   > **Tip:** Press Esc to exit the creation of the current polygon.

4. Right-click at the start point to close the polygon.

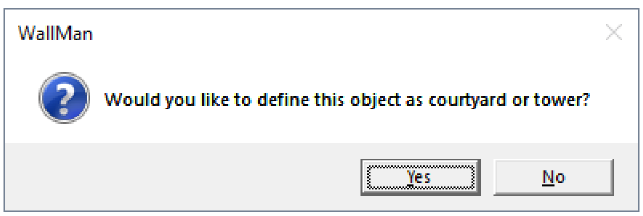


Figure 105: The `Would you like to define this object...` *message.*

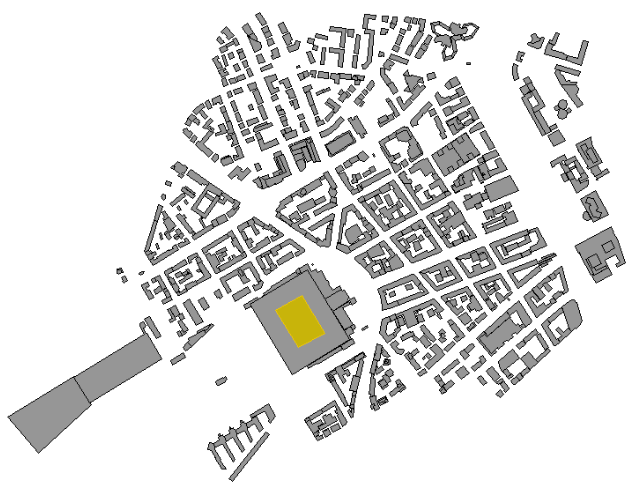


Figure 106: The tower is indicated in yellow in the X/Y view.

5. Click **Yes** to close the `Would you like to define this object...` message.
6. Exit the draw mode using one of the following workflows:
   - On the **Objects** menu, click **Select Objects** > **Select Single Object (Mouse)**.
   - On the **Objects** toolbar, click the **Select Object** icon.
   - Press F10 to use the keyboard shortcut.
7. Select the courtyard by clicking on the outline of the courtyard.

8. Right-click on the selected building and from the right-click context menu, click **Properties**.
The **Object Properties** dialog is displayed.
9. Under **Corners**, select a corner and click **Edit** to modify the height of the tower.

> **Note:** You can modify the height of any corner to change the height of the courtyard.

The **Enter Coordinates** dialog is displayed.

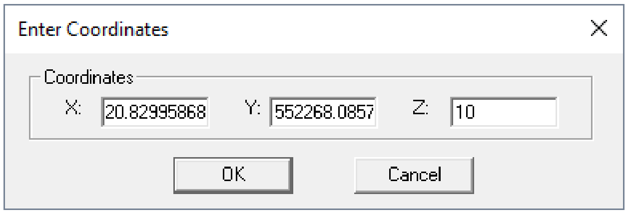


*Figure 107: The **Enter Coordinates** dialog.*

10. In the **Z** field, enter a value of `3` for the height of the tower.
11. Click **OK** to close the **Enter Coordinates** dialog.
12. Click **OK** to close the **Object Properties** dialog.

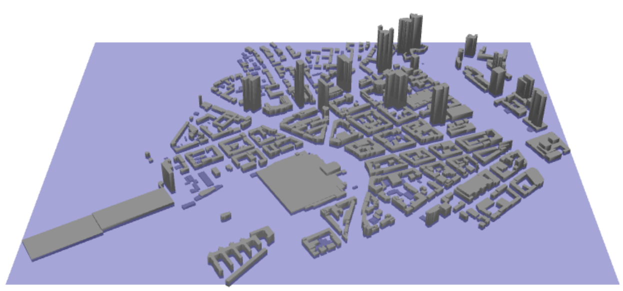


*Figure 108: The 3D view of the urban database. To view the courtyard in the 3D view, disable the **Fill Objects display** settings.*

13. Save the urban database.
    a) On the **File** menu, click **Save Database As**.
    b) Enter `Frankfurt_modifed.odb` as the file name for the outdoor database and click **Save**.

3.5.7 Drawing Vegetation

Draw a polygon and set the material properties to vegetation.

1. Enable the drawing of vegetation in the X/Y window using one of the following workflows:
    - On the **Objects** menu, click **Enter vegetation**.
    - On the **Objects** toolbar, click the **Enter vegetation** icon.
2. Enable the drawing of polygonal objects in the X/Y window using one of the following workflows:
    - On the **Objects** menu, click **Enter Basic Objects** > **Enter Polygonal Object**.

- On the **Objects** toolbar, click the **Add Polygonal Objects** icon.
- Press F7 to use the keyboard shortcut.

3. Click twice to specify the start point of the vegetation.
4. Draw the vegetation by clicking at the corners of the trees.
5. Right-click at the start point to close the polygon.

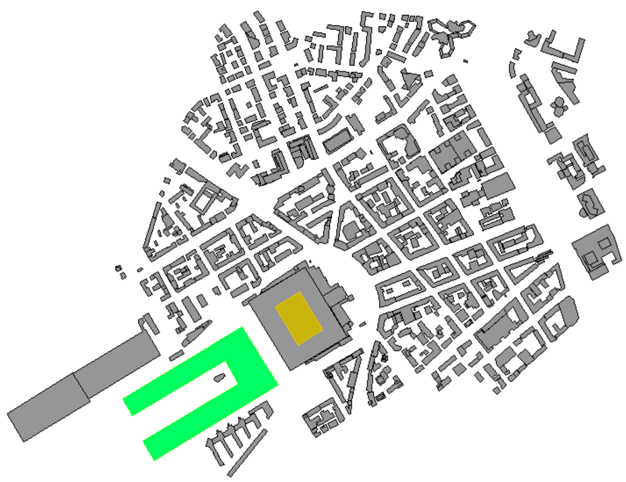


Figure 109: Drawn vegetation is indicated in green.

6. Exit the draw mode using one of the following workflows:
   - On the **Objects** menu, click **Select Objects** > **Select Single Object (Mouse)**.
   - On the **Objects** toolbar, click the **Select Object** icon.
   - Press F10 to use the keyboard shortcut.
7. Select the vegetation by clicking on the outline of the vegetation.
8. Right-click on the selected vegetation and from the right-click context menu, click **Properties**. The **Object Properties** dialog is displayed.
9. Under **Material Properties**, verify that the material is set to **Default Vegetation**.
10. Click **OK** to close the **Object Properties** dialog.

3.5.8 Saving the Database

Save the new and completed urban database to file.

1. On the **File** menu, click **Save Database As**.
2. Enter `Frankfurt_modified.odb`[22] and click **Save**.
3. On the **File** menu, click **Exit** to exit WallMan.

22. `Project3_Urban_Scenario\Database\Frankfurt_modified.odb`

3.6 Setting Up the Simulation in ProMan

Set up the propagation simulation parameters. Solve the urban database and inspect the coverage plots.

The base stations set in an urban environment, is solved using the following two methods: the dominant path model and COST 231 - extended Walfisch-Ikegami model.

3.6.1 Launching ProMan

Launch ProMan in Microsoft Windows using the Feko Launcher utility (which includes WinProp and newFASANT).

3.6.2 Creating a New Project

Load the urban geometry database that was created in WallMan.

1. On the **File** menu, click **New Project**.
   The **New Project** dialog is displayed.
2. Under **Scenario**, from the drop-down list, select **Urban Scenario (vector data for urban buildings and pixel topo data)**.
3. Under **Databases**, in the **3D building data (Vector database)** field, browse to `Frankfurt_modified.odb`[23].
4. Under **Polarimetric Analysis**, select **Standard (suitable for all scenarios and propagation models)**.

23. `Project3_Urban_Scenario\Database\Frankfurt_modified.odb`

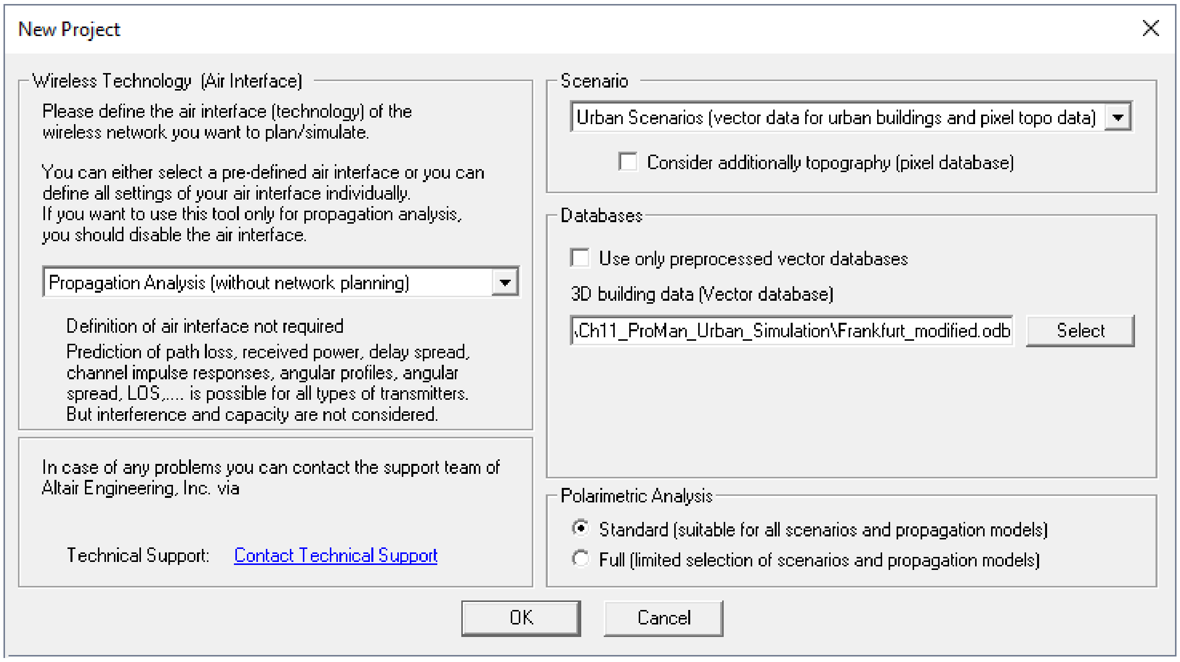


*Figure 110: The **New Project** dialog.*

5. Click **OK** to close the **New Project** dialog.
   The **Define Display Height** dialog is displayed.

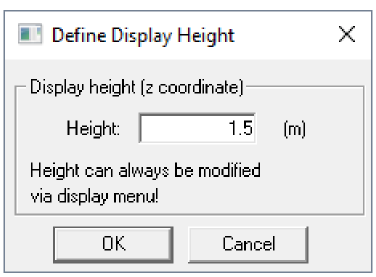


*Figure 111: The **Define display Height** dialog.*

6. In the **Height** field, use the default value of `1.5` m.

   > **Note:** This value is used only to specify the display height. This value has no impact on the height at which the prediction results are calculated.

7. Click **OK** to close the **Define Display Height** dialog.
   The top view of the urban geometry database is displayed.

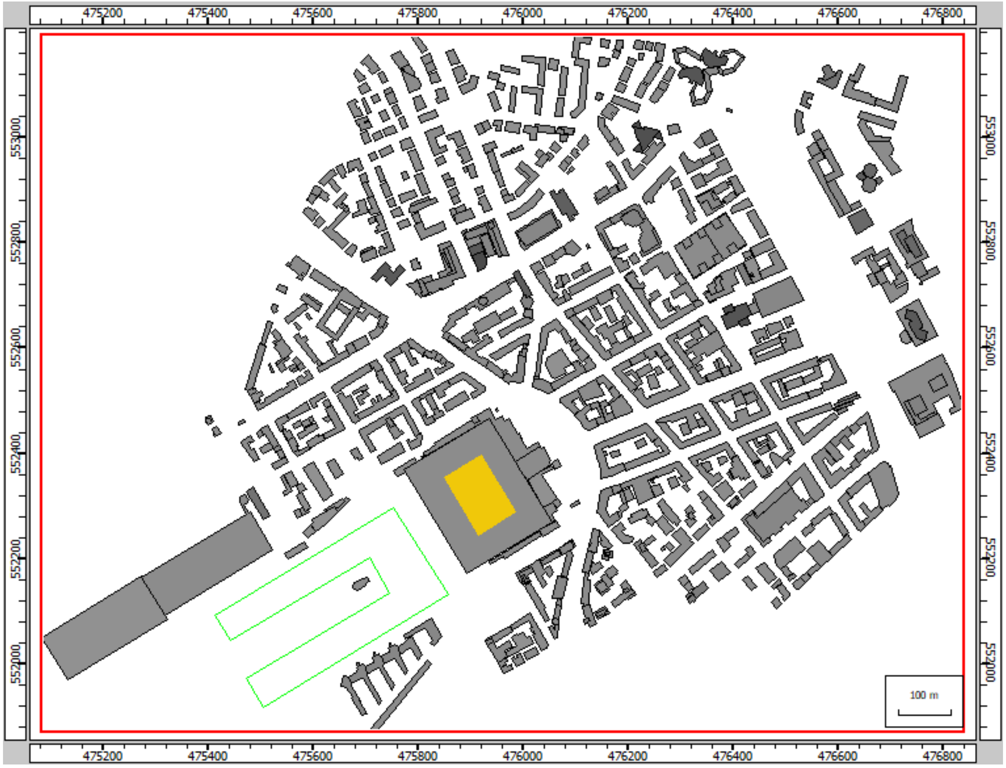


Figure 112: A top view of Frankfurt.

> **Note:** The red rectangle indicates the extent of the computational domain.

3.6.3 Verifying All Building Heights

Verify that all building heights are correct.

1. View all building heights using one of the following workflows:
    - On the **Settings** menu, click **Local Settings (Display of data)**.
    - On the **Edit** toolbar, click the **Local Settings (Display of data)** icon.

    The **Display Settings** dialog is displayed.

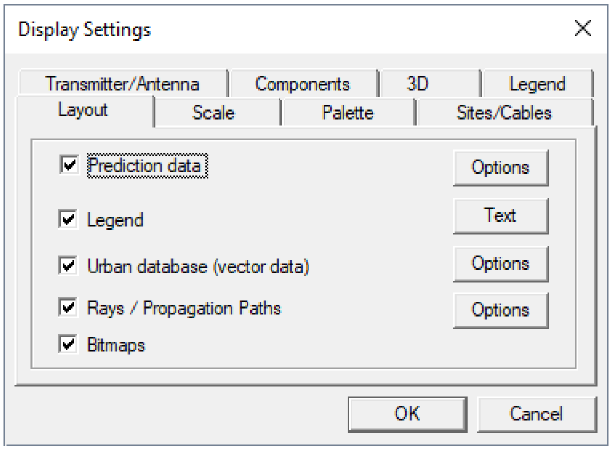


*Figure 113: The **Display Settings** (**Layout** tab) dialog.*

2. Next to the **Urban database (vector data)** check box, click **Options**.
   The **Display of Buildings** dialog is displayed.

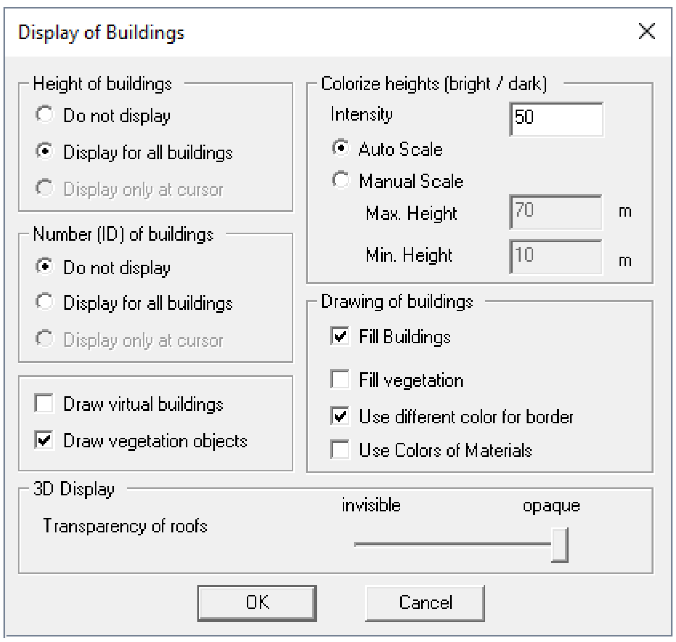


*Figure 114: The **Display of Buildings** dialog.*

3. Under **Height of buildings**, click **Display for all buildings**.
4. Click **OK** to close the **Display of Buildings** dialog.
5. Click **OK** to close the **Display Settings** dialog.
6. Confirm that all buildings heights are correct.

Figure 115: The height of each building is displayed. Zoom in to read specific values.

> **Note:** All building heights are displayed using rounded values.

7. Disable the display of all building heights by repeating Step 1 to Step 3, but click **Do not display**.

3.6.4 Determining Building Height for Antenna Placement

In an urban scenario, antennas are usually placed at the top of a building. When defining an antenna site, you require the height of the building to ensure that the antenna is placed above the building not inside.

1. Determine the height of a specific building using one of the following workflows:
    - On the **Display** menu, click **Balloon Tips**.
    - On the Utility toolbar, click the **Balloon tip** icon.

    The mouse cursor changes from a "+" to an "X".
2. Hover with the mouse over a building to view the building height in a balloon tip.

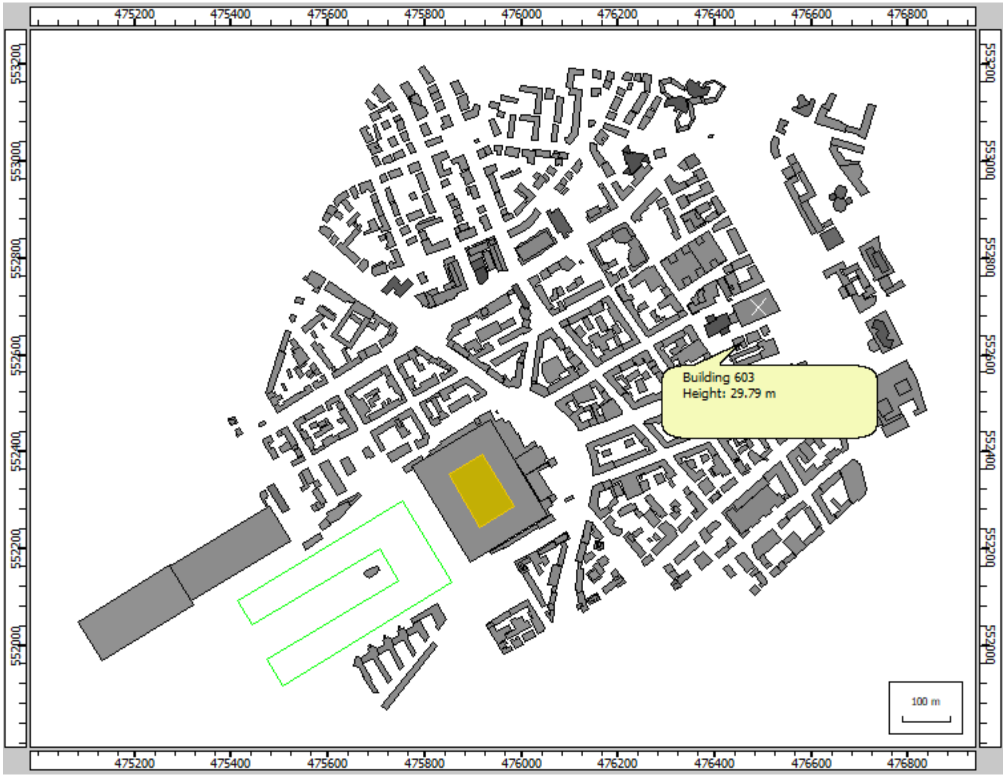


Figure 116: The height of the building at the mouse cursor is displayed in a balloon tip.

3. Repeat Step 1 to disable the balloon-tip mode.

3.6.5 Defining the First Antenna Site and Antennas

Define the first antenna site with three antennas.

The height of the building where the antenna 1 is to be placed is 135.84 m[24]. The height of the antenna mast is 15 m with the result that the antenna will be located at 150.84 m.

1. Specify the transmitter type and settings using one of the following workflows:
   - On the **Project** menu, click **Sites** > **Site: New**.
   - On the **Project** toolbar, click the **Set Site** icon.

   The **Transmitter Type** dialog is displayed.

24. Determine the building height as described in Determining Building Height for Antenna Placement.

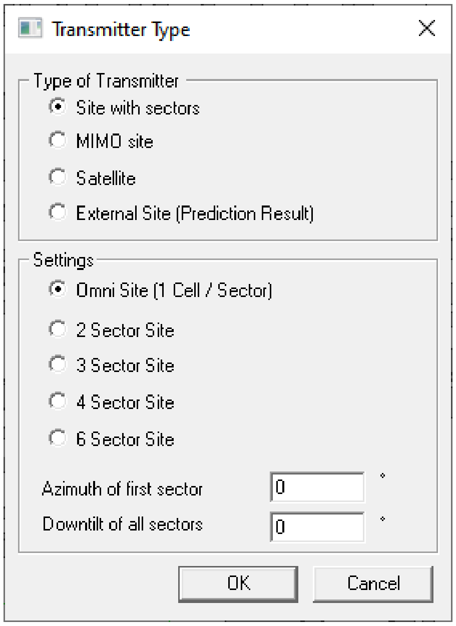


*Figure 117: The **Transmitter Type** dialog.*

2. Under **Settings**, click **3 Sector Site**.
3. Click **OK** to close the **Transmitter Type** dialog.
In the 2D view, the mouse cursor is displayed as a circle to indicate that the **Set site** tool is enabled.
4. Click near the point (indicated by an orange circle) in Figure 118.

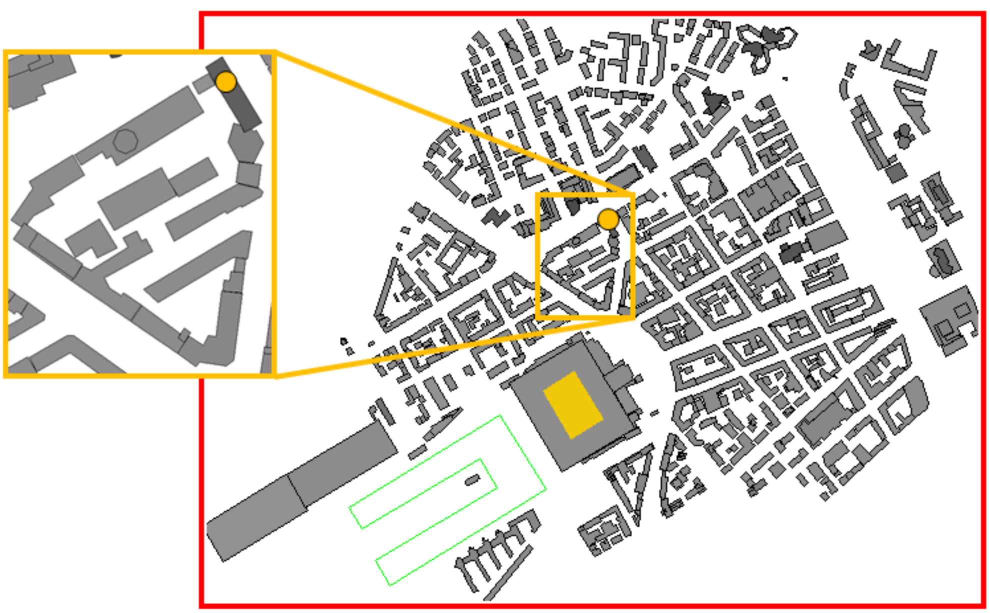


Figure 118: Place the first antenna site at the location of the orange dot.

> **Note:** The exact coordinates are not important for this example, but the above location is used in the steps that follow.

The **Site** dialog is displayed.

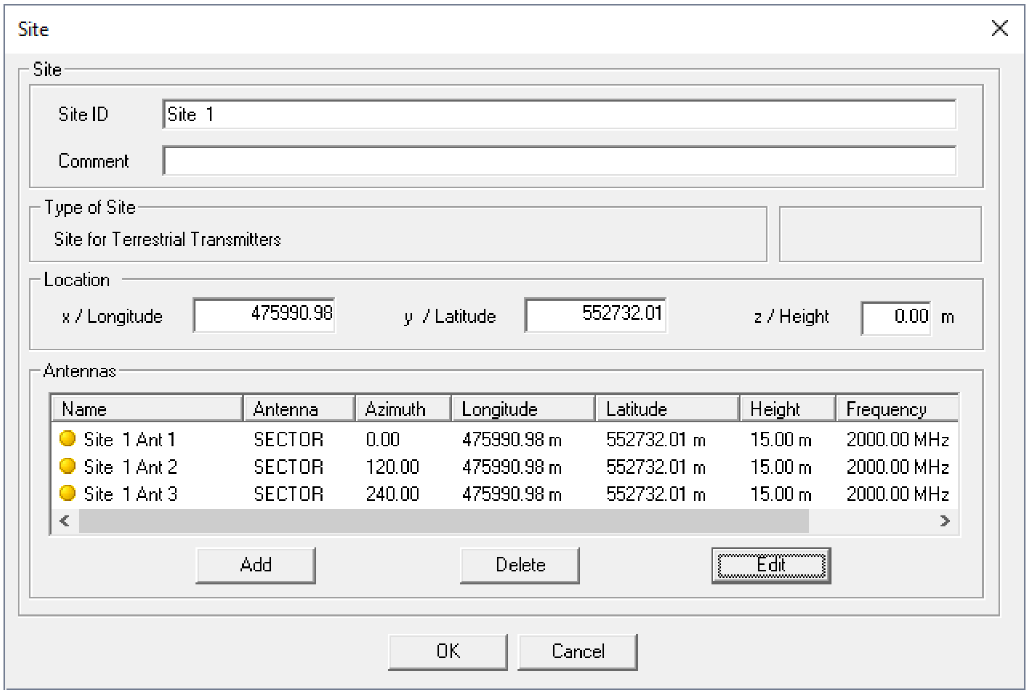


*Figure 119: The **Site** dialog.*

5. Under **Location,** in the **z/Height** field, enter a value of `135.84` m.
6. On the **Site** dialog, click on **Site 1 Antenna 1** to select and click **Edit**.
   The **Cell** dialog is displayed for antenna 1.
7. Under **Transmitter Settings**, in the **Frequency (used for propagation)** field, enter a value of `1800` MHz.
8. Under **Location of Antenna**, in the **z / Height** field, enter a value of `150.84` m.
9. Under **Antenna Pattern**, click **Directional / Sector antenna**.
10. Under **Orientation**, in the **Downtilt** field, enter a value of `4`°.
11. Under **Antenna Pattern**, click **Select** to browse to the file `farfield_gain_3d.ffe`.
12. Click **OK** to close the **Cell** dialog.

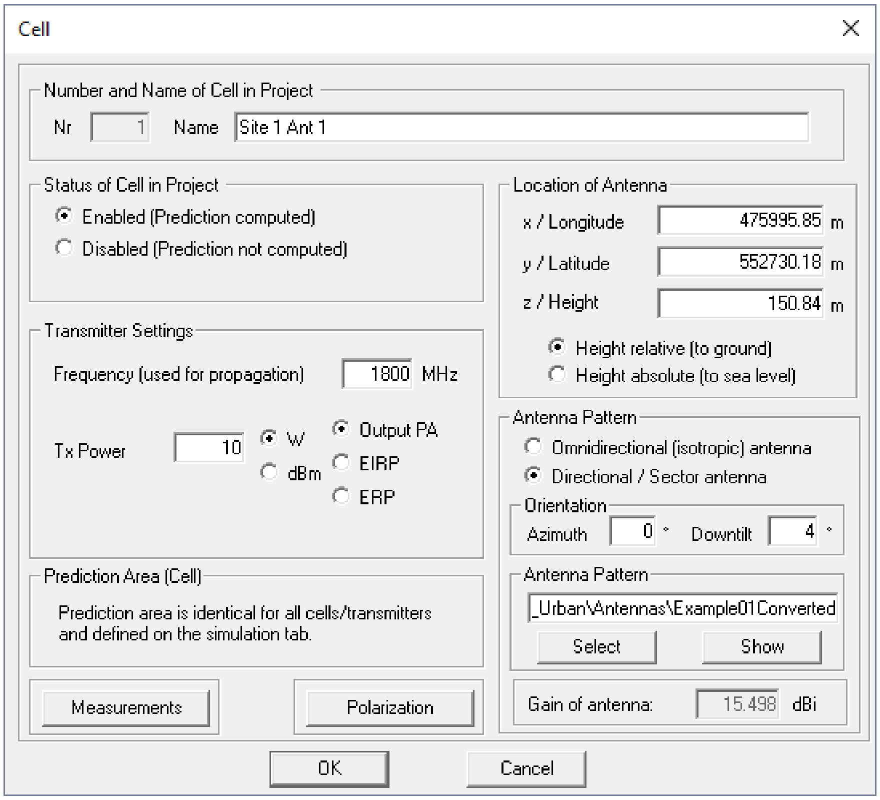


*Figure 120: The **Cell** dialog for antenna 1.*

13. Repeat Step 6 to Step 12 to define antenna 2.

14. Repeat Step 6 to Step 12 to define antenna 3.

15. Click **OK** to close the **Site** dialog.

16. Disable the **Set site** tool by clicking again on the **Set Site** icon.

3.6.6 Defining the Second Antenna Site and Antennas

Define the second antenna site with three antennas.

The height of the building where the antenna 2 is to be placed is 30.11 m[25]. The height of the antenna mast is 15 m with the result that the antenna will be located at 45.11 m.

1. Specify the transmitter type and settings using one of the following workflows:

- On the **Project** menu, click **Sites** > **Site: New**.
- On the **Project** toolbar, click the **Set Site** icon.

The **Transmitter Type** dialog is displayed.

25. Determine the height of the building as described in Determining Building Height for Antenna Placement.

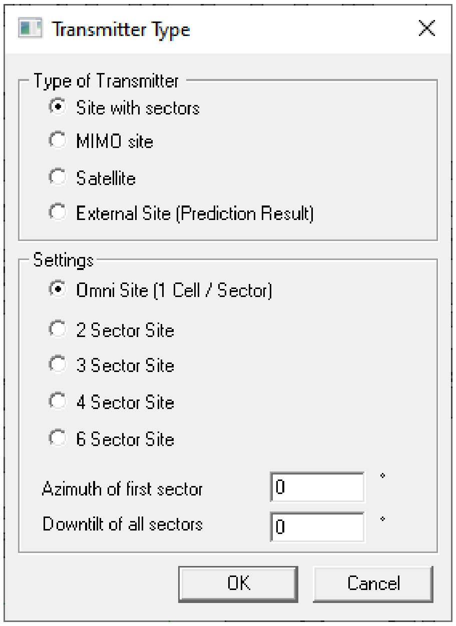


*Figure 121: The **Transmitter Type** dialog.*

2. Under **Settings**, click **3 Sector Site**.
3. Click **OK** to close the **Transmitter Type** dialog.
   In the 2D view, the mouse cursor is displayed as a circle to indicate that the **Set site** tool is enabled.
4. Click near the point (indicated by an orange circle) in Figure 122.

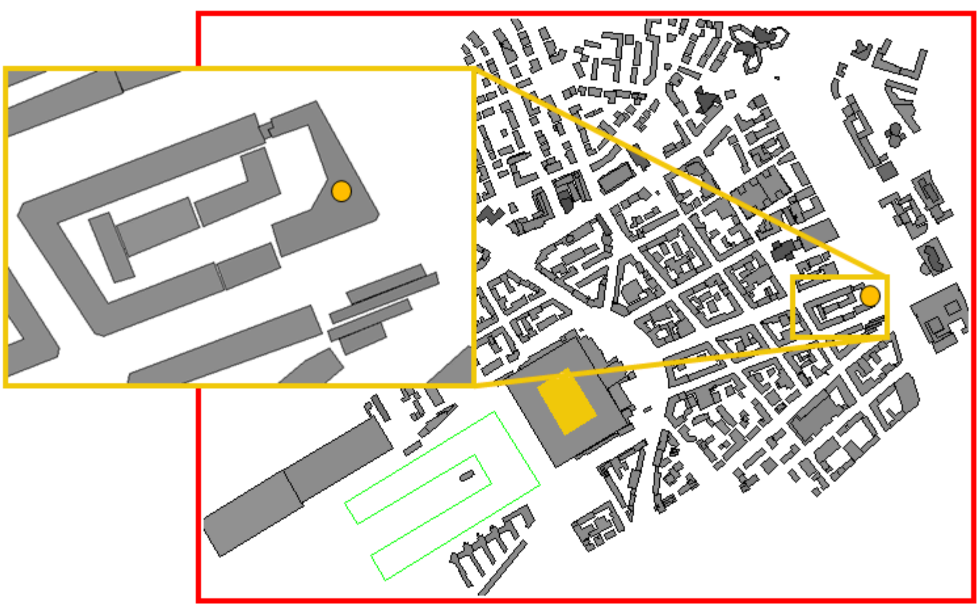


Figure 122: Place the second antenna site at the location of the orange dot.

> **Note:** The exact coordinates are not important for this example, but the above coordinate is used in the steps that follow.

The **Site** dialog is displayed.

5. Under **Location,** in the **z/Height** field, enter a value of `30.11` m.
6. On the **Site** dialog, click on **Site 2 Antenna 1** to select and click **Edit**.
   The **Cell** dialog is displayed for antenna 1.
7. Under **Transmitter Settings**, in the **Frequency (used for propagation)** field, enter a value of `1800` MHz.
8. Under **Location of Antenna**, in the **z / Height** field, enter a value of `45.11` m.
9. Under **Antenna Pattern**, click **Directional / Sector antenna**.
10. Under **Orientation**, in the **Downtilt** field, enter a value of `4`°.
11. Under **Antenna Pattern**, click **Select** to browse to the file `farfield_gain_3d.ffe`.

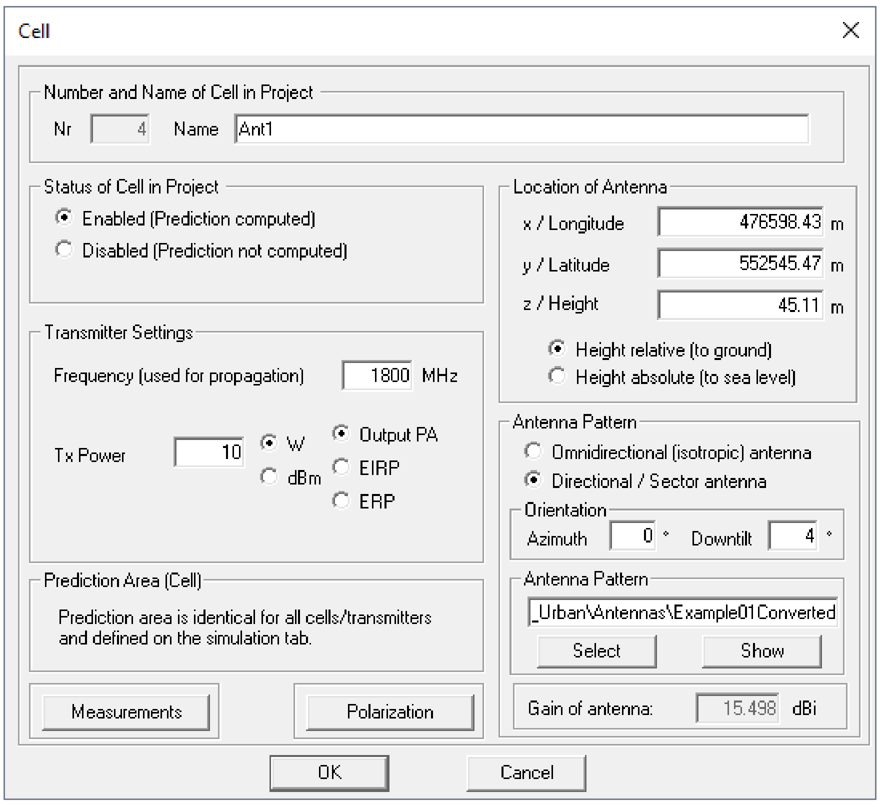


*Figure 123: The **Cell** dialog for antenna 1.*

12. Click **OK** to close the **Cell** dialog.
13. Repeat Step 6 to Step 12 to define antenna 2.
14. Repeat Step 6 to Step 12 to define antenna 3.
15. Click **OK** to close the **Site** dialog.
16. Disable the **Set site** tool by clicking again on the **Set Site** icon.

3.6.7 Using the Dominant Path Model (DPM)

The urban database is solved using the dominant path model.

The dominant path model (DPM) is ideally suited to compute coverage predictions in very large areas as the model does not require preprocessing of the vector building database. The DPM model only focuses on the dominant path or paths between the transmitter and receiver, which leads to short computation time. The accuracy of this method is nearly identical to a ray-tracing model.

Specifying the Prediction Resolution and Height

Define the resolution grid and the height where the prediction results are to be calculated.

1. Launch the **Edit Project Parameters** dialog using one of the following workflows:
   - On the **Project** menu, click **Edit Project Parameters**.
   - On the **Project** toolbar, click the **Edit Project Parameters** icon.
   - Press F3 to use the keyboard shortcut.
2. Click the **Simulation** tab.
3. Under **Resolution of prediction results**, in the **Resolution** field, enter a value of `2` m.
   The prediction results will be computed with a resolution (grid) of 2 m.
4. Under **Prediction Height**, in the **Height** field, enter a value of `1.5` m.

   > **Tip:** Multiple prediction heights can be specified by entering space-separated values.
   > For example: `1.5 2 2.5`

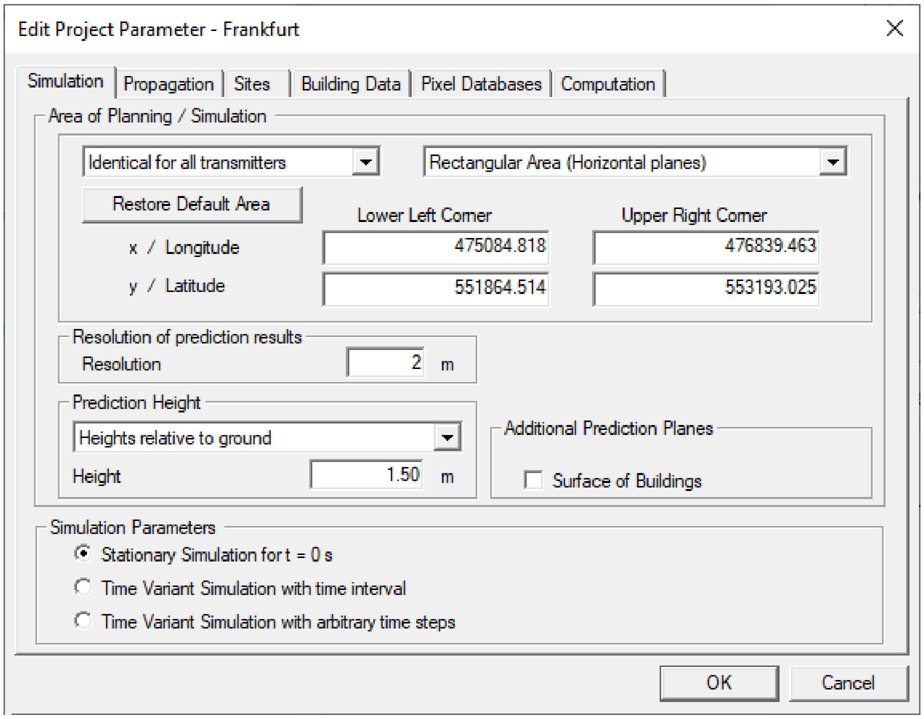


Figure 124: The ***Edit Project Parameters*** *dialog -* ***Simulation*** *tab.*

Note: Keep the dialog open to define additional project parameters.

Specifying the Output Folder for the Prediction Results

Specify the folder for the prediction results to be computed using the dominant path model.

1. Click the **Propagation** tab.
2. Specify the output folder for the results to be computed using the dominant path model.
   a) Under **Output Directory / Basic Filename for Propagation Results**, in the **Directory** field, change the default `PropName` to `Results\Prop03_DPM`.

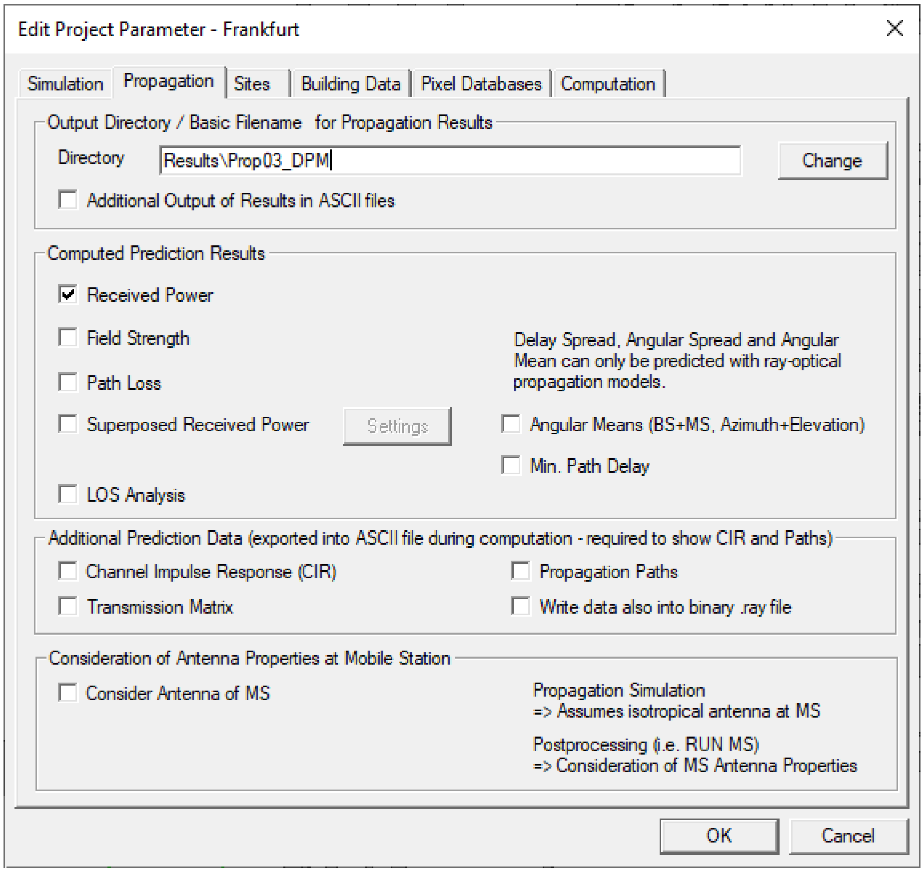


*Figure 125: The **Edit Project Parameters** dialog - **Propagation** tab.*

> **Note:** Keep the dialog open to define additional project parameters.

Defining the Prediction Requests

Specify the predictions to be computed.

1. Under **Computed Prediction Results**, select the **Field strength** check box.
2. Under **Computed Prediction Results**, select the **Path Loss** check box.
3. Under **Computed Prediction Results**, select the **LOS**[26] **Analysis** check box.

> **Note:** Keep the dialog open to define additional project parameters.

26. Line-of-sight (LOS) condition: Direct line of sight between transmitted and receiver.

Specifying the Computation Method

Select the dominant path model (DPM) as computation method.

1. Click the **Computation** tab.
2. Under **Prediction model (Urban)**, click **Dominant Path Model**.
3. Under **Indoor Prediction**, select the **Indoor Coverage (without indoor walls)** check box.

> **Note:** The option computes an estimation of the indoor coverage.

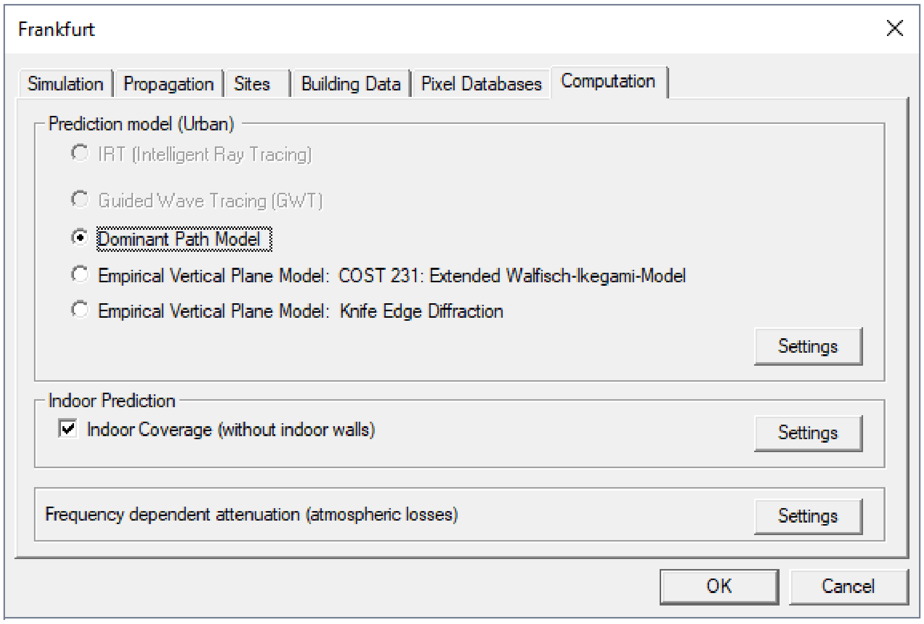


*Figure 126: The **Edit Project Parameters** dialog - **Computation** tab.*

4. Click **OK** to close the **Edit Project Parameter** dialog.

Saving the Project

Save the new project to file.

1. On the **File** menu, click **Save Project As**.
2. Enter `Frankfurt.net` as the file name for the project and click **Save**.

Launching the Solver

Compute the propagation for all antennas to obtain the prediction results.

Launch the Solver using one of the following workflows:

- On the **Project** toolbar, click the **Computes propagation for all antennas** icon.
- On the **Computation** menu, click **Propagation: Compute All**.
- Press F5 to use the keyboard shortcut.

The Solver is launched, and the **Computation** dialog is displayed.

> **Note:** For this example, several warnings are displayed. Ignore these warnings, as it only states that the imported pattern is a directivity pattern rather than a gain pattern.

Viewing the Prediction Results

Display the power results using the dominant path model.

1. View the power in the 3D view using the dominant path model in the urban environment.
    a) On the **Edit** toolbar, click the **3D View** icon.
    b) In the tree, expand **Results: Propagation** to view the sites.
    c) In the tree, expand **Site 2** to view the three antennas.
    d) In the tree, expand **Site 2 Antenna 3** to view the **Power**.

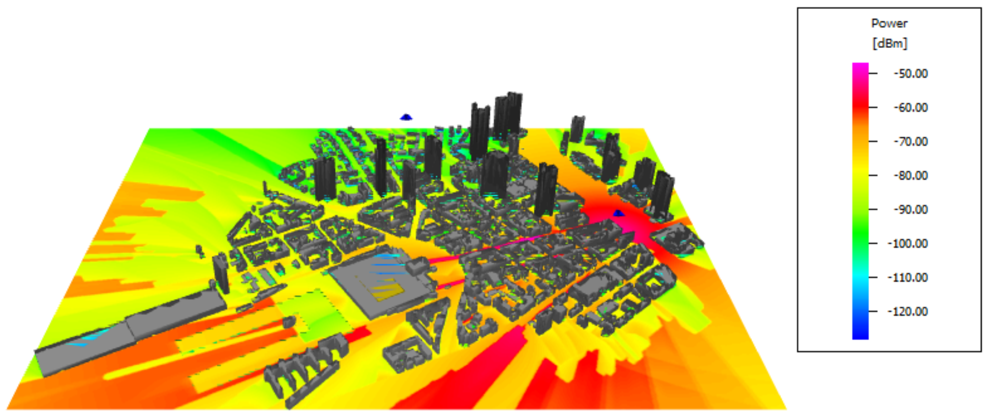


Figure 127: View the power (dBm) in the 3D view.

    a) Click the **3D View** icon again to return to the 2D view.
2. View the power using the dominant path model in the urban environment.
    a) In the tree, expand **Results: Propagation** to view Site 2.
    b) In the tree, expand **Site 2** to view the three antennas.
    c) In the tree, expand **Site 2 Antenna 3** to view the **Field Strength** and **Power** entries.
    d) In the tree, click **Power** to view the results.

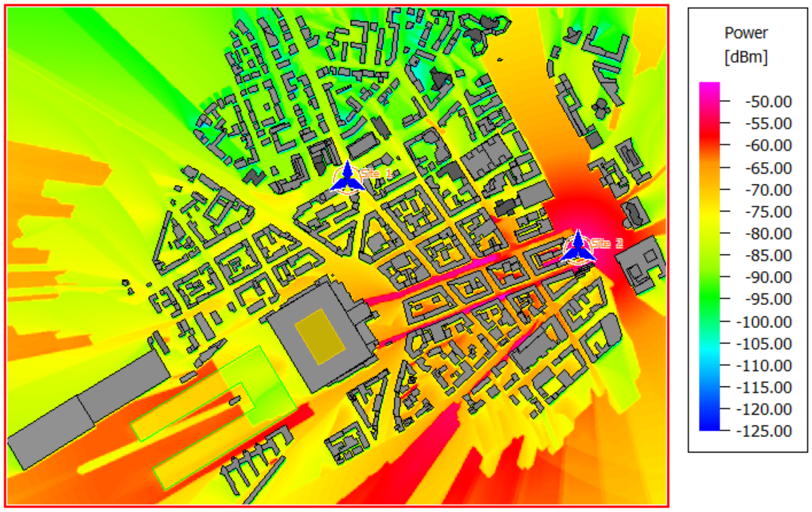


Figure 128: Power calculated for Site 2 Antenna 3 using the dominant path model (DPM).

3. View the power inside the buildings.

a) On the **Settings** menu, click **Local Settings (Display of Data)**.
b) Click the **Layout** tab and next to the **Urban database (vector data)**, click **Options**.
c) On the **Display of buildings** dialog, under **Drawing of buildings**, clear the **Fill Buildings** check box.
d) Click **OK** to close the **Display of Buildings** dialog.
e) Click **OK** to close the **Display Settings** dialog.

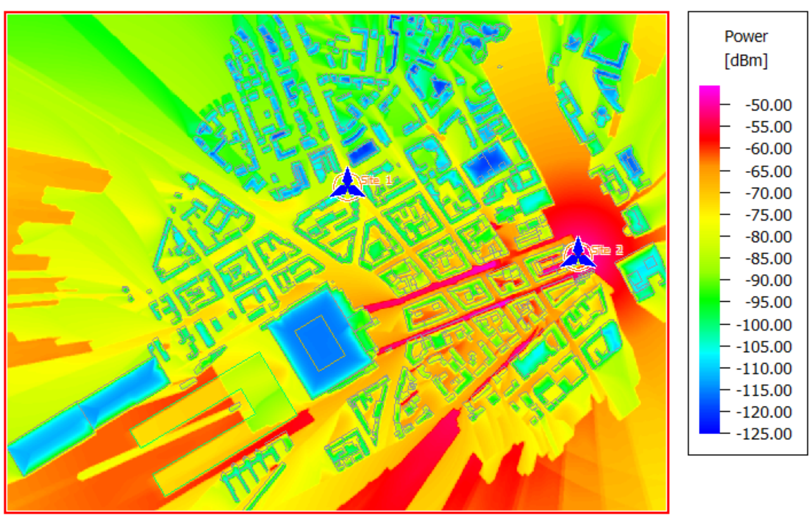


*Figure 129: Power calculated for Site 2 Antenna 3 using the dominant path model (DPM). The **Fill Buildings** display setting is disabled.*

3.6.8 Using COST 231: Extended Walfisch-Ikegami Model

The urban database is solved using the COST 231 - extended Walfisch-Ikegami model.

This method is suited for high transmitters in urban scenarios when the dominant path is expected to be in the vertical plane over rooftops, followed by diffraction down into the street.

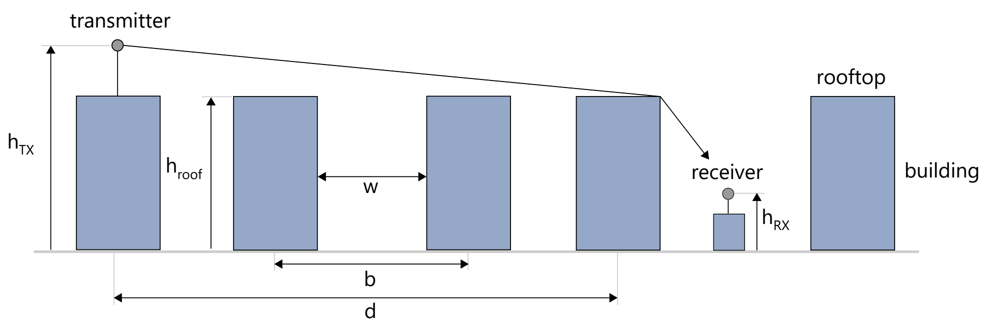


Figure 130: Urban propagation scenario using the COST 231 Walfisch-Ikegami Model.

A wave that is guided along a street between buildings would not be included. Simulations using COST 231 - extended Walfisch-Ikegami model tends to be fast.

Specifying the Output Folder for the Prediction Results

Specify the folder for the prediction results to be computed using the COST 231 - extended Walfisch-Ikegami model.

1. Launch the **Edit Project Parameters** dialog using one of the following workflow:
   - On the **Project** menu, click **Edit Project Parameters**.
   - On the **Project** toolbar, click the **Edit Project Parameters** icon.
   - Press F3 to use the keyboard shortcut.
2. Click the **Propagation** tab.
3. Specify the output folder for the results to be computed using the dominant path model.
   a) Under **Output Directory / Basic Filename for Propagation Results**, in the **Directory** field, change `Prop03_DPM` to `Results\Prop03_COST231`.

Note: Keep the dialog open to define additional project parameters.

Specifying the Computation Method

Select the COST 231 - extended Walfisch-Ikegami model as computation method.

1. Click the **Computation** tab.
2. Under **Prediction model (Urban)**, click **Empirical Vertical Plane Model: COST 231: Extended Walfisch-Ikegami-Model**.

3. Under **Indoor Prediction**, select the **Indoor Coverage (without indoor walls)** check box.
4. Click **OK** to close the **Edit Project Parameter** dialog.

Launching the Solver

Compute the propagation for all antennas to obtain the prediction results.

Launch the Solver using one of the following workflows:

- On the **Project** toolbar, click the **Computes propagation for all antennas** icon.
- On the **Computation** menu, click **Propagation: Compute All**.
- Press F5 to use the keyboard shortcut.

The Solver is launched, and the **Computation** dialog is displayed.

> **Note:** For this example, several warnings are displayed. Ignore these warnings, as it only states that the imported pattern is a directivity pattern rather than a gain pattern.

Viewing the Prediction Results

Display the power results using the COST 231 - extended Walfisch-Ikegami model.

1. In the tree, expand **Results: Propagation** to view Site 2.
2. In the tree, expand **Site 2** to view the three antennas.
3. In the tree, expand **Site 2 Antenna 3** to view the **Field Strength** and **Power** entries.
4. In the tree, click **Power** to view the results.

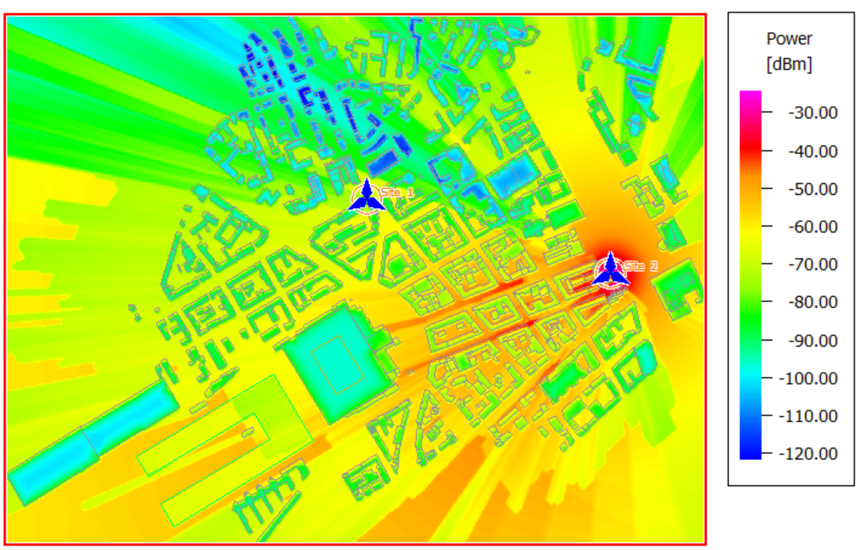


Figure 131: Power calculated for Site 2 Antenna 3 using the COST 231 - extended Walfisch-Ikegami model.

3.7 Final Remarks

This example showed how to analyze base stations in a city, to create the urban database using WallMan and to obtain coverage plots using ProMan.

Many concepts were introduced in this example that apply to models commonly created in WallMan and ProMan.

The base stations, set in an urban environment, were solved using the dominant path model and COST 231 - extended Walfisch-Ikegami model. The dominant path model is in general recommended over empirical models because it includes all relevant effects that influence the actual radio channel.

Base Stations on Hills Near a City

4

This example considers the application of analyzing base stations on hills near a city, set in a rural or suburban hilly terrain.

This chapter covers the following:

4.1 Example Overview

This example considers the application of analyzing base stations in a rural or suburban hilly terrain.

The 3D model of the rural/suburban environment is created by importing topography and clutter databases to allow for accurate predictions of the signal level.

The antenna patterns were obtained using AMan, but the steps on how to obtain the antenna pattern are not in the scope of this example.

Coverage plots are produced using ProMan to determine the cell phone coverage for two base stations set in hilly terrain. Two different propagation models are used, namely the dominant path model (DPM) and the deterministic two ray model (DTR).

4.2 Topics Discussed in Example

Before starting this example, check if the topics discussed in this example are relevant to the intended application and experience level.

The topics discussed in this example are:

- ProMan
    - Launch ProMan.
    - Import topography and clutter databases.
    - Specify the antenna sites, orientations and properties.
    - Specify the simulation parameters.
    - Specify the computation method.
    - Save the project.
    - Launch the Solver.
    - View the prediction results and compare the results using different models.

Note: Follow the example steps in the order they are presented as each step uses its predecessor as a starting point.

Tip: Find the completed model in the Altair installation directory, for example:

`Altair\2025.1\help\winprop\examples\GetStarted_models\Project4_Rural_Suburban_Scenario`.

4.3 Example Prerequisites

Before starting this example, ensure that the system satisfies the minimum requirements.

The requirements for this example are:

- Feko 2025.1[27] or later should be installed.

27. WinProp is included as part of the Feko installation.

4.4 Pixel Databases for Rural/Suburban Scenarios

Pixel databases are used to describe the topography, land usage and buildings in a rural/suburban scenario to obtain accurate predictions.

The wave propagation in rural and suburban scenarios is often characterized by multipath propagation due to interactions (reflections, diffractions, scattering) at various obstacles (hills, buildings, towers).

For the multipath propagation model, such as the rural ray-tracing model, considering phenomena like multiple reflections and waveguiding effects in canyons is required to obtain accurate predictions of the signal level and the spatial channel impulse response.

However, this approach requires rural pixel databases for the description of topography, land usage, and buildings within the simulation environment.

4.4.1 Topography Database

A topographical database is a pixel database that contains surface elevation information as a function of position.

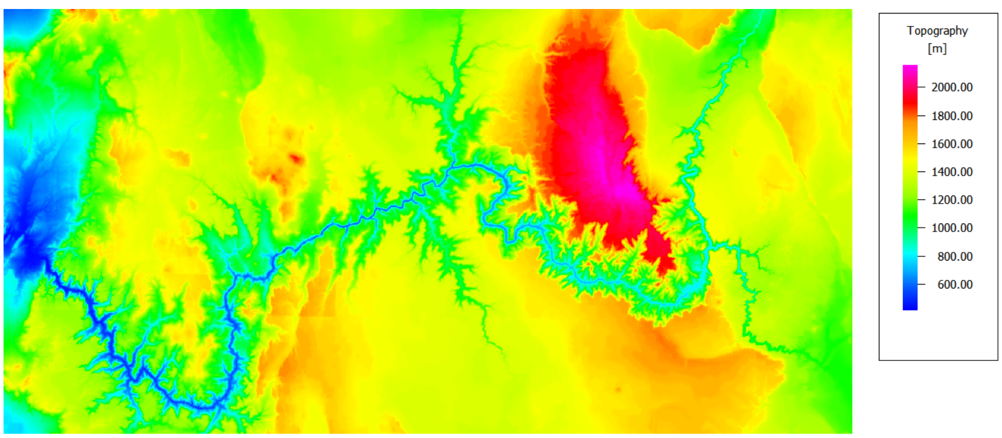


Figure 132: An example of a topographical database for the Grand Canyon.

Convert a third-party format to the WinProp data format by clicking **Data** > **Topography Database** > **Convert** in ProMan.

4.4.2 Clutter Database

A clutter database is a pixel matrix and contain information about and usage at a given location.

Land usage databases are also called clutter databases or morpho databases. Land usage influences the wave propagation in a rural or suburban scenario.

> **Note:** The use of clutter databases are optional and not mandatory for predictions.

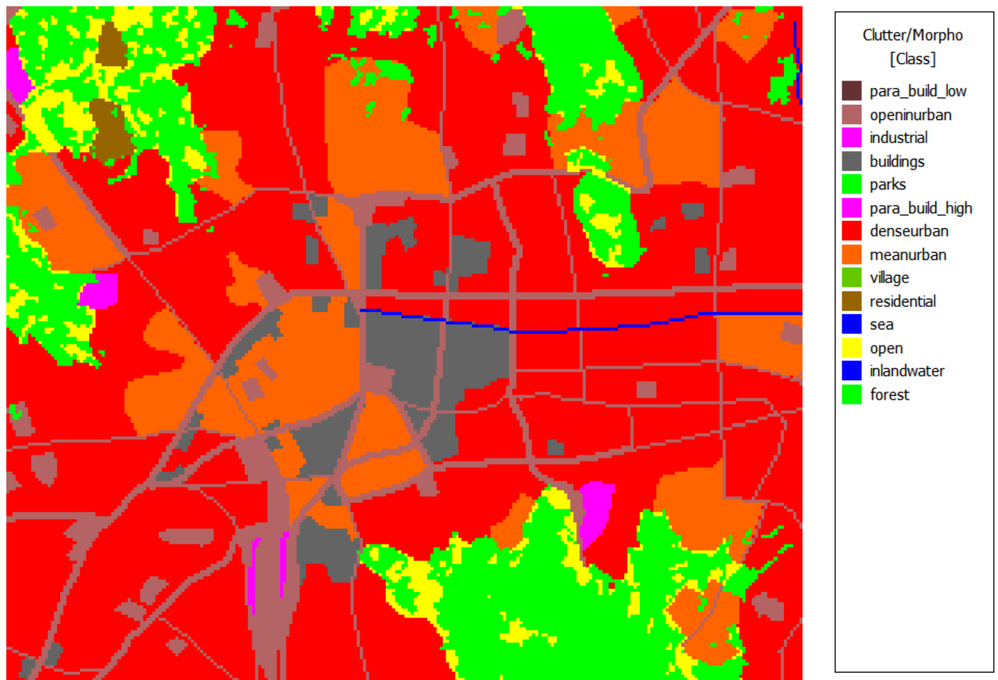


Figure 133: An example of a clutter database for Seoul.

Convert a third-party format to the WinProp data format by clicking **Data** > **Clutter (Morpho) Database** > **Convert**.

4.5 Setting Up the Simulation in ProMan

Set up the propagation simulation parameters. Solve the rural/suburban database and inspect the coverage plots for various models.

The rural/suburban database is solved using the following models:

- dominant path model (DPM)
- deterministic two ray model (DTR) with knife edge diffraction

4.5.1 Launching ProMan

Launch ProMan in Microsoft Windows using the Feko Launcher utility (which includes WinProp and newFASANT).

4.5.2 Creating a New Project

1. On the **File** menu, click **New Project**.
   The **New Project** dialog is displayed.
2. Under **Scenario**, from the drop-down list, select **Rural and Suburban Scenarios (Pixel databases for topo and clutter)**.
   a) Select the **Consider additionally land usage (clutter, morpho)** check box.
3. Under **Databases**, select the three database file:
   a) In the **Topography (Pixel Database)** field, browse to `HillyTerrain.tdb`[28].
   b) In the **Land usage / Clutter (Pixel database)** field, browse to `HillyTerrain.mdb`[29].
   c) In the **Land usage / Clutter (Class Definitions)** field, browse to `HillyTerrain.mct`[30].

> **Note:** Topography and clutter databases are supplied by external vendors and can be converted to WinProp file formats.

28. `Altair\2025.1\help\winprop\examples\GetStarted_models\Project4_Rural_Suburban_Scenario\Database\HillyTerrain.tdb`
29. `Altair\2025.1\help\winprop\examples\GetStarted_models\Project4_Rural_Suburban_Scenario\Database\HillyTerrain.mdb`
30. `Altair\2025.1\help\winprop\examples\GetStarted_models\Project4_Rural_Suburban_Scenario\Database\HillyTerrain.mct`

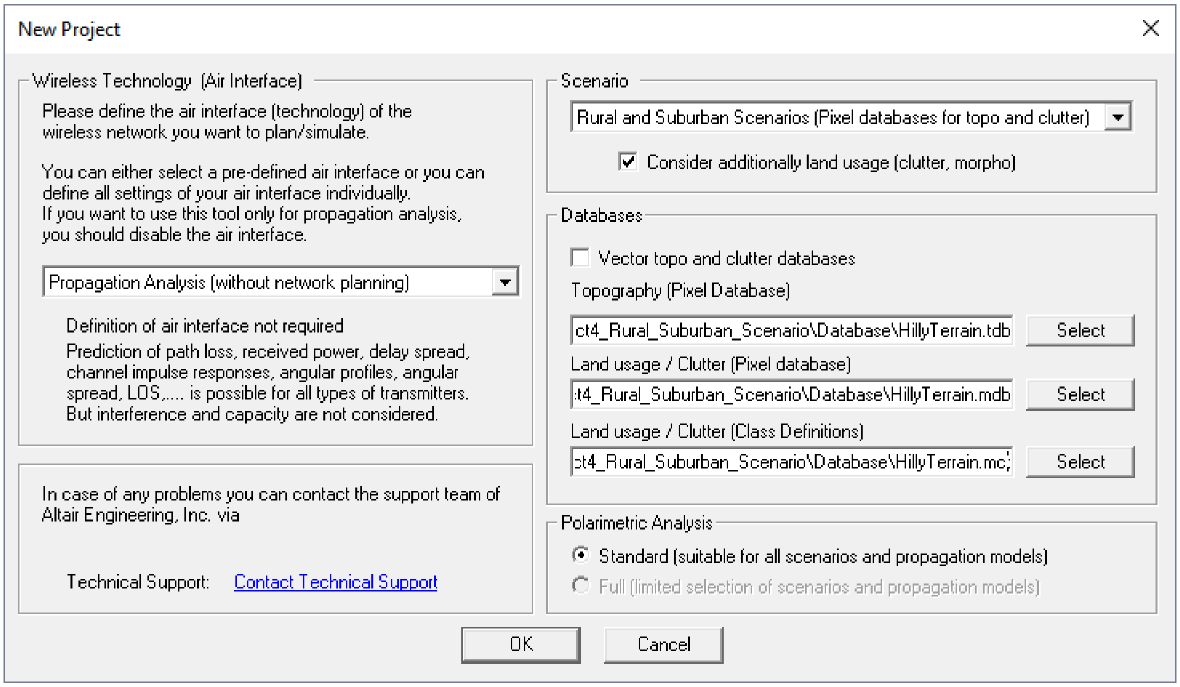


*Figure 134: The **New Project** dialog.*

4. Click **OK** to close the **New Project** dialog.
   A top view of the topography database is displayed.

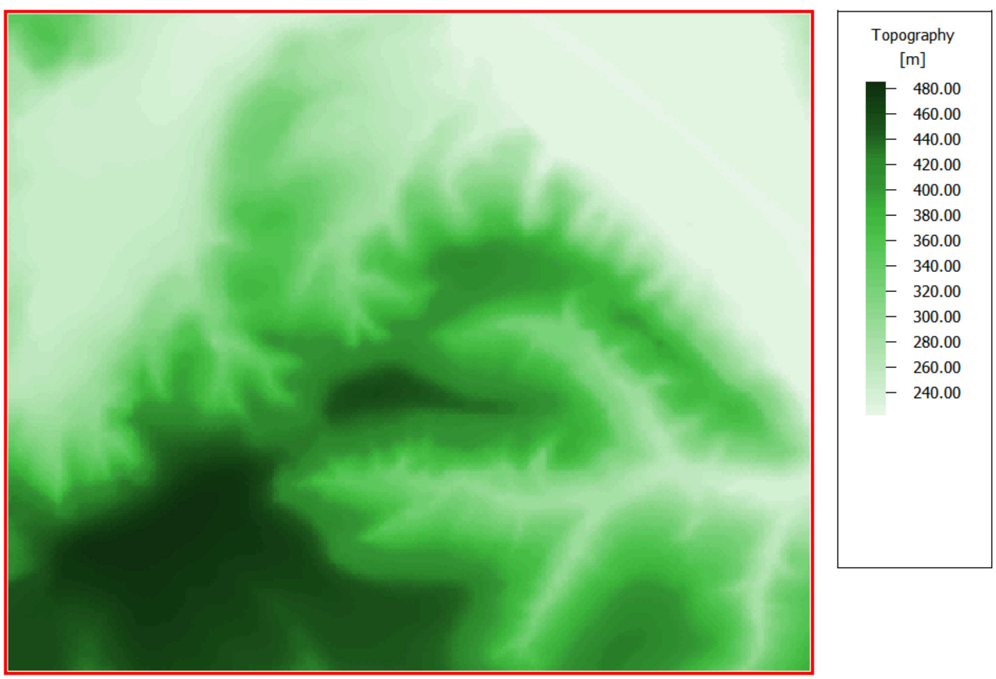


Figure 135: Top view of the topography database.

4.5.3 Viewing the Clutter Database

View the clutter database to obtain information regarding land usage.

1. In the tree, expand **Database** to view the imported databases.
2. In the tree, click **Clutter/Morpho** to view the land usage of the hilly terrain.

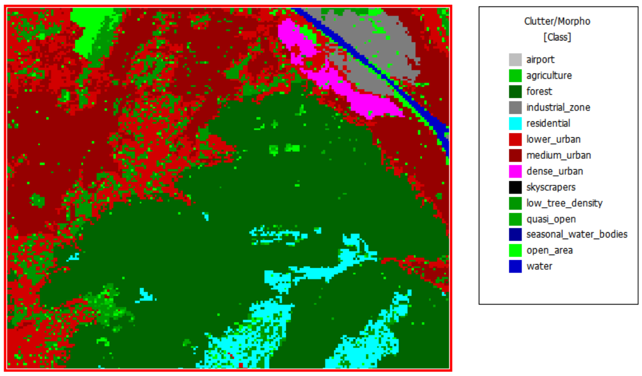


Figure 136: Top view of the clutter database.

> **Note:** The city center is located at the top right, indicated in pink.

3. Observe the land usage in Figure 136.
   - Upper left of database: medium-density urban and low-density urban
   - Upper right of database: city center and industrial zone
   - Center of database: Forested hills
4. View the topography database along with the clutter database.
   a) On the **Settings** menu, click **Local Settings (Display of data)**.
   b) Click the **Layout** tab.
   c) Select the **Topography database (DEM)** check box.

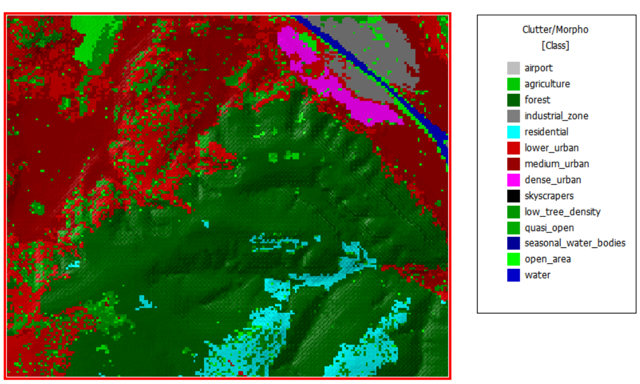


Figure 137: Top view of the clutter database along with the topography.

4.5.4 Defining the First Antenna Site and Antennas

Define the first cellular base station located on the highest hill. The antennas are placed 30 m above ground.

1. Specify the transmitter type and settings using one of the following workflows:
    - On the **Project** menu, click **Sites** > **Site: New**.
    - On the **Project** toolbar, click the **Set Site** icon.

    The **Transmitter Type** dialog is displayed.

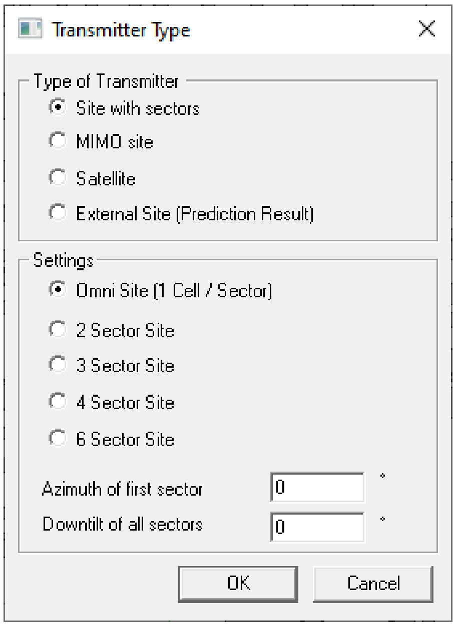
    

    *Figure 138: The **Transmitter Type** dialog.*

2. Under **Settings**, click **3 Sector Site**.
3. Click **OK** to close the **Transmitter Type** dialog.
In the 2D view, the mouse cursor is displayed as a circle to indicate that the **Set site** tool is enabled.
4. Place the cellular base station with a left-mouse click on the highest hill in the model, at or near (X, Y) = (513628, 5400187), as indicated in Figure 139.

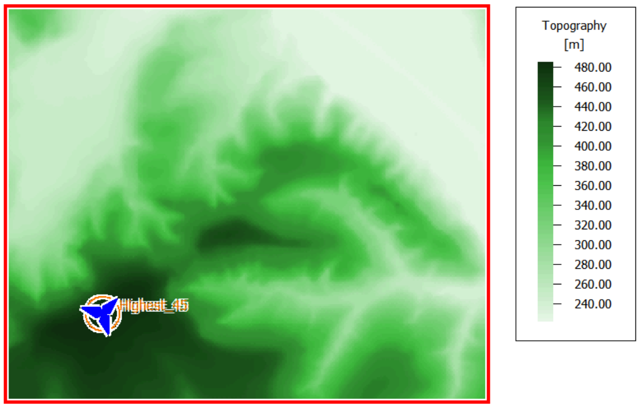


Figure 139: Location of the first cellular base station. The base station is located on the highest hill.

> **Note:** The exact coordinates are not important for this example, but the above location is used in the steps that follow.

The **Site** dialog is displayed.

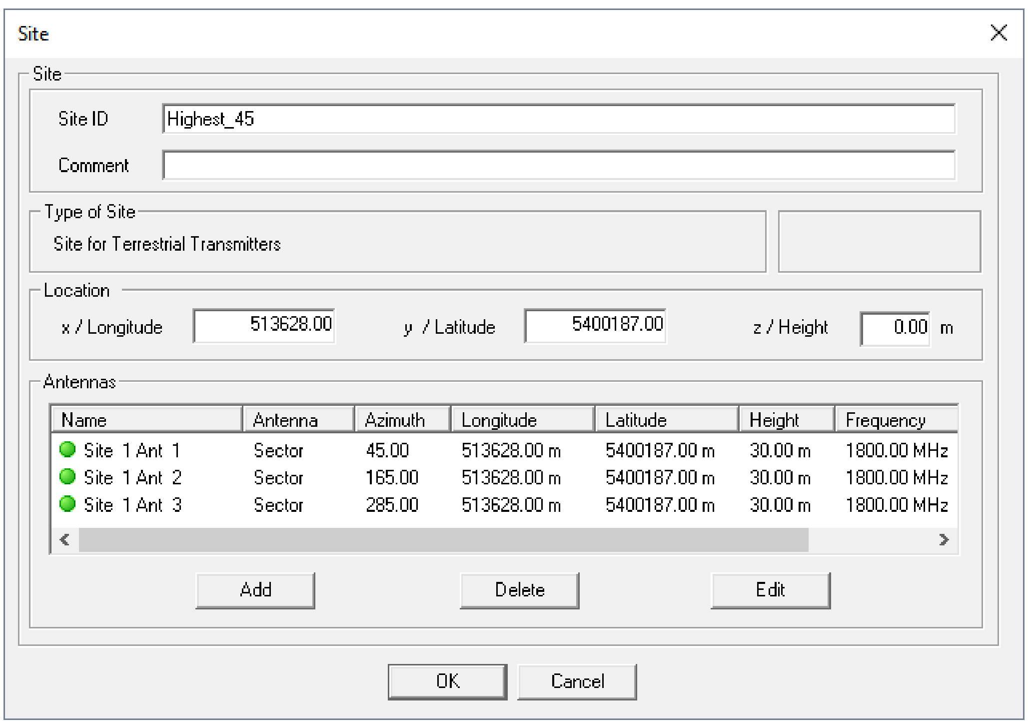


*Figure 140: The **Site** dialog.*

5. In the **Site ID** field, change the label to **Highest_45**.
6. Under **Location,** in the **z/Height** field, enter a value of `0` m.
7. Click on **Site 1 Antenna 1** to select and click **Edit**.
   The **Cell** dialog is displayed for antenna 1.

8. Under **Transmitter Settings**, in the **Frequency (used for propagation)** field, enter a value of `1800` MHz.
9. Under **Location of Antenna**, in the **z / Height** field, enter a value of `30` m.
10. Under **Antenna Pattern**, click **Directional / Sector antenna**.
11. Under **Orientation**, in the **Azimuth** field, enter a value of `45`°.
12. Under **Orientation**, in the **Downtilt** field, enter a value of `0`°.
13. Under **Antenna Pattern**, click **Select** to browse to the file `Sector.apb`[31].

> **Note:** `Sector.apb` is an antenna pattern created in AMan.

14. Click **OK** to close the **Cell** dialog.

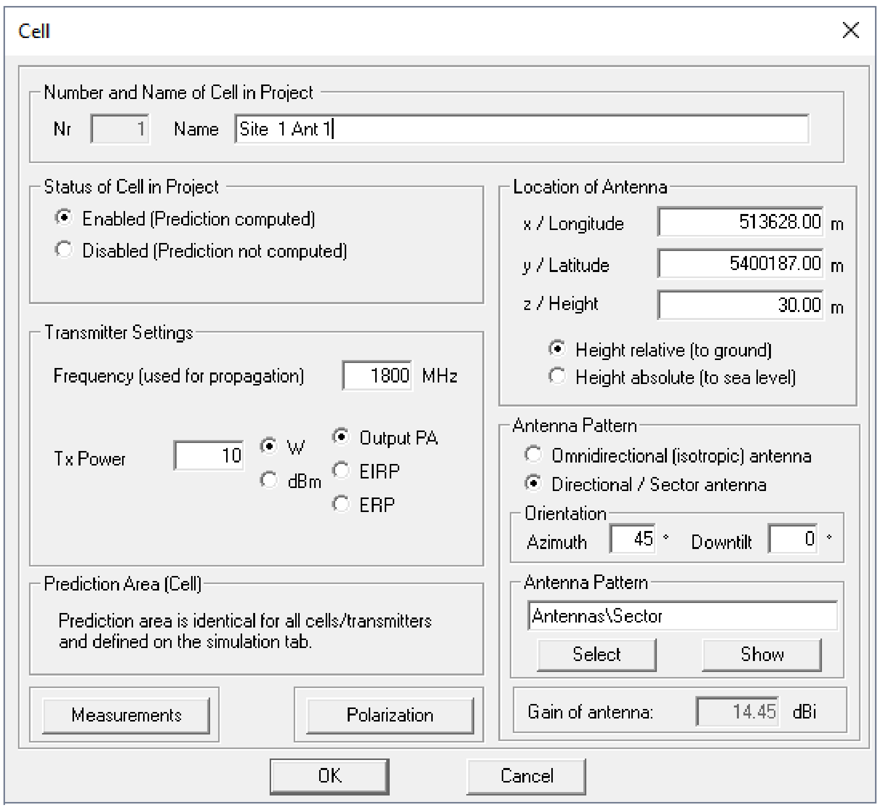


*Figure 141: The **Cell** dialog for antenna 1.*

15. Repeat Step 7 to Step 14 to define antenna 2.
    a) For the antenna orientation, change **Azimuth** to 165°.
16. Repeat Step 7 to Step 14 to define antenna 3.
    a) For the antenna orientation, change **Azimuth** to 285°.
17. Click **OK** to close the **Site** dialog.

31. `Altair\2025.1\help\winprop\examples\GetStarted_models\Project4_Rural_Suburban_Scenario\Antennas\Sector.apb`

18. Disable the **Set site** tool by clicking again on the **Set Site** icon.

4.5.5 Defining the Second Antenna Site and Antennas

Define the second cellular base station located on a lower hill. The antennas are placed 30 m above ground.

1. Specify the transmitter type and settings using one of the following workflows:
   - On the **Project** menu, click **Sites** > **Site: New**.
   - On the **Project** toolbar, click the **Set Site** icon.

   The **Transmitter Type** dialog is displayed.

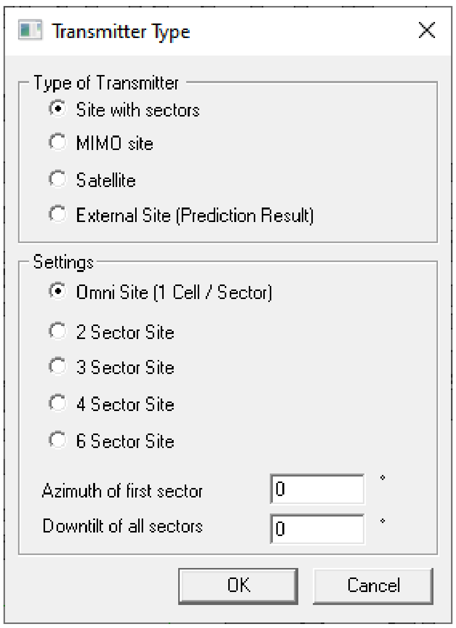


*Figure 142: The **Transmitter Type** dialog.*

2. Under **Settings**, click **3 Sector Site**.
3. Click **OK** to close the **Transmitter Type** dialog.
   In the 2D view, the mouse cursor is displayed as a circle to indicate that the **Set site** tool is enabled.
4. Place the cellular base station with a left-mouse click on a lower hill closer to town in the model, at or near (X, Y) = (516000, 5402142) as indicated in Figure 143.

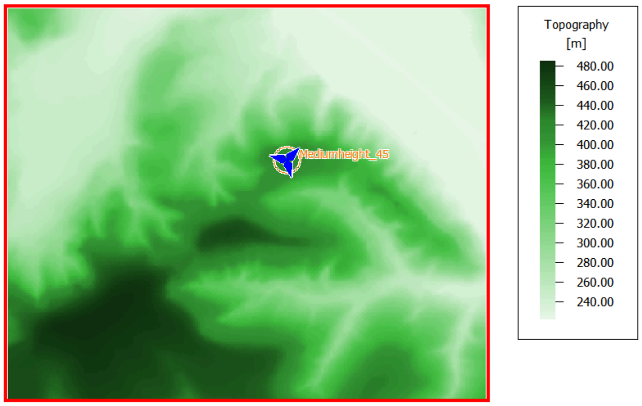


Figure 143: Location of the second cellular base station. The base station is placed on a lower hill.

> **Note:** The exact coordinates are not important for this example, but the above location is used in the steps that follow.

The **Site** dialog is displayed.

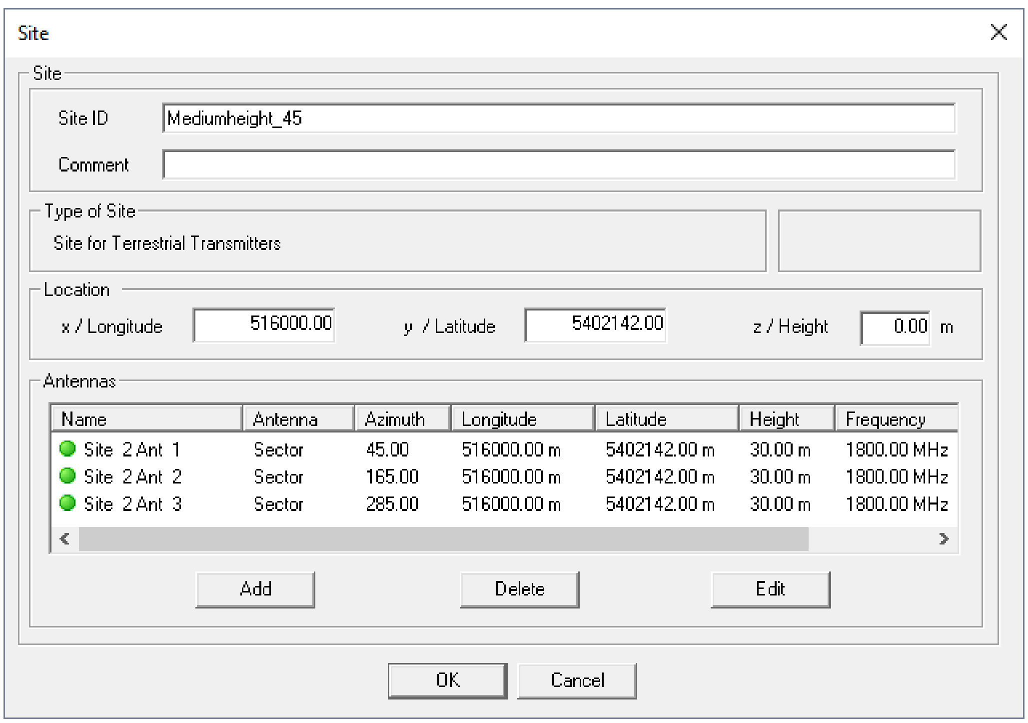


*Figure 144: The **Site** dialog.*

5. In the **Site ID** field, change the label to **Mediumheight_45**.
6. Under **Location,** in the **z/Height** field, enter a value of `0` m.
7. Click on **Site 2 Ant 1** to select and click **Edit**.
   The **Cell** dialog is displayed for antenna 1.

8. Under **Transmitter Settings**, in the **Frequency (used for propagation)** field, enter a value of `1800` MHz.
9. Under **Location of Antenna**, in the **z / Height** field, enter a value of `30` m.
10. Under **Antenna Pattern**, click **Directional / Sector antenna**.
11. Under **Orientation**, in the **Azimuth** field, enter a value of `45`°.
12. Under **Orientation**, in the **Downtilt** field, enter a value of `0`°.
13. Under **Antenna Pattern**, click **Select** to browse to the file `Sector.apb`[32].

> **Note:** `Sector.apb` is an antenna pattern created in AMan.

14. Click **OK** to close the **Cell** dialog.

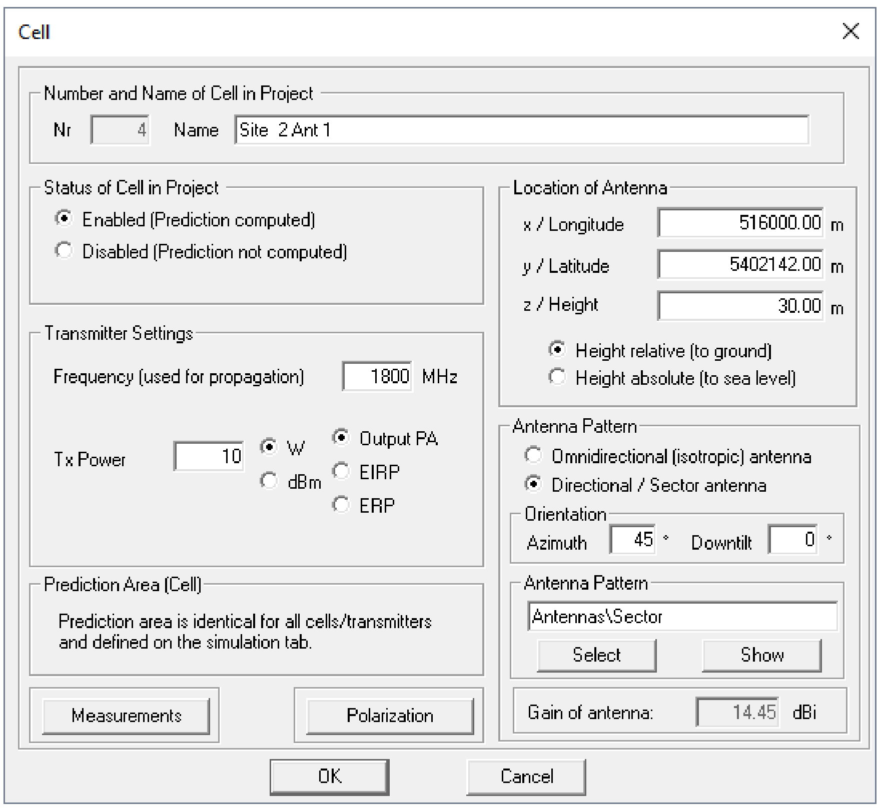


*Figure 145: The **Cell** dialog for antenna 1.*

15. Repeat Step 7 to Step 14 to define antenna 2.
    a) For the antenna orientation, change **Azimuth** to 165°.
16. Repeat Step 7 to Step 14 to define antenna 3.
    a) For the antenna orientation, change **Azimuth** to 285°.
17. Click **OK** to close the **Site** dialog.

32. `Altair\2025.1\help\winprop\examples\GetStarted_models\Project4_Rural_Suburban_Scenario\Antennas\Sector.apb`

18. Disable the **Set site** tool by clicking again on the **Set Site** icon.

4.5.6 Using the Dominant Path Model (DPM)

The rural/suburban database is solved using the dominant path model (DPM).

Specifying the Prediction Resolution and Height

Define the resolution grid and the height where the prediction results are to be calculated.

1. Launch the **Edit Project Parameters** dialog using one of the following workflows:
    - On the **Project** menu, click **Edit Project Parameters**.
    - On the **Project** toolbar, click the **Edit Project Parameters** icon.
    - Press F3 to use the keyboard shortcut.
2. Click the **Simulation** tab.
3. Under **Resolution of prediction results**, in the **Resolution** field, enter a value of `20` m.
   The prediction results will be computed with a resolution (grid) of 20 m.
4. Under **Prediction Height**, in the **Height** field, enter a value of `1.5` m.

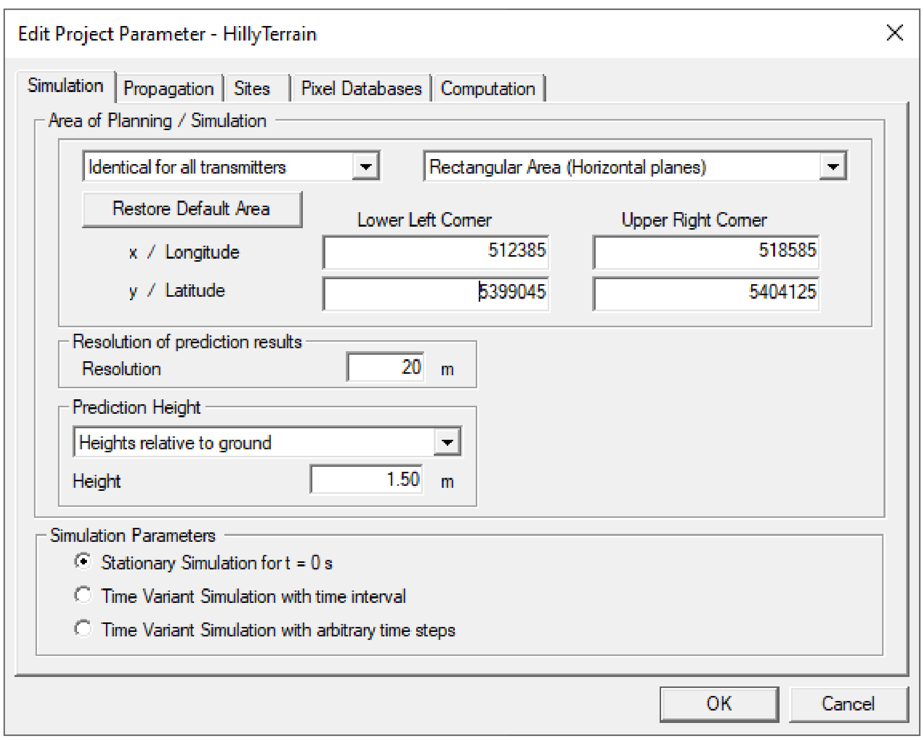


*Figure 146: The **Edit Project Parameters** dialog - **Simulation** tab.*

> **Note:** Keep the dialog open to define additional project parameters.

Specifying the Output Folder for the Prediction Results

Specify the folder for the prediction results to be computed using the DPM.

1. Click the **Propagation** tab.
2. Specify the output folder for the results to be computed using the dominant path model.
   a) Under **Output Directory / Basic Filename for Propagation Results**, in the **Directory** field, change the default `PropName` to `Results\Prop04_DPM`.

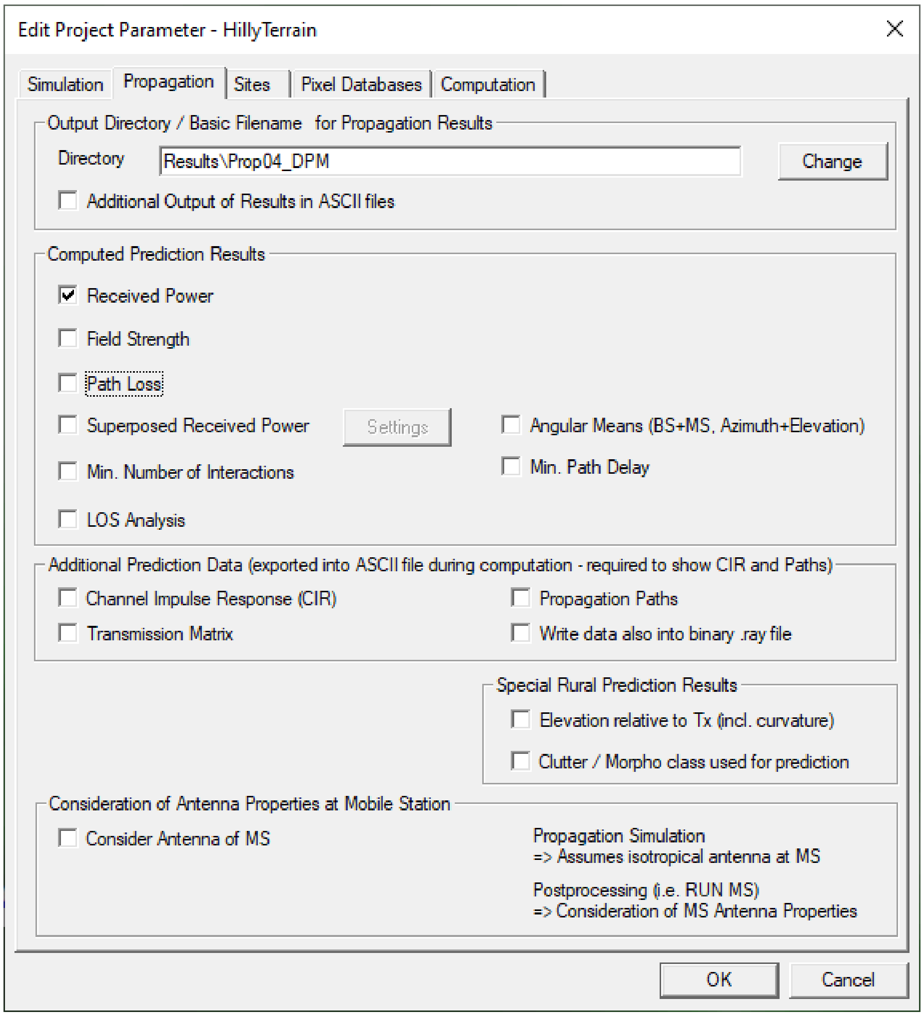


*Figure 147: The **Edit Project Parameters** dialog - **Propagation** tab.*

> **Note:** Keep the dialog open to define additional project parameters.

Defining the Prediction Results

Specify the predictions to be computed.

1. Under **Computed Prediction Results**, select the **Field strength** check box.
2. Under **Computed Prediction Results**, select the **Path Loss** check box.

Note: Keep the dialog open to define additional project parameters.

Specifying the Computation Method

Select the dominant path model (DPM) as computation method.

1. Click the **Computation** tab.
2. Under **Prediction model**, click **Dominant Path Model (DPM)**.

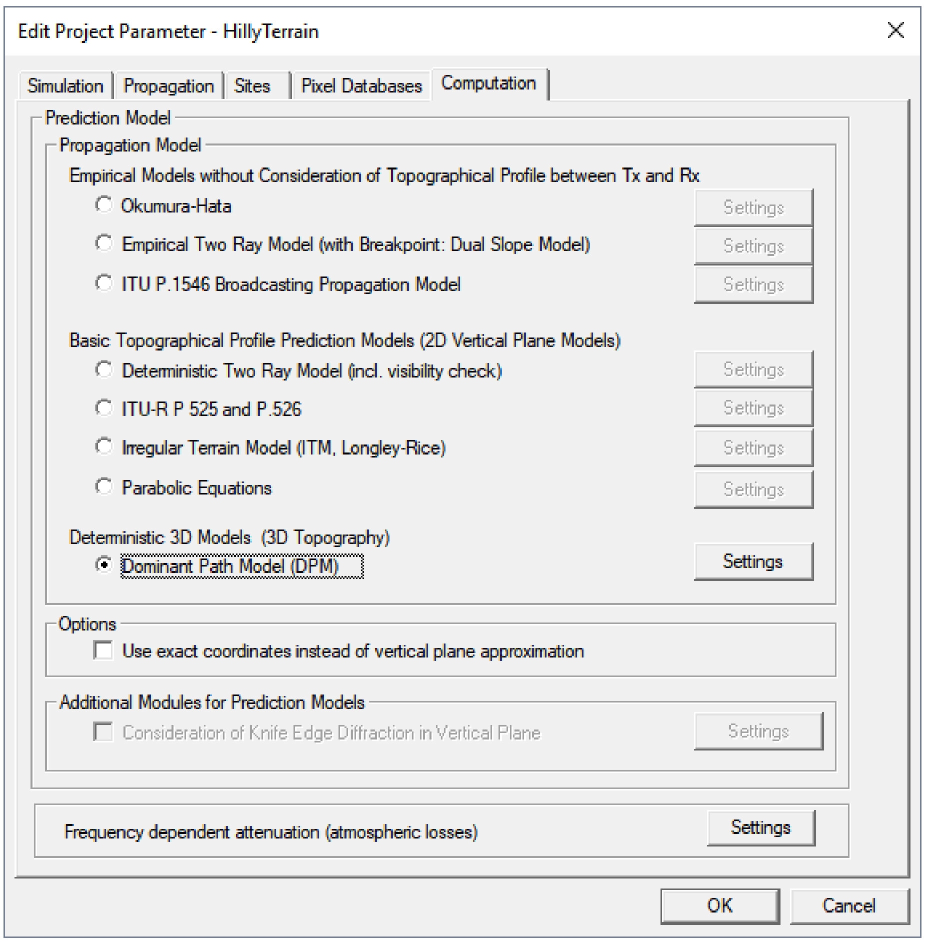


Figure 148: The ***Edit Project Parameters*** *dialog -* ***Computation*** *tab.*

3. Click **OK** to close the **Edit Project Parameter** dialog.

Saving the Project

Save the new project to file.

1. On the **File** menu, click **Save Project As**.
2. Enter `HillyTerrain.net` as the file name for the project and click **Save**.

Launching the Solver

Compute the propagation for all antennas to obtain the prediction results.

Launch the Solver using one of the following workflows:

- On the **Project** toolbar, click the **Computes propagation for all antennas** icon.
- On the **Computation** menu, click **Propagation: Compute All**.
- Press F5 to use the keyboard shortcut.

The Solver is launched, and the **Computation** dialog is displayed.

Viewing the Prediction Results

Display the power results using the dominant path model (DPM).

1. View the power using the DPM for the base station located on the highest hill.

a) In the tree, expand **Results: Propagation** to view the results for the two base stations.

b) In the tree, expand **Highest_45** to view the base station on the highest hill.

c) In the tree, expand **Site 1 Ant 1** to view the result entries.

d) In the tree, click **Power** to view the power result.

e) Right-click on the legend and from the right-click context menu, click **Thresholds** > **Manual**.

f) In the **Max** field, enter a value of `-30` dBm.

g) In the **Min** field. enter a value of `-120` dBm.

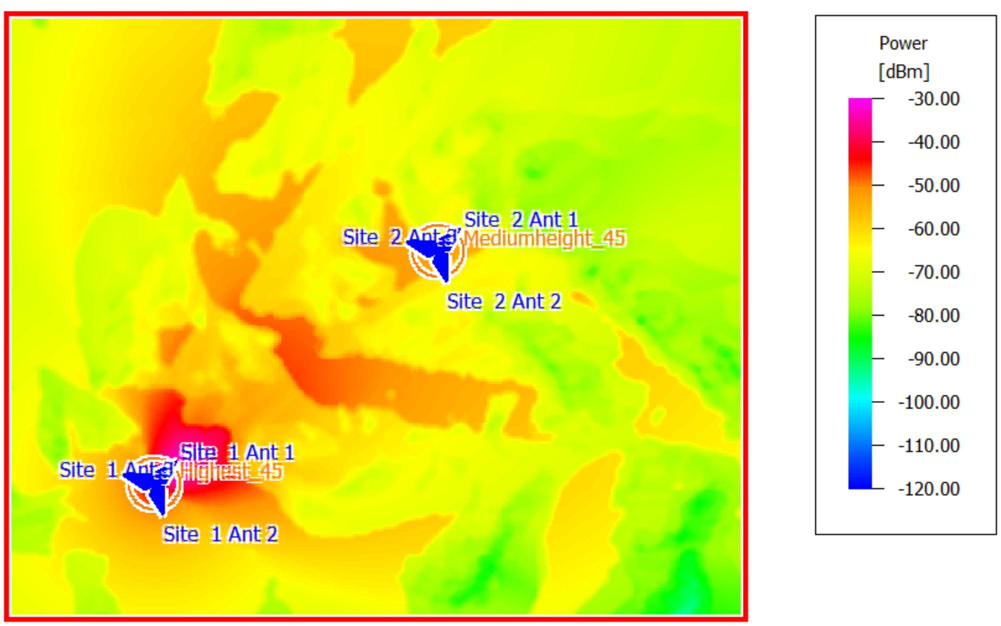


Figure 149: Power calculated for the base station located at the highest hill - Site 1 Ant 1 using the DPM.

Note that this antenna has broad coverage over a large area, but not towards the city center. It has no line of sight to the city center; a few lower hills are in the way.

2. View the power using the DPM for the base station located on a lower hill.
   a) In the tree, expand **Results: Propagation** to view the results for the two base stations.
   b) In the tree, expand **Mediumheight_45** to view the base station on the lower hill.
   c) In the tree, expand **Site 2 Ant 1** to view the result entries.
   d) In the tree, click **Power** to view the power result.

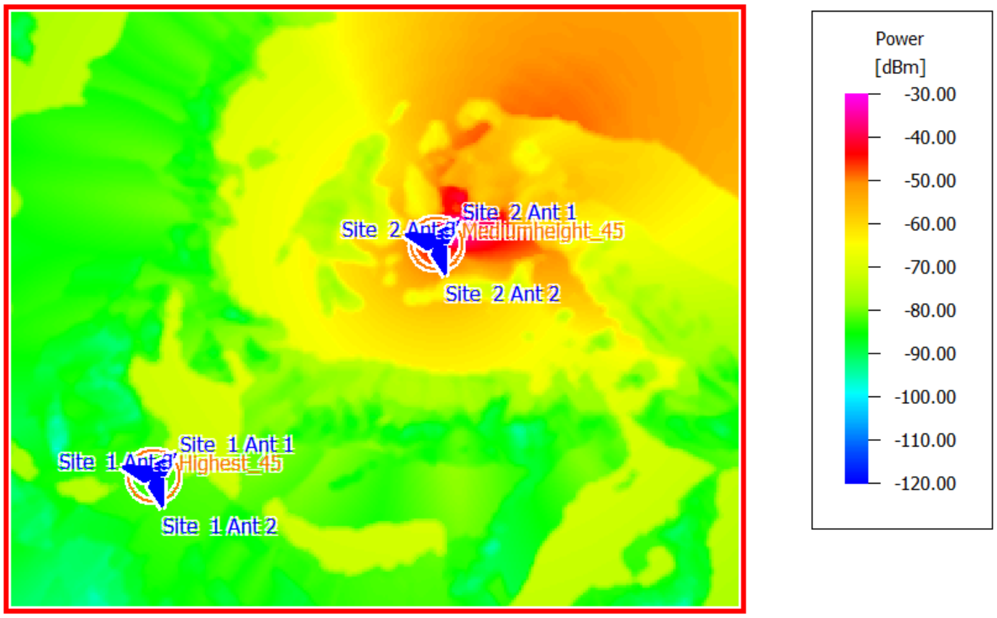


Figure 150: Power calculated for the base station located on a lower hill - Site 2 Ant 1 using the DPM.

Note that this antenna has great coverage of the city and poor coverage elsewhere.

4.5.7 Using the Deterministic Two Ray Model (DTR)

The rural/suburban database is solved using the deterministic two ray model (DTR).

Specifying the Output Folder for the Prediction Results

Specify the folder for the prediction results to be computed using the DTR.

1. Click the **Propagation** tab.
2. Specify the output folder for the results to be computed using the deterministic two ray model.
    a) Under **Output Directory / Basic Filename for Propagation Results**, in the **Directory** field, change the default `PropName` to `Results\Prop04_DTR`.

Specifying the Computation Method

Select the deterministic two ray model (DTR) as computation method.

1. Click the **Computation** tab.
2. Under **Prediction model**, click **Deterministic Two Ray Model (incl. visibility check)**.
3. Under **Additional Modules for Prediction Models**, select the **Consideration of Knife Edge Diffraction in Vertical Plane** check box.

    Note:

    The deterministic two ray model only predicts power for pixels that can be reached by the direct and/or ground-reflected ray.

    For pixels farther away, the knife edge diffraction method extends the results of the two-ray model by considering diffractions at hilltops and obstacles.

4. Click **OK** to close the **Edit Project Parameter** dialog.

Launching the Solver

Compute the propagation for all antennas to obtain the prediction results.

Launch the Solver using one of the following workflows:

- On the **Project** toolbar, click the RUN PRO **Computes propagation for all antennas** icon.
- On the **Computation** menu, click **Propagation: Compute All**.
- Press F5 to use the keyboard shortcut.

The Solver is launched, and the **Computation** dialog is displayed.

Viewing the Prediction Results

Display the power results using the deterministic two ray model (DTR).

1. View the power using the DTR for the base station located on the highest hill.
   a) In the tree, expand **Results: Propagation** to view the results for the two base stations.
   b) In the tree, expand **Highest_45** to view the base station on the highest hill.
   c) In the tree, expand **Site 1 Ant 1** to view the result entries.
   d) In the tree, click **Power** to view the power result.

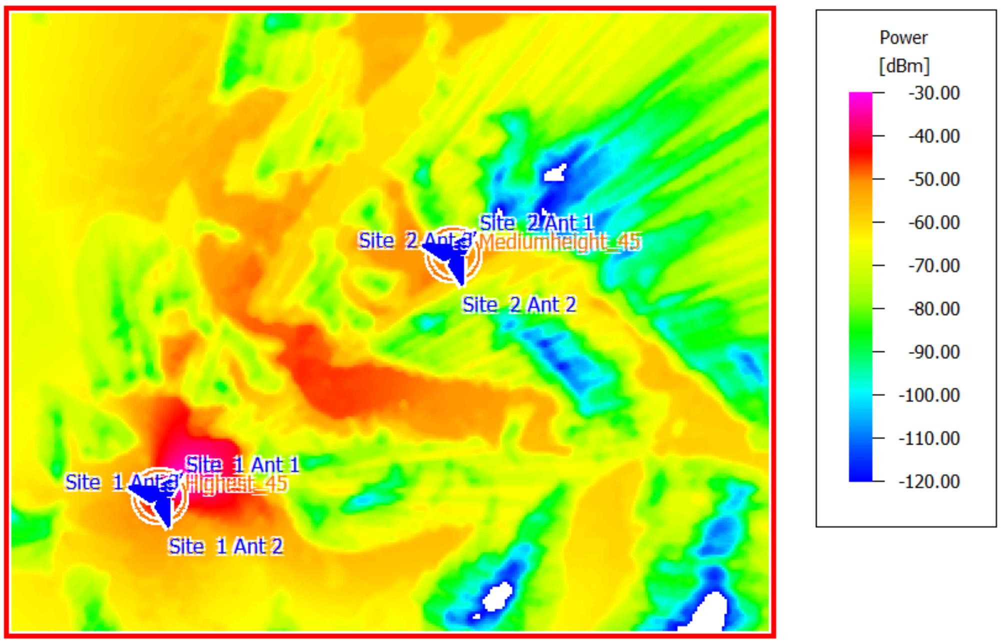


Figure 151: Power calculated for the base station located at the highest hill - Site 1 Ant 1 using the DTR.

2. View the power using the DTR for the base station located on a lower hill.
   a) In the tree, expand **Results: Propagation** to view the results for the two base stations.
   b) In the tree, expand **Mediumheight_45** to view the base station on the lower hill.
   c) In the tree, expand **Site 2 Ant 1** to view the result entries.
   d) In the tree, click **Power** to view the power result.

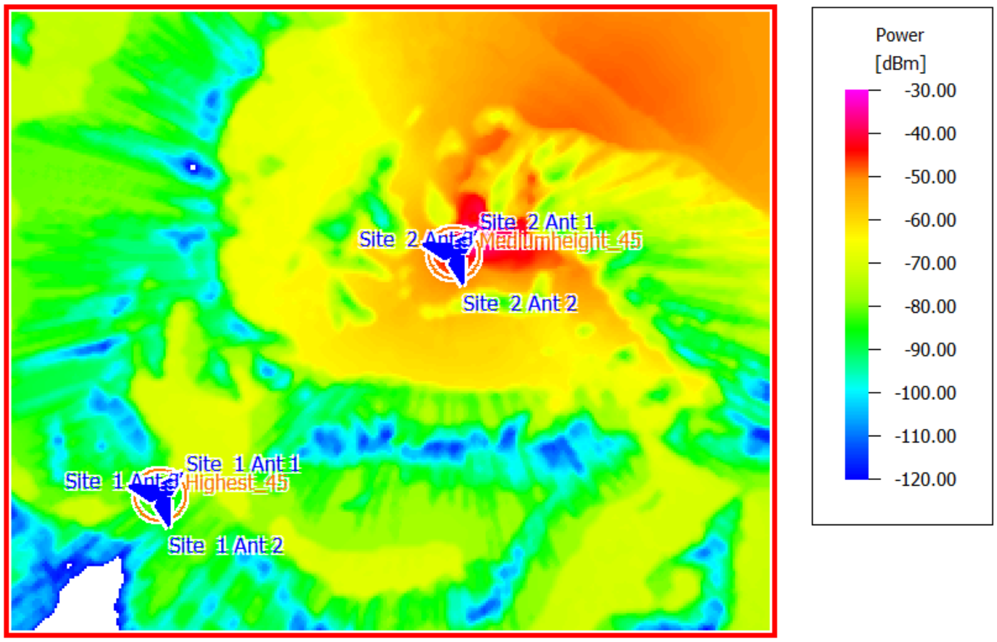


Figure 152: Power calculated for the base station located on a lower hill - Site 2 Ant 1 using the DTR.

The DTR model only provides line-of-sight predictions. If the rays are shadowed by obstacles, the rays are not considered. The received power is only predicted for pixels which can be reached by the direct ray and/or the ground reflected ray. To get a prediction for the non-line-of-sight pixels, the DTR must be combined with the knife edge diffraction model to include the diffractions at the topographical obstacles.

The white pixels in the results indicate results below -120 dBm as the legend threshold range was specified from -30 dBm to -120 dBm.

4.6 Final Remarks

This example showed how to analyze two cellular base stations set in a rural/suburban scenario with hilly terrain and to obtain coverage plots using ProMan.

Many concepts were introduced in this example that apply to models commonly created in ProMan. The two cellular base stations in a hilly terrain were solved using two different models. The dominant path model (DPM) is the best choice for rural/suburban scenario with hilly or mountainous terrain.

Network Planning

5

This example considers the application of analyzing three base stations, set in a building. The network planning simulation is based on a pre-defined air interface file.

This chapter covers the following:

5.1 Example Overview

This example considers a network planning simulation in ProMan.

> **Note:**
>
> A network-planning simulation starts with regular propagation simulation that provides results like received power over the area of interest.
>
> As a second step, a network planning simulation is launched that adds results like Signal-to-Noise and Interference ratio (SNIR), cell assignment, and maximum data rate. Network planning can be regarded as the post-processing of a propagation simulation.

For this example, three base station sites are defined in an indoor scenario. For each site, an isotropic antenna is placed and the carriers are defined.

Coverage plots are produced using a propagation simulation to determine the cell phone reception inside a building. The propagation model used to solve the database is the dominant path model (DPM).

A network planning simulation is launched that uses the propagation results to provide the best cell assignment and interference levels.

5.2 Topics Discussed in Example

Before starting this example, check if the topics discussed in this example are relevant to the intended application and experience level.

The topics discussed in this example are:

- ProMan
  - Launch ProMan.
  - Specify a predefined air interface file (`.wst`)[33].
  - Specify the antenna sites, powers, and carriers of the three base stations.
  - Specify the simulation parameters.
  - Specify the computation method.
  - Save the project.
  - Launch the Solver (propagation simulation).
  - Launch the Solver (network simulation).
  - View the prediction results (for example, Signal-to-Noise and Interference Ratio (SNIR))

Note: Follow the example steps in the order they are presented as each step uses its predecessor as a starting point.

Tip: Find the completed model in the Altair installation directory, for example:

`Altair\2025.1\help\winprop\examples\GetStarted_models\Project5_Network_Planning`.

33. Available for most of the common wireless technologies.

5.3 Example Prerequisites

Before starting this example, ensure that the system satisfies the minimum requirements.

The requirements for this example are:

- Feko 2025.1[34] or later should be installed.

34. WinProp is included as part of the Feko installation.

5.4 Predefined Air Interface File (.WST)

Network parameters can be loaded from a predefined `.wst` file which is available for most of the common wireless technologies.

For network planning, the air interface (for example, CDMA, OFDM), requires parameters to be defined related to the carriers (number, bandwidth, separation), transmission modes, coding, and the required signal-to-noise-and-interference ratio at the receiver. This information may be loaded from a `.wst` file[35].

> **Tip:** Find a list of predefined `.wst` files in the Altair installation directory, for example:
>
> `Altair\2025.1\help\winprop\examples\ExampleGuide_models\Example-A07-Air_Interfaces_aka_Wireless_Standards.zip`.

35. Alternatively, you can define the individual air interface manually (only recommended for experienced users).

5.5 Setting Up the Simulation in ProMan

Define the three base station sites, antennas and carriers.

The indoor database is solved using the dominant path model (DPM).

5.5.1 Launching ProMan

Launch ProMan in Microsoft Windows using the Feko Launcher utility (which includes WinProp and newFASANT).

5.5.2 Creating a New Project

1. On the **File** menu, click **New Project**.
   The **New Project** dialog is displayed.

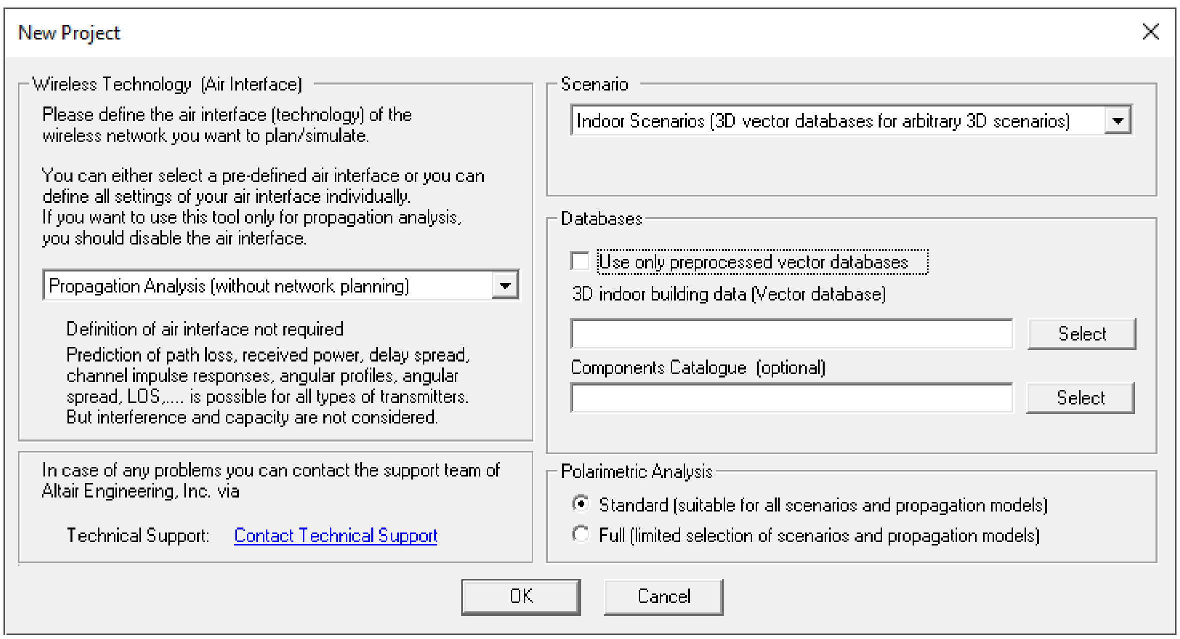
   

   *Figure 153: The **New Project** dialog.*

2. Under **Wireless Technology (Air Interface)**, from the drop-down list, select **Network Planning based on description file for air interface** and browse to `LTE_Band1_BW_05MHz_FDD.wst`[36].
3. Under **Scenario**, from the drop-down list, select **Indoor Scenarios (3D vector databases for arbitrary 3D scenarios)**.

36. `Altair\2025.1\help\winprop\examples\GetStarted_models\Project5_Network_Planning\LTE_Band1_BW_05MHz_FDD.wst`

4. Under **Databases**, in the **3D indoor building data (Vector database)** field, browse to `Office.idb`[37].
5. Under **Polarimetric Analysis**, select **Standard (suitable for all scenarios and propagation models)**.
6. Click **OK** to close the **New Project** dialog.
   The **Define Display Height** dialog is displayed.

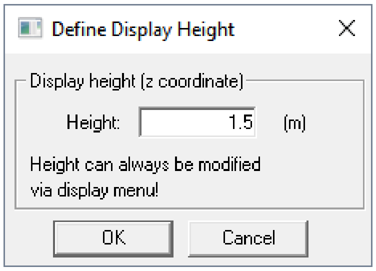


*Figure 154: The **Define display Height** dialog.*

7. In the **Height** field, use the default value of `1.5` m.

   > **Note:** This value is used only to specify the display height. This value has no impact on the height at which the prediction results are calculated.

8. Click **OK** to close the **Define Display Height** dialog.

5.5.3 Saving the Project

Save the new project to file.

1. On the **File** menu, click **Save Project**.
2. Save the new project as `office.net`.
   Two files are written to disk:
   - `office.net`
   - `office.nip`

   > **Note:**
   > To share a network planning project, you require a `.net` file and one of the following:
   > - `.nip` (indoor scenario)
   > - `.nup` (urban scenario)
   > - `.nrp` (rural scenario)

37. `Altair\2025.1\help\winprop\examples\GetStarted_models\Project5_Network_Planning\Office.idb`

5.5.4 Defining the First Base Station

Define the first site, place the first omnidirectional antenna at this location, and assign a carrier. The antenna is placed at a height of 2.5 m above ground.

The first antenna is placed at the intersection of the corridors (top, left) at a height of 2.5 m, see Figure 155. A carrier is assigned to the antenna.

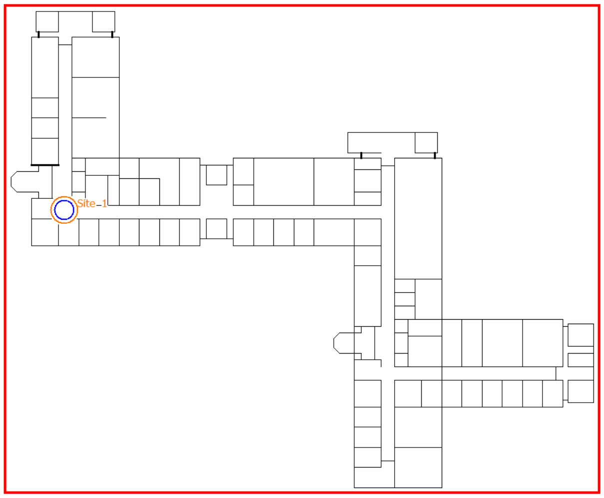


Figure 155: Location of the first antenna site.

1. Specify the transmitter type and settings using one of the following workflows:
   - On the **Project** menu, click **Sites** > **Site: New**.
   - On the **Project** toolbar, click the **Set Site** icon.

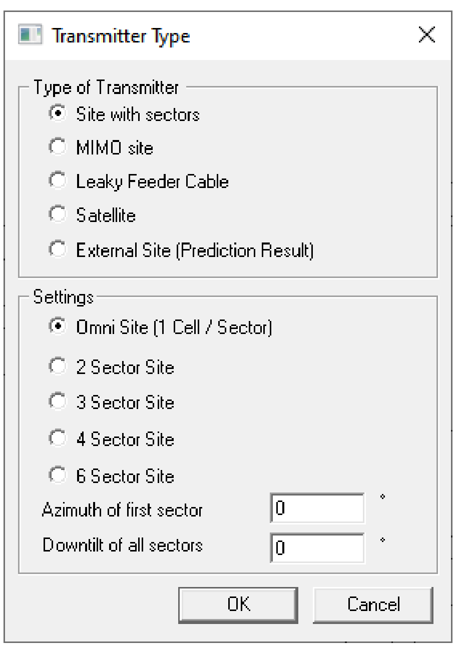


*Figure 156: The **Transmitter Type** dialog.*

2. Use the default settings.

> **Note:** Use **Omni Site (1 Cell/Sector)** as only a single antenna is defined per site. This option does not imply an omnidirectional antenna.

3. Click **OK** to close the **Transmitter Type** dialog.
   In the 2D view, the mouse cursor is displayed as a circle to indicate that the **Set site** tool is enabled.
4. Click near point (X, Y) = (5.84, 6.35) in the 2D view to place the site.

> **Tip:** The coordinates at the current mouse cursor are displayed in the Status bar.

The **Site** dialog is displayed.

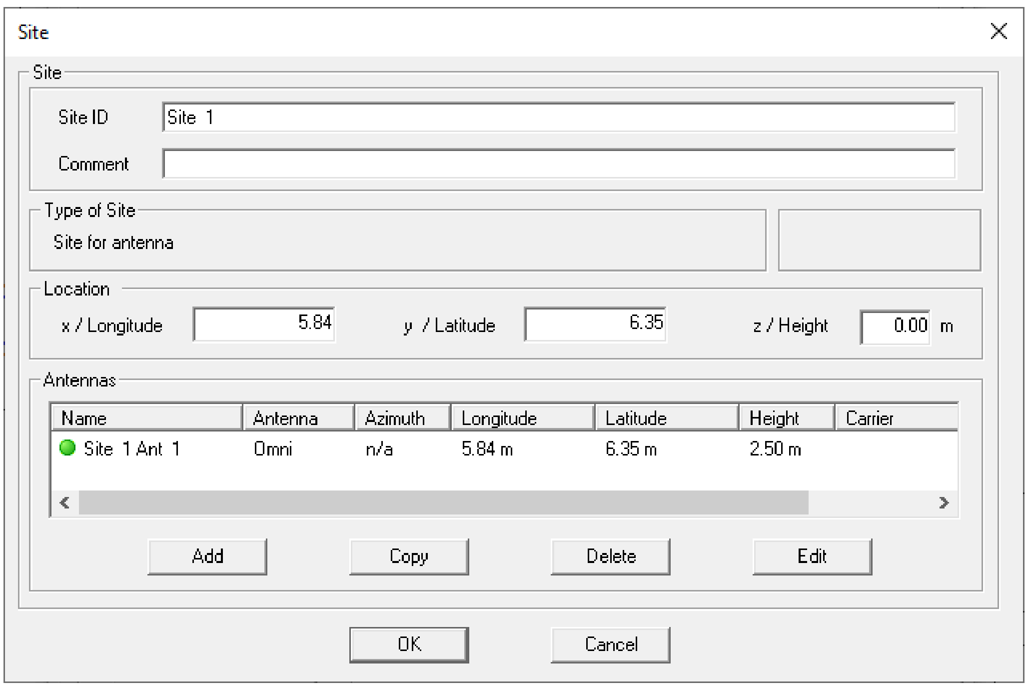


*Figure 157: The **Site** dialog.*

5. On the **Site** dialog, click on **Site 1 Ant 1** to select and click **Edit**.
   The **Cell** dialog is displayed.

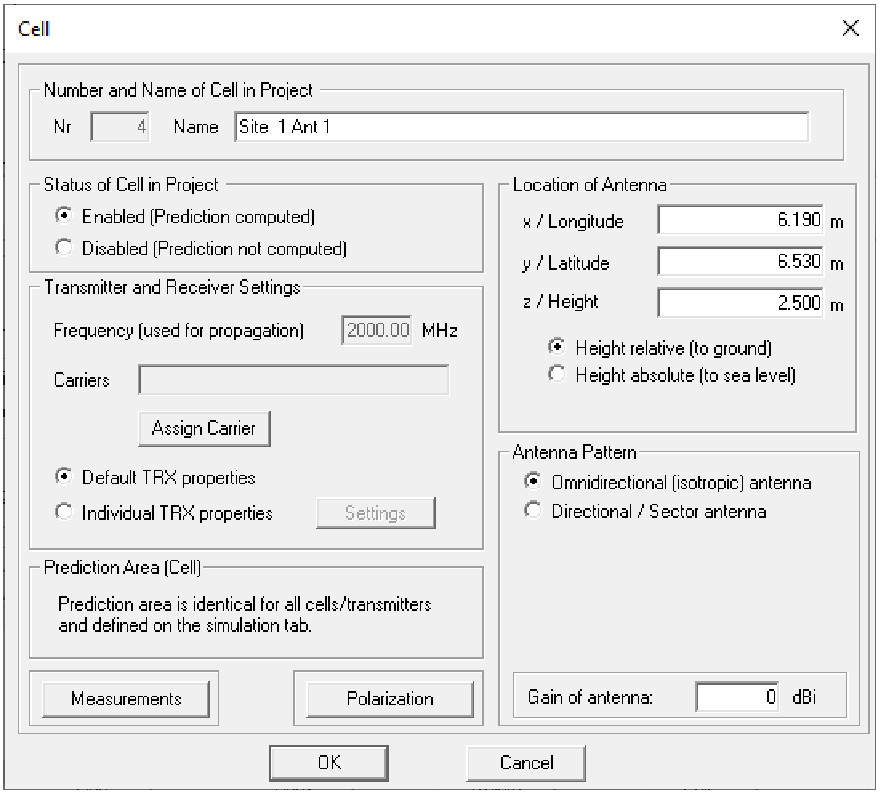


Figure 158: The ***Cell*** *dialog.*

6. Under **Antenna Pattern**, confirm that **Omnidirectional (isotropic) antenna** is selected.
7. Under **Transmitter and Receiver Settings**, click **Assign Carrier**.
   The **Carrier Assignment** dialog is displayed.

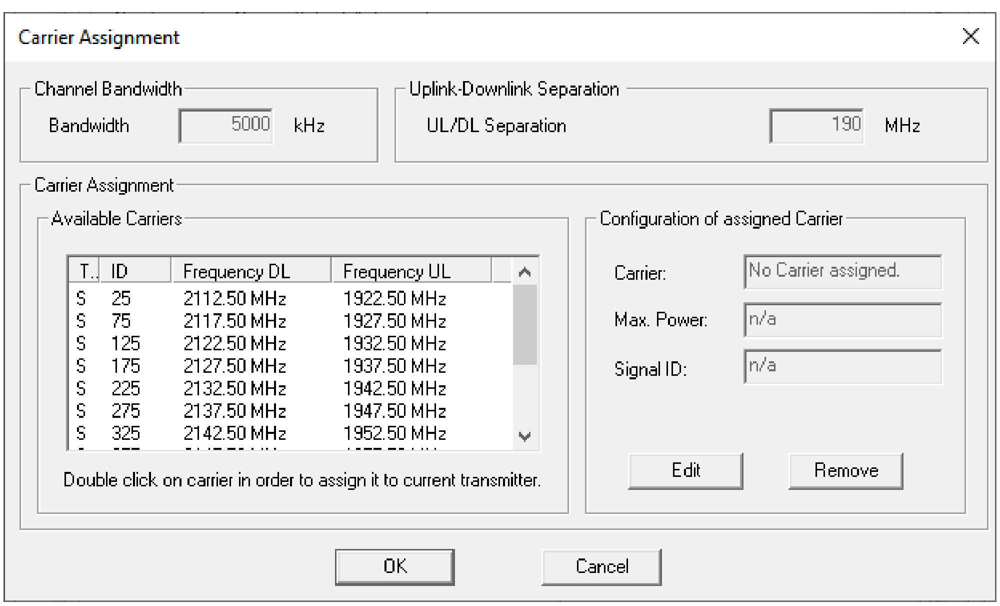


Figure 159: The ***Carrier Assignment*** *dialog.*

8. Under **Available Carriers**, double-click on a carrier to select.

> **Note:** For this site, *ID 25* was selected as carrier.

The **Carrier** dialog is displayed.

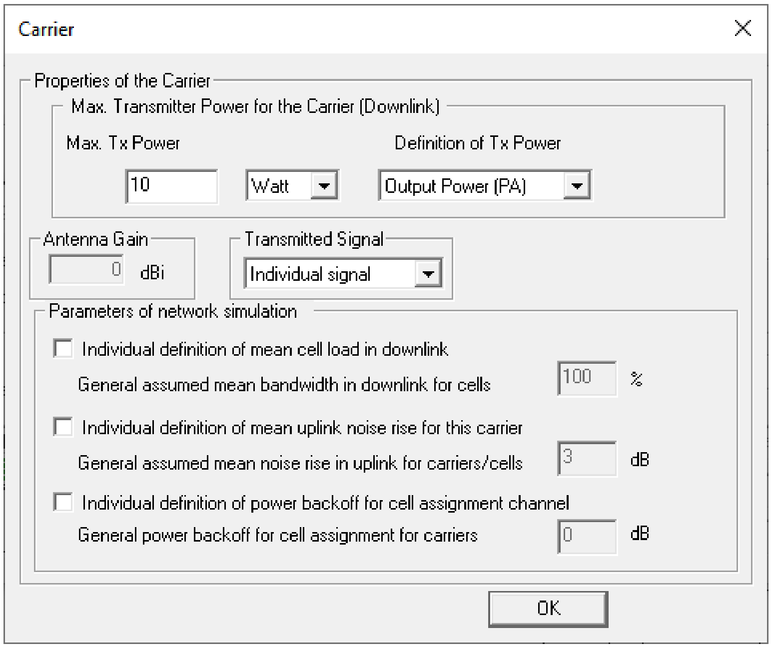


*Figure 160: The **Carrier** dialog.*

9. Under **Properties of the Carrier**, set **Max. TX Power** to 10 dBm.

10. Click **OK** to close the **Carrier** dialog.

11. Click **OK** to close the **Carrier Assignment** dialog.

12. Click **OK** to close the **Cell** dialog.

13. Click **OK** to close the **Site** dialog.

14. Disable the **Set site** tool by clicking again on the **Set Site** icon.

5.5.5 Defining the Second Base Station

Define the second site, place the second omnidirectional antenna at this location, and assign a carrier. The antenna is placed at a height of 2.5 m above ground.

The second antenna is placed at the intersection of the corridors (bottom, right) at a height of 2.5 m, see Figure 161. Use the same carrier for antenna 2 as was defined for antenna 1.

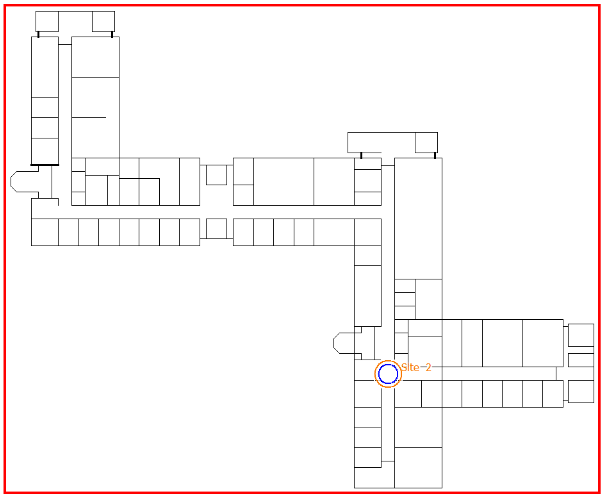


Figure 161: Location of the second antenna site.

1. Specify the transmitter type and settings using one of the following workflows:
    - On the **Project** menu, click **Sites** > **Site: New**.
    - On the **Project** toolbar, click the **Set Site** icon.

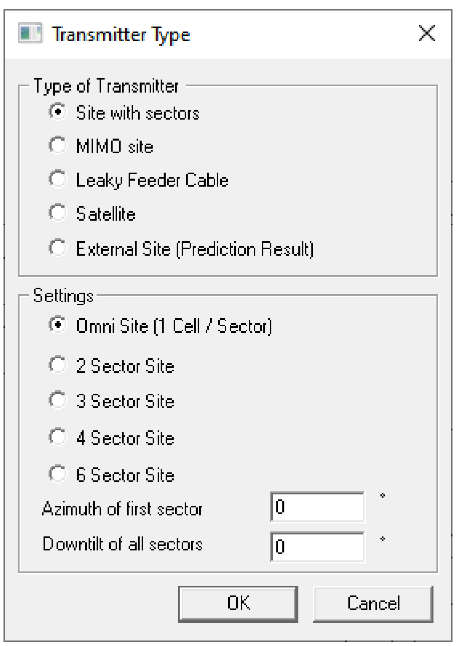


*Figure 162: The **Transmitter Type** dialog.*

2. Use the default settings.

> **Note:** Use **Omni Site (1 Cell/Sector)** as only a single antenna is defined per site. This option does not imply an omnidirectional antenna.

3. Click **OK** to close the **Transmitter Type** dialog.

In the 2D view, the mouse cursor is displayed as a circle to indicate that the **Set site** tool is enabled.

4. Click near point (X, Y) = (63.6700, -22.8800) in the 2D view to place the site.

> **Tip:** The coordinates at the current mouse cursor are displayed in the Status bar.

The **Site** dialog is displayed.

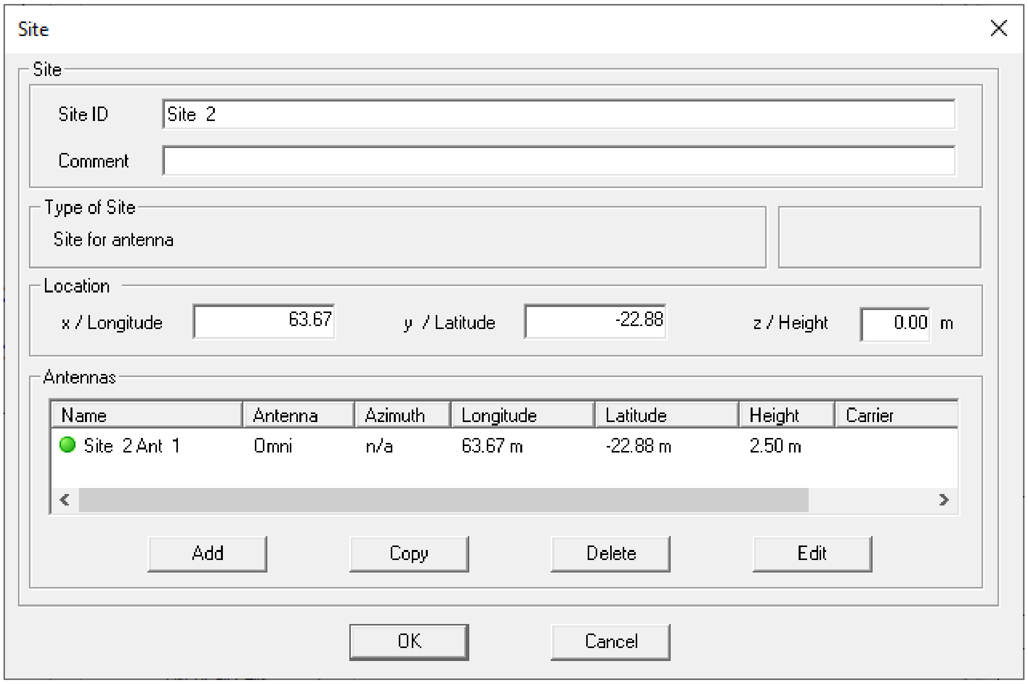


*Figure 163: The **Site** dialog.*

5. On the **Site** dialog, click on **Site 2 Ant 1** to select and click **Edit**.
   The **Cell** dialog is displayed.

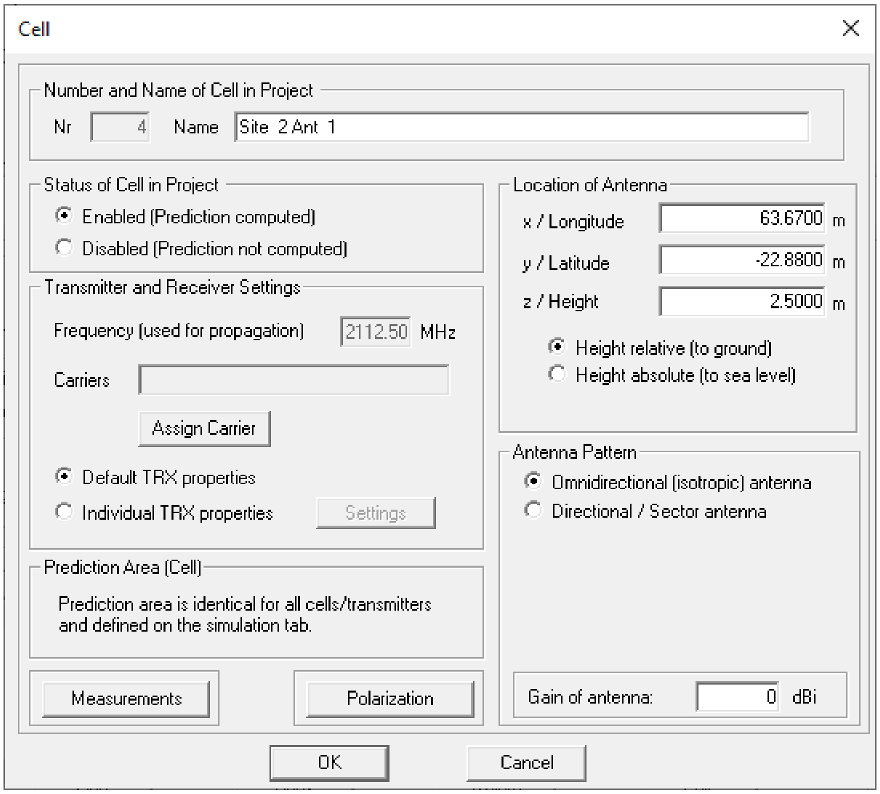


Figure 164: The ***Cell*** *dialog.*

6. Repeat Step 6 to Step 14 to specify the antenna and its carrier.

> **Note:** In this example, the same carrier is assigned to base station 2 as was assigned to base station 1.

5.5.6 Defining the Third Base Station

Define the third site, place the third omnidirectional antenna at this location, and assign a carrier. The antenna is placed at a height of 2.5 m above ground.

The third antenna is placed at the intersection of the corridors (center, right) at a height of 2.5 m, see Figure 165. A carrier is assigned to the antenna.

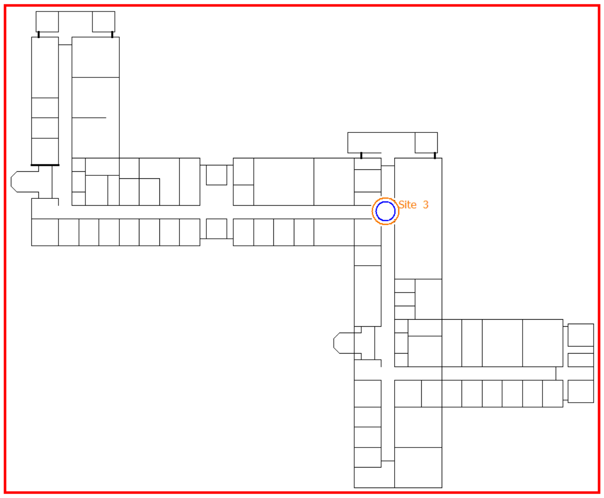


Figure 165: Location of the third antenna site.

1. Specify the transmitter type and settings using one of the following workflows:
   - On the **Project** menu, click **Sites** > **Site: New**.
   - On the **Project** toolbar, click the **Set Site** icon.

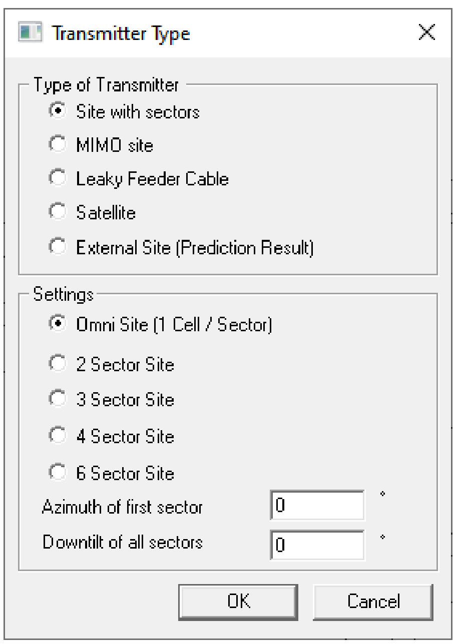


*Figure 166: The **Transmitter Type** dialog.*

2. On the **Transmitter Type** dialog, use the default settings.

   > **Note:** Use **Omni Site (1 Cell/Sector)** as only a single antenna is defined per site. This option does not imply an omnidirectional antenna.

3. Click **OK** to close the **Transmitter Type** dialog.

In the 2D view, the mouse cursor is displayed as a circle to indicate that the **Set site** tool is enabled.

4. Click near point (X, Y) = (63.1400, 6.1400) in the 2D view to place the site.

> **Tip:** The coordinates at the current mouse cursor are displayed in the Status bar.

The **Site** dialog is displayed.

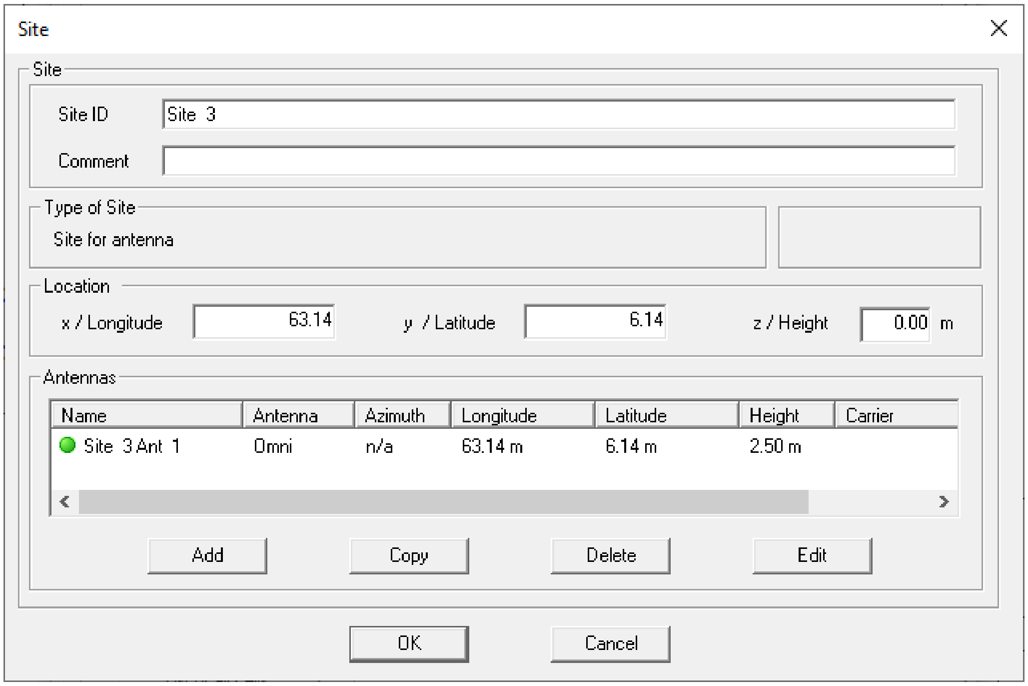


*Figure 167: The **Site** dialog.*

5. On the **Site** dialog, click on **Site 3 Ant 1** to select and click **Edit**.
The **Cell** dialog is displayed.

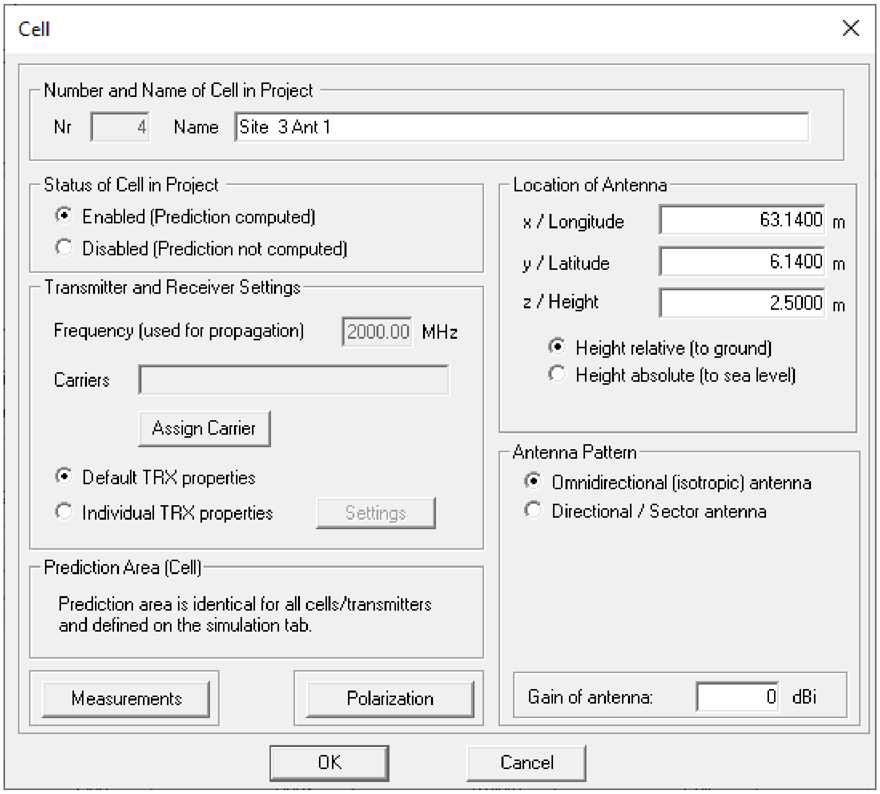


*Figure 168: The **Cell** dialog.*

6. Under **Antenna Pattern**, confirm that **Omnidirectional (isotropic) antenna** is selected.
7. Under **Transmitter and Receiver Settings**, click **Assign Carrier**.
   The **Carrier Assignment** dialog is displayed.

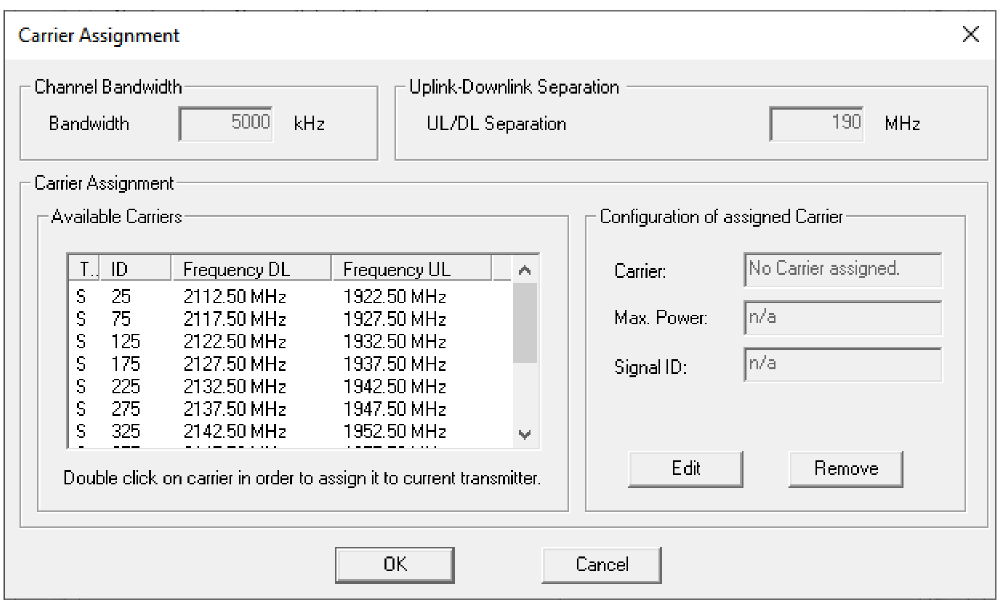


*Figure 169: The **Carrier Assignment** dialog.*

8. Under **Available Carriers**, double-click on a carrier to select.

> **Note:** For this site, *ID 75* was selected as carrier.

The **Carrier** dialog is displayed.

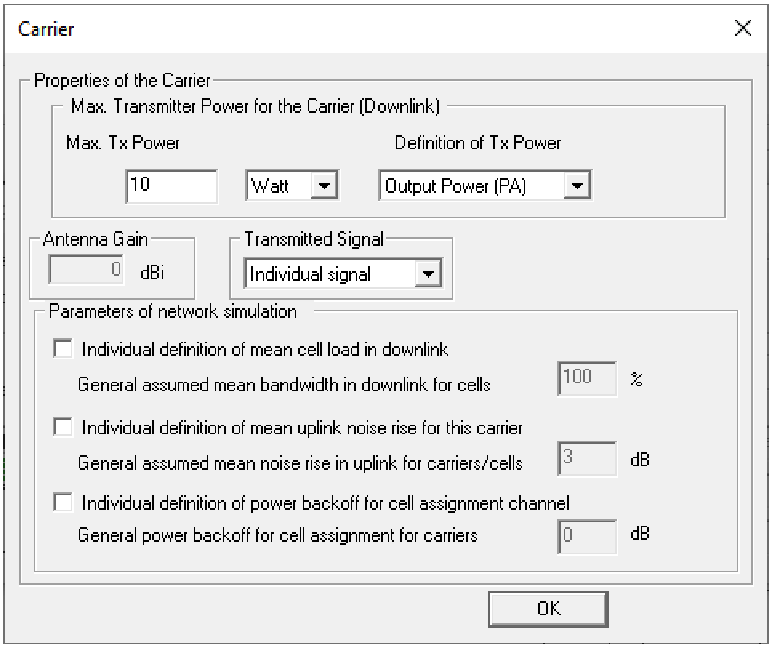


*Figure 170: The **Carrier** dialog.*

9. Under **Properties of the Carrier**, set **Max. TX Power** to 10 dBm.
10. Click **OK** to close the **Carrier** dialog.
11. Click **OK** to close the **Carrier Assignment** dialog.
12. Click **OK** to close the **Cell** dialog.
13. Click **OK** to close the **Site** dialog.
14. Disable the **Set site** tool by clicking again on the **Set Site** icon.

5.5.7 Project Parameters

Before starting a propagation simulation and a network simulation, define the parameters related to the project.

Specifying the Air Interface Settings

Specify the parameters for the air interface (wireless standard).

> **Note:**
> The parameters for the air interface were already defined by loading the `.wst` file.
>
> You are encouraged to explore the numerous settings available for the air interface.

1. Launch the **Edit Project Parameters** dialog using one of the following workflows:
   - On the **Project** menu, click **Edit Project Parameters**.
   - On the **Project** toolbar, click the **Edit Project Parameters** icon.
   - Press F3 to use the keyboard shortcut.
2. Click the **Air Interface** tab.

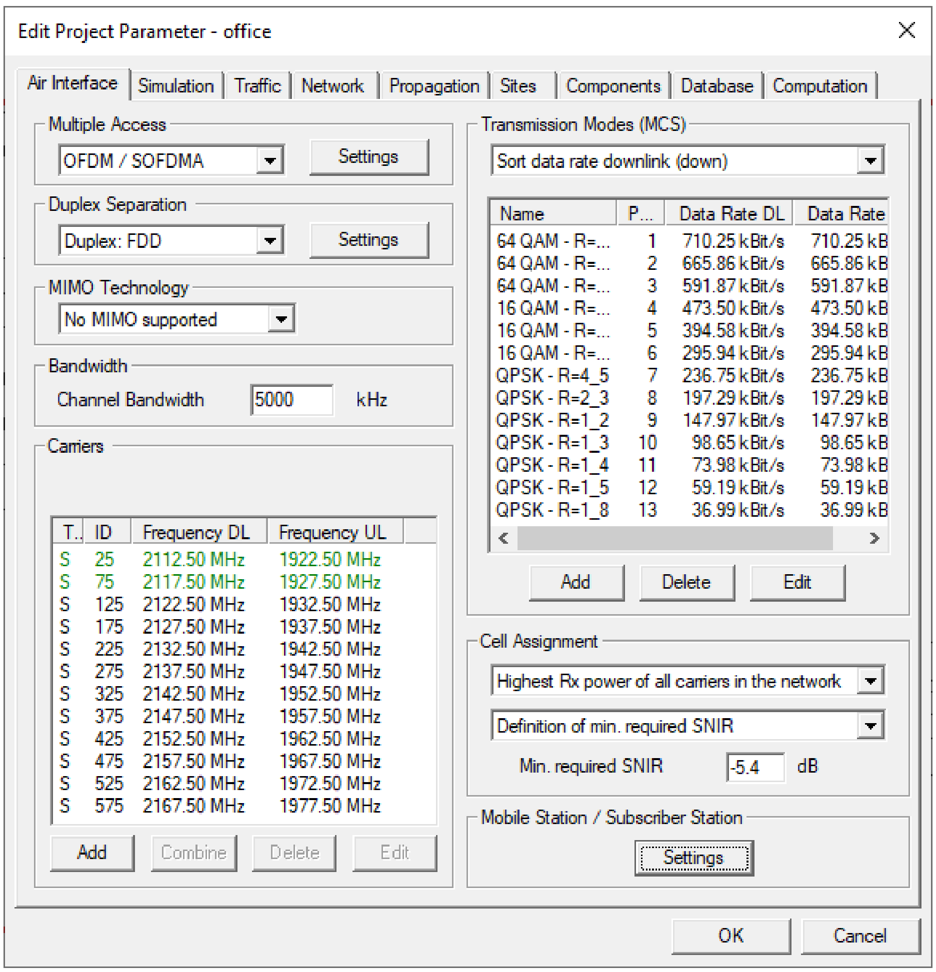


*Figure 171: The **Edit Project Parameters** dialog - **Air Interface** tab.*

3. Under **Multiple Access**, click **Settings**.

   The **OFDM and OFDMA** dialog is displayed.

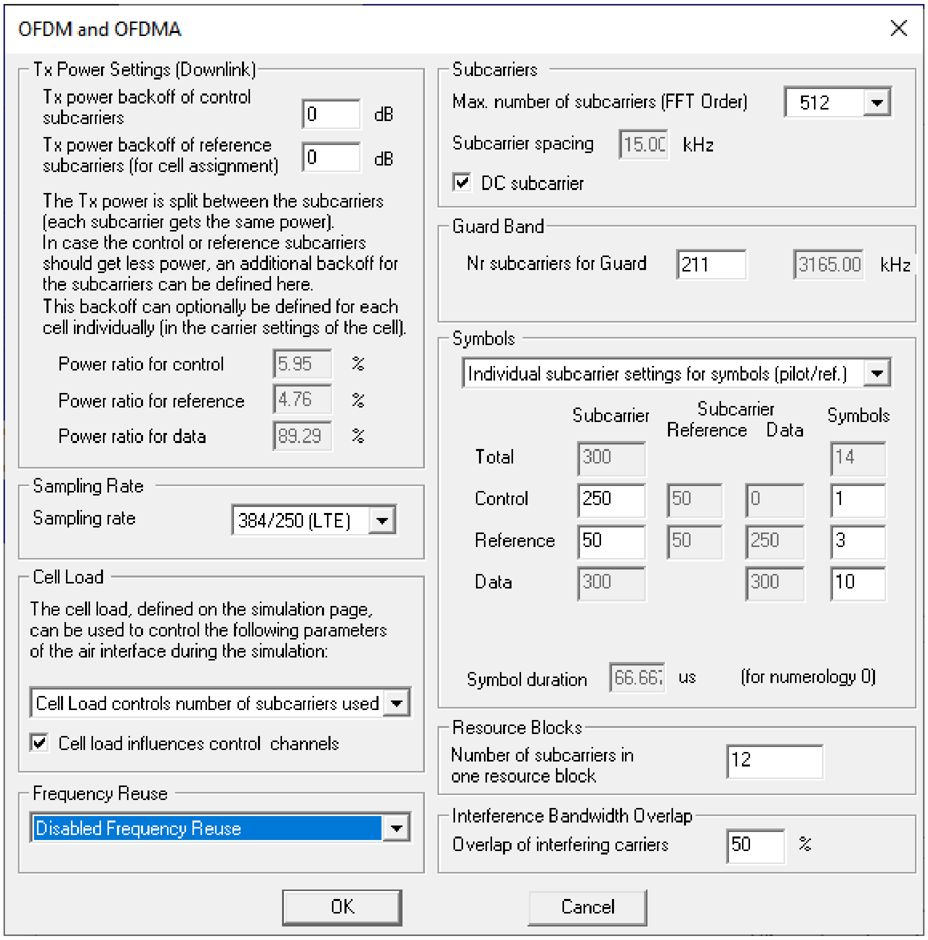


*Figure 172: The **OFDM and OFDMA** dialog.*

a) Under **Subcarriers**, view the **Max. number of subcarriers (FFT Order)**.

b) Click **OK** to close the **OFDM and OFDMA** dialog.

4. Under **Duplex Separation**, click **Settings**.

The **Duplex Properties FDD** dialog is displayed.

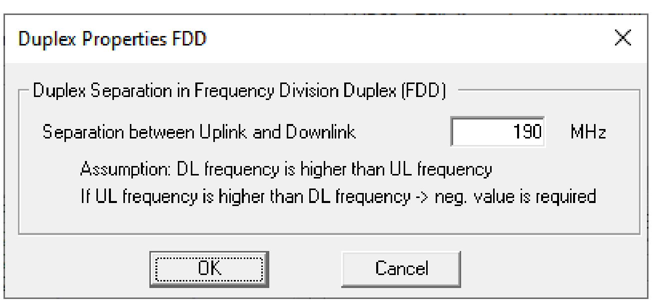


*Figure 173: The **Duplex Properties FDD** dialog.*

a) Under **Duplex Separation in Frequency Division Duplex (FDD)**, view the **Separation between Uplink and Downlink**.

b) Click **OK** to close the **Duplex Properties FDD** dialog.

5. Under **Mobile Station / Subscriber Station**, click **Settings**.

   The **Mobile/Subscriber Stations** dialog is displayed.

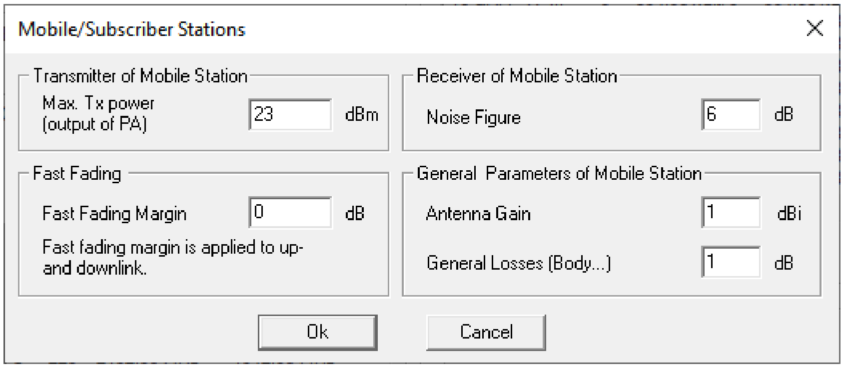


*Figure 174: The **Mobile/Subscriber Stations** dialog.*

   a) View the settings of the mobile/subscriber stations.
   b) Click OK to close the **Mobile/Subscriber Stations** dialog.

> **Note:** Keep the dialog open to define additional project parameters.

Specifying the Prediction Resolution, Height, and Network Type

Define the resolution grid, the height where the prediction results are to be calculated, and the type of simulation for the network planning.

1. Click the **Simulation** tab.
2. Under **Resolution of prediction results**, in the **Resolution** field, enter a value of `0.5` m.
   The prediction results will be computed with a resolution (grid) of 0.5 m.
3. Under **Prediction Height (relative to ground)**, in the **Height** field, enter a value of `1.5` m.
4. Under **Type of Network Simulation**, select **Static Simulation (homogeneous traffic per cell)**.

   > **Note:** A static simulation with homogeneous traffic is the most common choice.

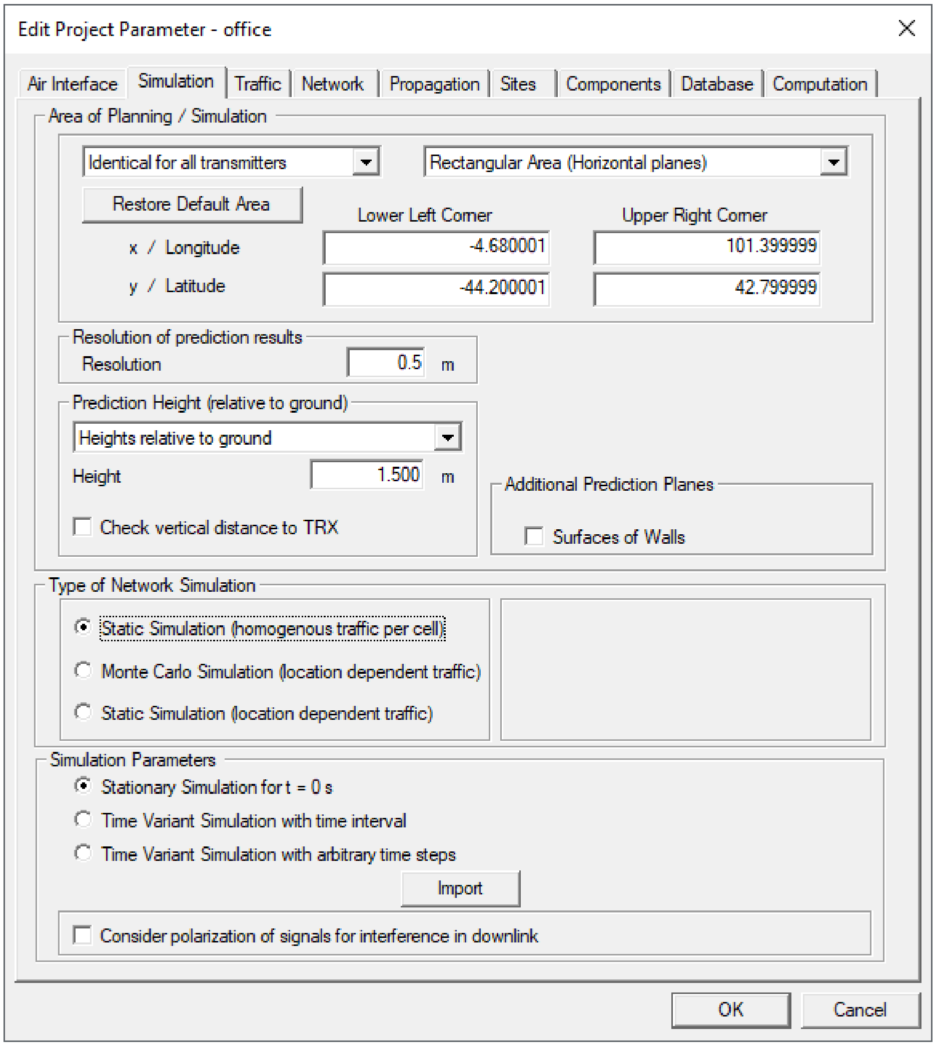


*Figure 175: The **Edit Project Parameters** dialog - **Simulation** tab.*

Note: Keep the dialog open to define additional project parameters.

Specifying the Traffic in the Network

Specify the cell load settings that will be used for interference calculations.

1. Click the **Traffic** tab.
2. Under **Consideration of Traffic and Load in Network**, select **Cell load defined by user (no location dependent traffic)**.
   If the traffic is defined as independent of the location, a traffic map is not required because it is assumed that the traffic is homogeneously distributed over the complete prediction area.
3. Under **Definition of Cell Load and Noise Rise**, in the **Assumed mean Tx power in downlink for each transmitter/cell** field, enter a value of `100`%.

Note:
- A mean Tx power of 100% represents the worst case for interference, where every transmitter operates at full power.
- Parameters can also be set per site.

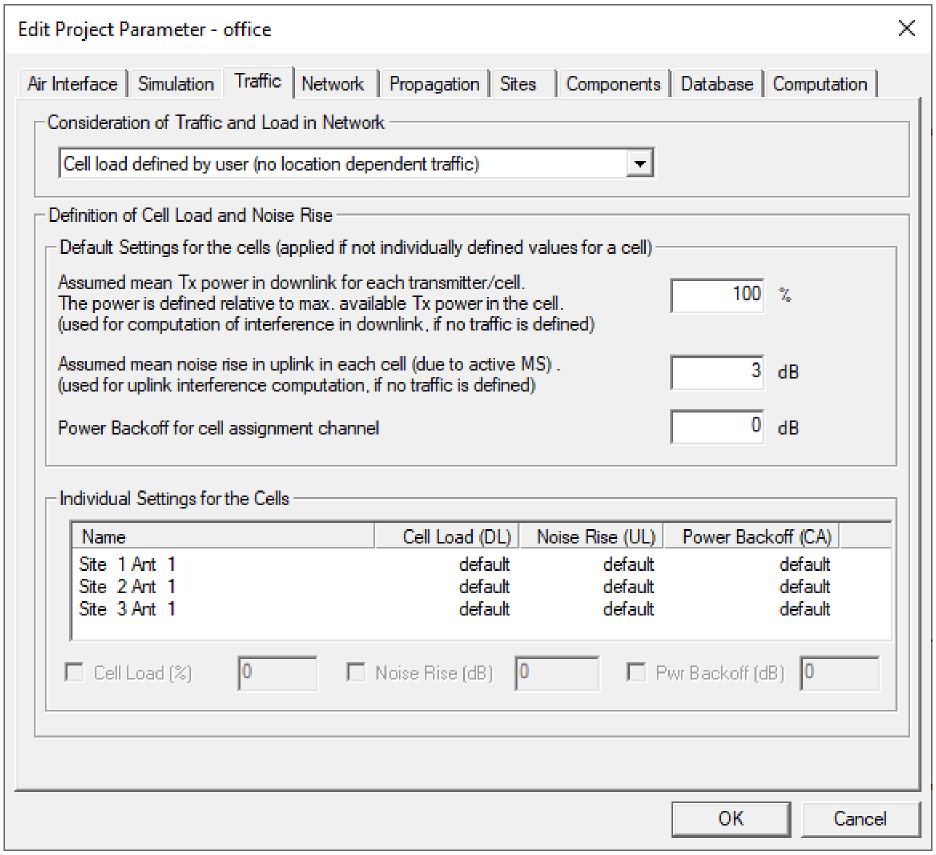


*Figure 176: The **Edit Project Parameters** dialog - **Traffic** tab.*

Note: Keep the dialog open to define additional project parameters.

Specifying the Output Folder for the Network Results

Specify the folder for the network prediction results to be computed using the dominant path model (DPM).

1. Click the **Network** tab.
2. Specify the output folder for the results to be computed using the dominant path model.
    a) Under **Output Directory for Network Results**, in the **Directory** field, change the default `PropName` to `Results\dpm`.

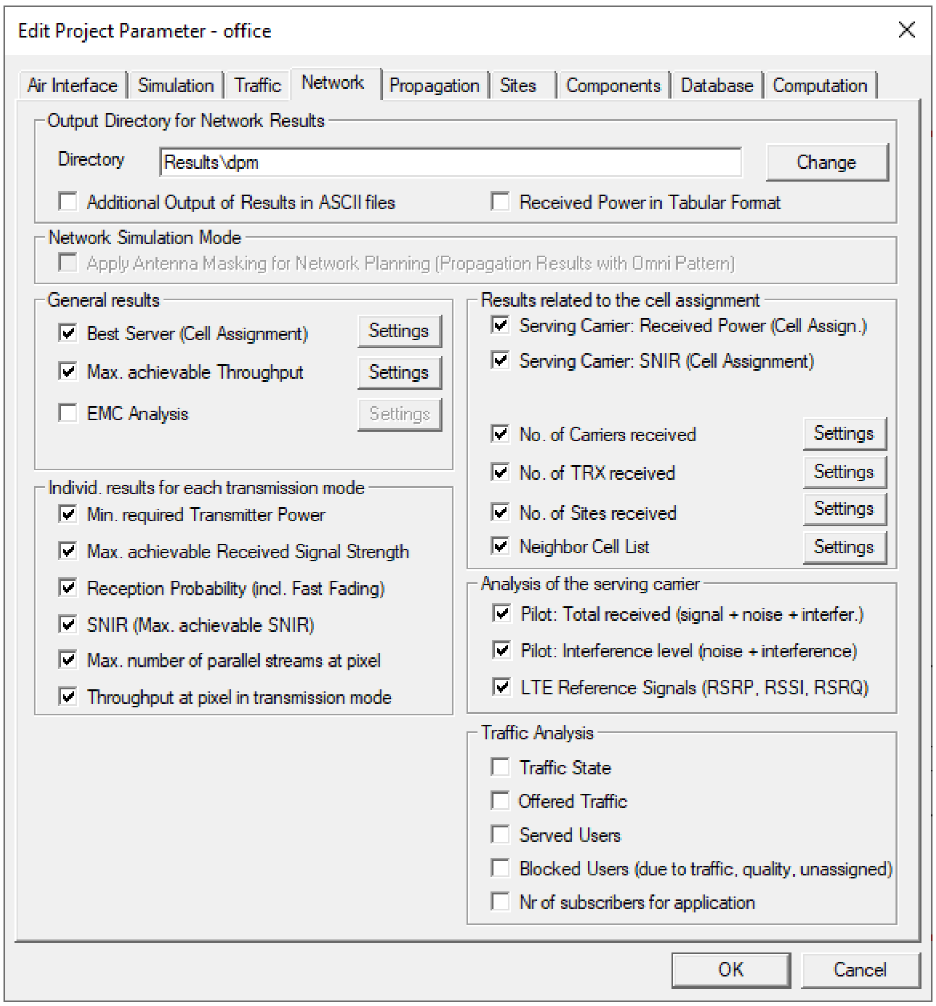


*Figure 177: The **Edit Project Parameters** dialog - **Network** tab.*

> **Note:** Keep the dialog open to define additional project parameters.

Specifying the Output Folder for the Propagation Results

Specify the folder for the propagation prediction results to be computed using the dominant path model (DPM).

1. Click the **Propagation** tab.
2. Specify the output folder for the results to be computed using the dominant path model.
    a) Under **Output Directory / Basic Filename for Propagation Results**, in the **Directory** field, change the default `PropName` to `Results\dpm`.

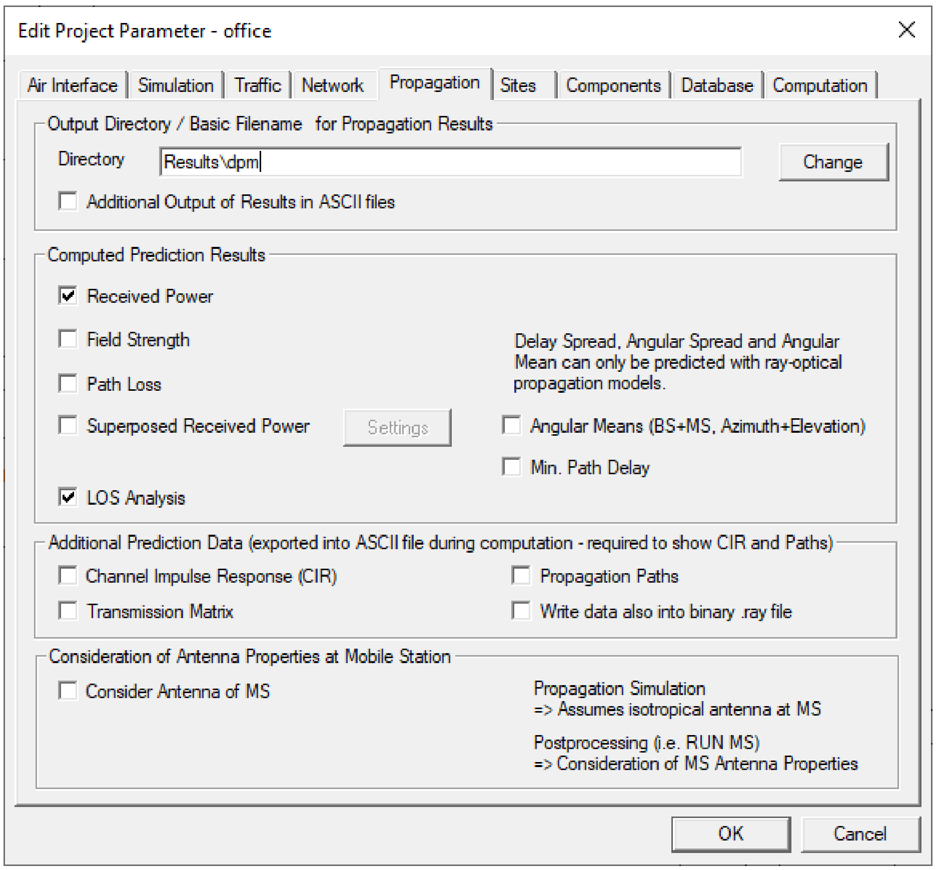


*Figure 178: The **Edit Project Parameters** dialog - **Propagation** tab.*

> **Note:** Keep the dialog open to define additional project parameters.

Specifying the Computation Method

The indoor database is solved using the dominant path model (DPM)

1. Click the **Computation** tab.
2. Under **Semi-Deterministic Propagation Models**, click **Dominant Path Model (DPM)**.

> **Note:** The dominant path model is fast and can be used for network planning.

3. Under **Computation of signal level along propagation path (valid for all propagation models)**, select **Empirical Losses for Transmission, Reflection, and Diffraction**.

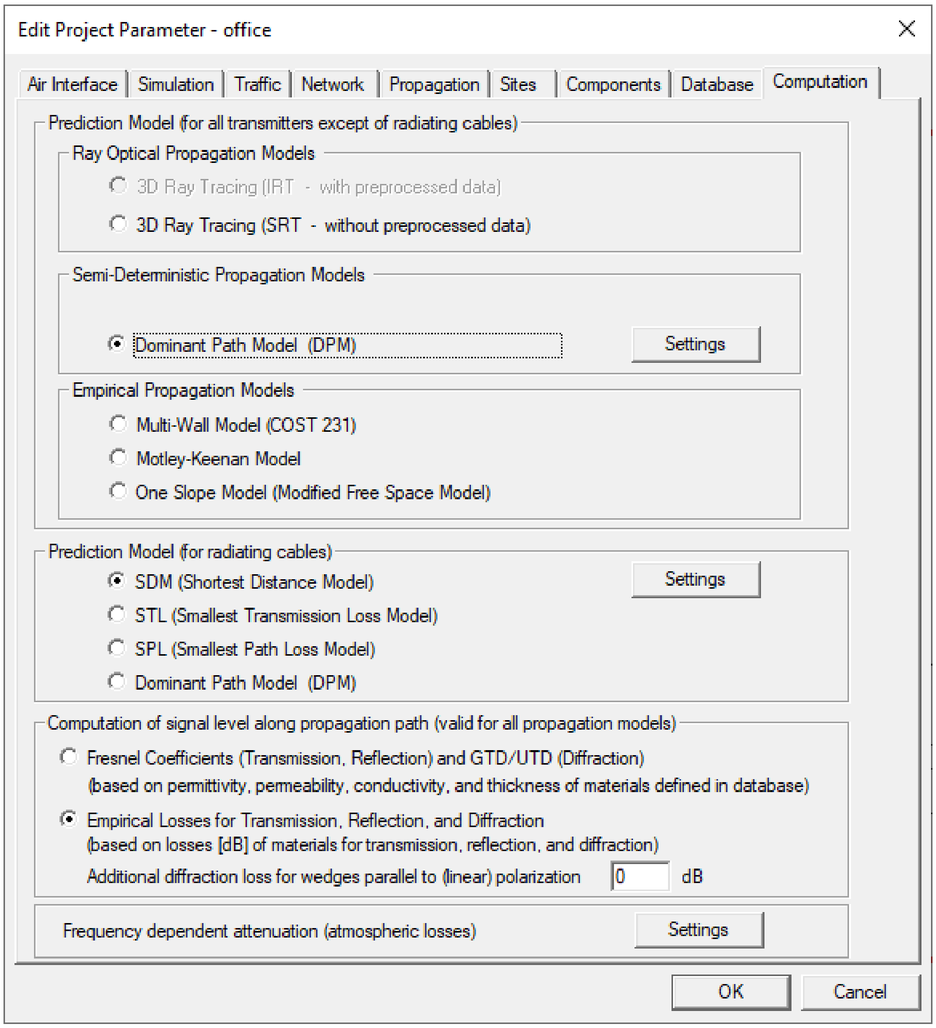


*Figure 179: The **Edit Project Parameters** dialog - **Computation** tab.*

4. Click **OK** to close the **Edit Project Parameter** dialog.

5.5.8 Launching the Solver (Propagation Simulation)

Compute the network coverage for the three antennas to obtain the prediction results.

Launch the Solver (propagation simulation) using one of the following workflows:

- On the **Project** toolbar, click the **Computes propagation for all antennas** icon.
- On the **Computation** menu, click **Propagation: Compute All**.
- Press F5 to use the keyboard shortcut.

The Solver is launched and the **Computation** dialog is displayed.

Viewing the Prediction Results

Display the power results using the dominant path model (DPM).

View the power using the DPM for the third antenna site.

a) In the tree, expand **Results: Propagation** to view the results for the three antennas.

b) In the tree, expand **Site3** to view the third antenna.

c) In the tree, expand **Site 3 Ant 1** to view the result entries.

d) In the tree, expand **Carrier 75** to view the carriers.

e) In the tree, click **Power** to view the power result.

Figure 180: Power calculated for Site 3 Ant 1 using the DPM.

5.5.9 Launching the Solver (Network Simulation)

Compute the propagation for the three antennas to obtain the prediction results.

Launch the Solver (propagation simulation) using one of the following workflows:

- On the **Project** toolbar, click the RUN NET **Network Simulation** icon.
- On the **Computation** menu, click **Network Simulation**.
- Press F7 to use the keyboard shortcut.

The Solver is launched and the **Computation** dialog is displayed.

Viewing the Prediction Results

Display the results from the network planning simulation.

1. View the cell area to determine which site is received best (depending on the location and defined settings).
   a) In the tree, expand **Results: Network** to view the network planning results.
   b) In the tree, click **Cell Area** to determine which site is received best.

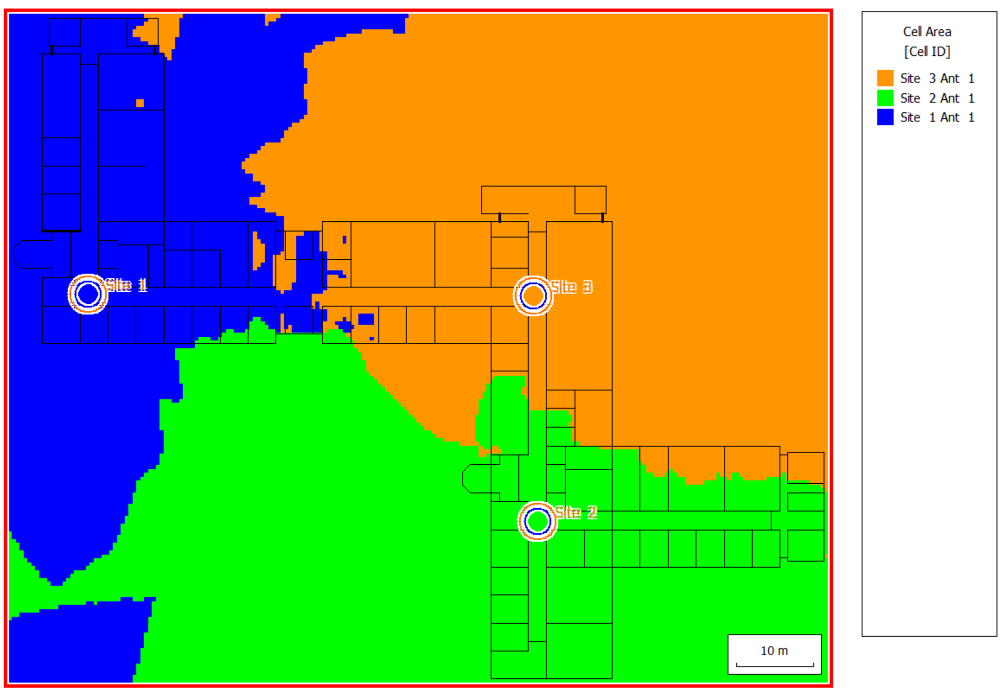


Figure 181: The cell area showing which site is received best for each receiver pixel.

2. View the best server for each receiver pixel.
   a) In the tree, expand **Results: Network** to view the network planning results.
   b) In the tree, click **Best server** to determine the best server for each receiver pixel.

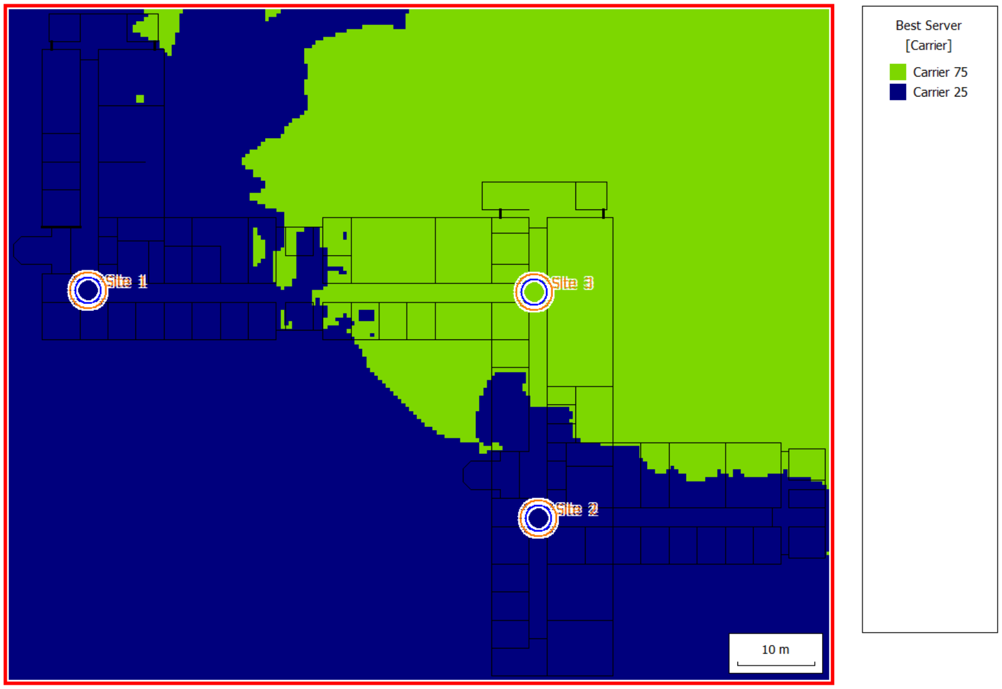


Figure 182: The best server result for each pixel. Note that Site 1 and Site 2 use the same carrier.

3. View the received power for cell assignment.

a) In the tree, expand **Results: Network** to view the network planning results.

b) In the tree, expand **Cell Assignment** and click **Received Power**.

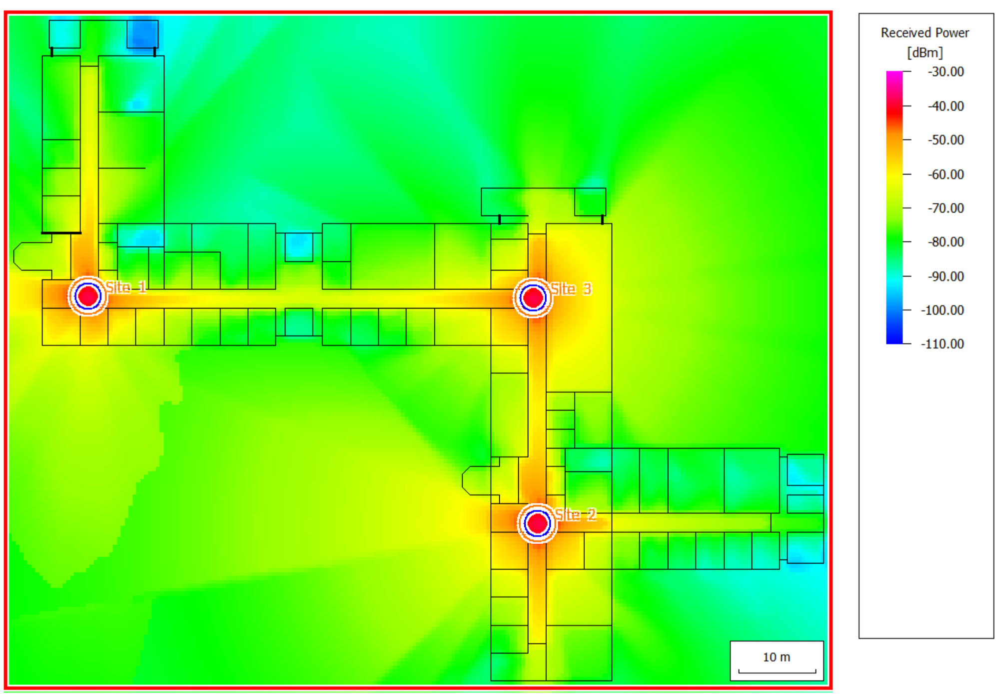


Figure 183: The received power for the cell assignment.

4. View the Signal-to-Noise-and-Interference Ratio (SNIR).

a) In the tree, expand **Results: Network** to view the network planning results.

b) In the tree, expand **Cell Assignment** and click **DL: SNIR (max)**.

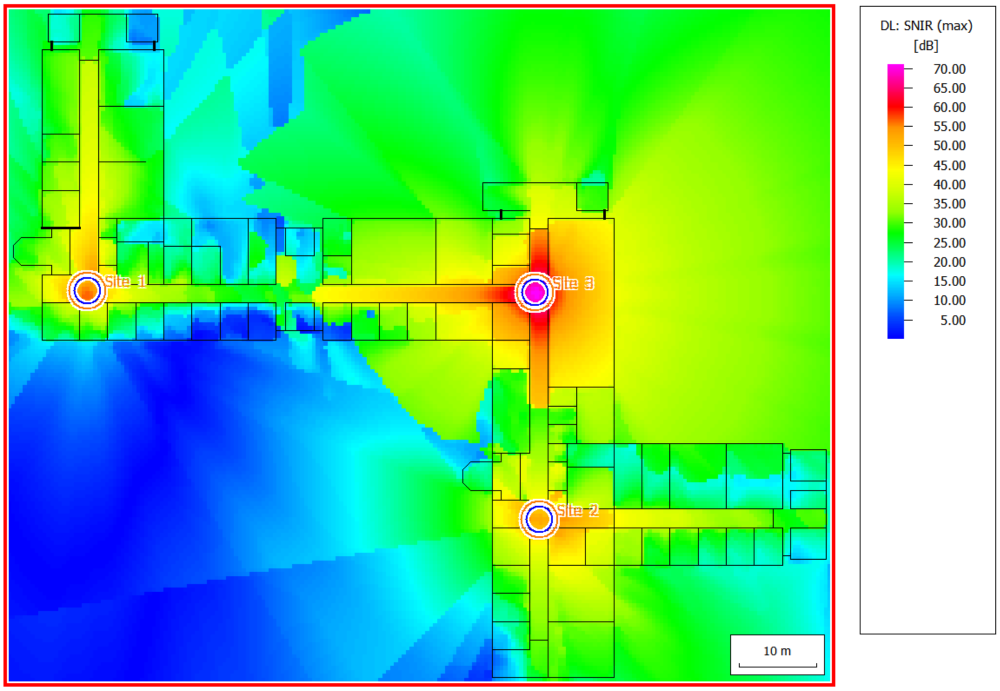


Figure 184: The SNIR is low in the lower-left quadrant.

5. View the interference results.

a) In the tree, expand **Results: Network** to view the network planning results.

b) In the tree, expand **Cell Assignment** and click **Pilot: Interference**.

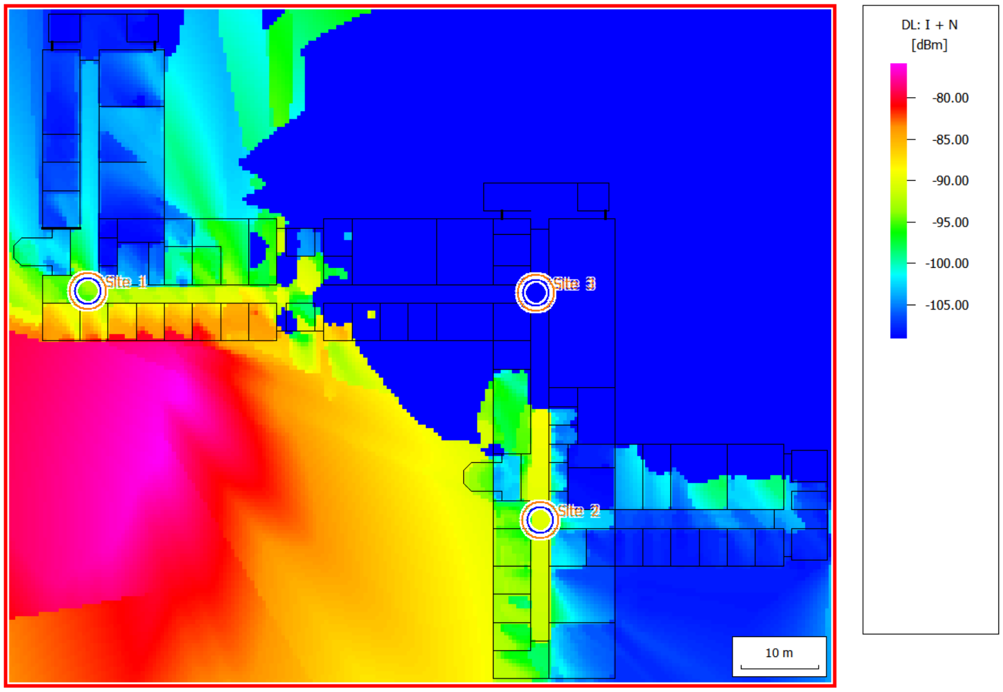


Figure 185: The interference in the lower-left quadrant is high because Site 1 and Site 2 are on the same carrier.

The interference occurs because both sites emit an individual signal on the same frequency. This can be changed by either assigning different carriers or by keeping the same carriers but making them transmit the same signal, so the signal from one is no longer the interference of the other.[38]

6. View the minimum transmit power to determine if the chosen modulation scheme can be used.

a) In the tree, expand **Results: Network** to view the network planning results.

b) In the tree, expand **64 QAM - R=3_4** and click **DL: Min Tx Power BS**.

38. See Figure 160, under **Transmitted Signal**.

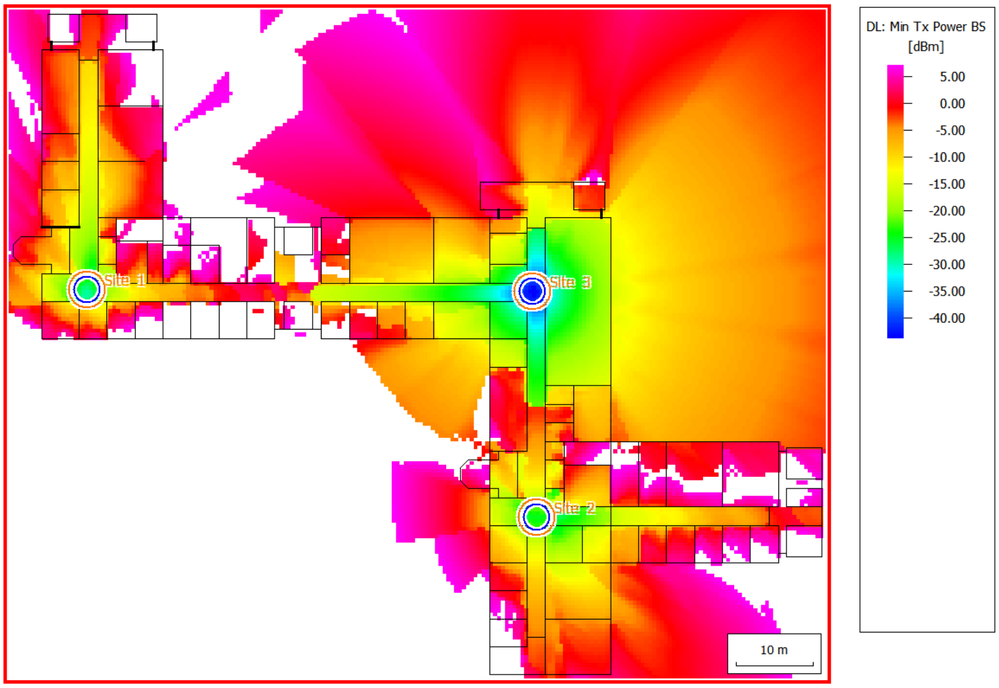


Figure 186: In white areas, the chosen modulation scheme cannot be used (a slower one may still work).

7. View the data rate to determine if communication is possible for the chosen scheme.

a) In the tree, expand **Results: Network** to view the network planning results.

b) In the tree, expand **64 QAM - R=3_4** and click **DL: Data Rate**.

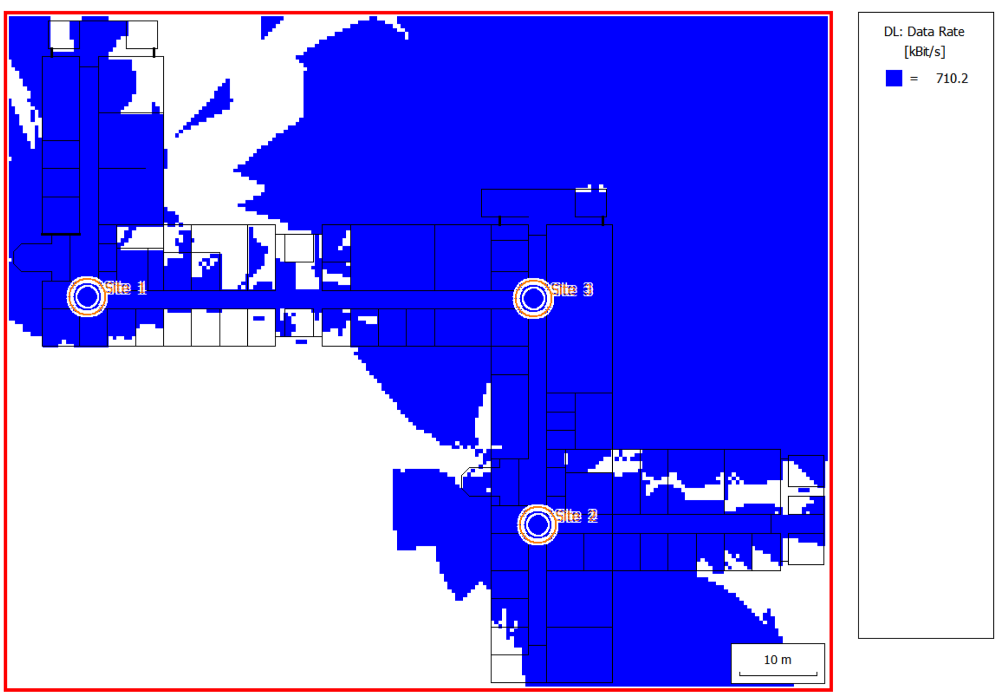


Figure 187: In non-white areas, communication can take place at the data-rate of the chosen scheme.

5.5.10 Final Remarks

This example showed how to analyze three base stations set in an indoor scenario and to obtain coverage plots using ProMan.

Many concepts were introduced in this example that apply to models commonly created in ProMan. The three base stations were solved using the dominant path model (DPM).

As a first step, a propagation simulation was performed to determine the best cell phone reception inside a building. As s second step, a network planning simulation was performed to provide the best cell assignment and interference levels.

Index

Special Characters

Numerics

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