

# Appendix A:

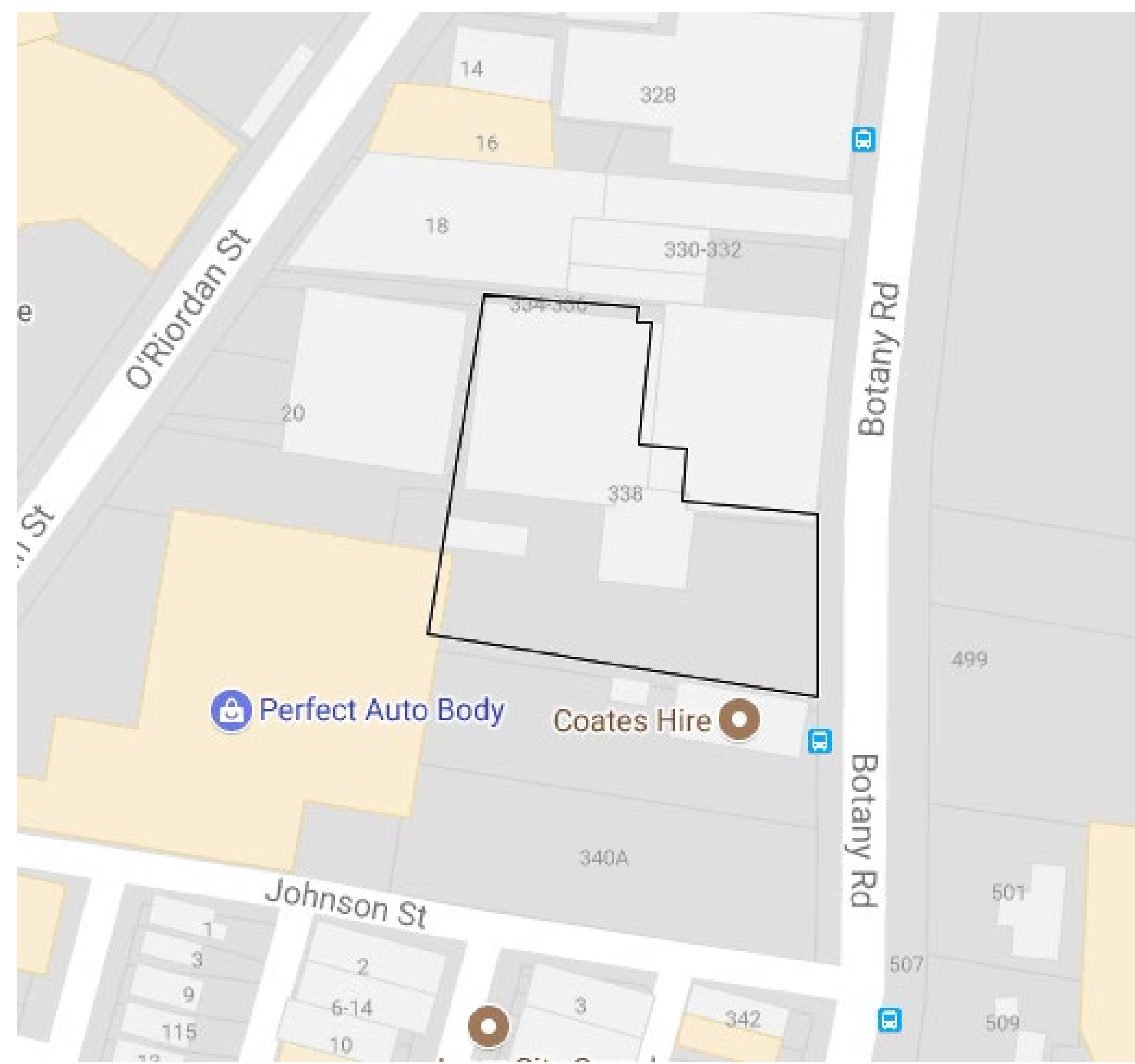
# Demonstration Scenario

“How to Setup Geo-referencing in a Building or Linear Infrastructure Model”

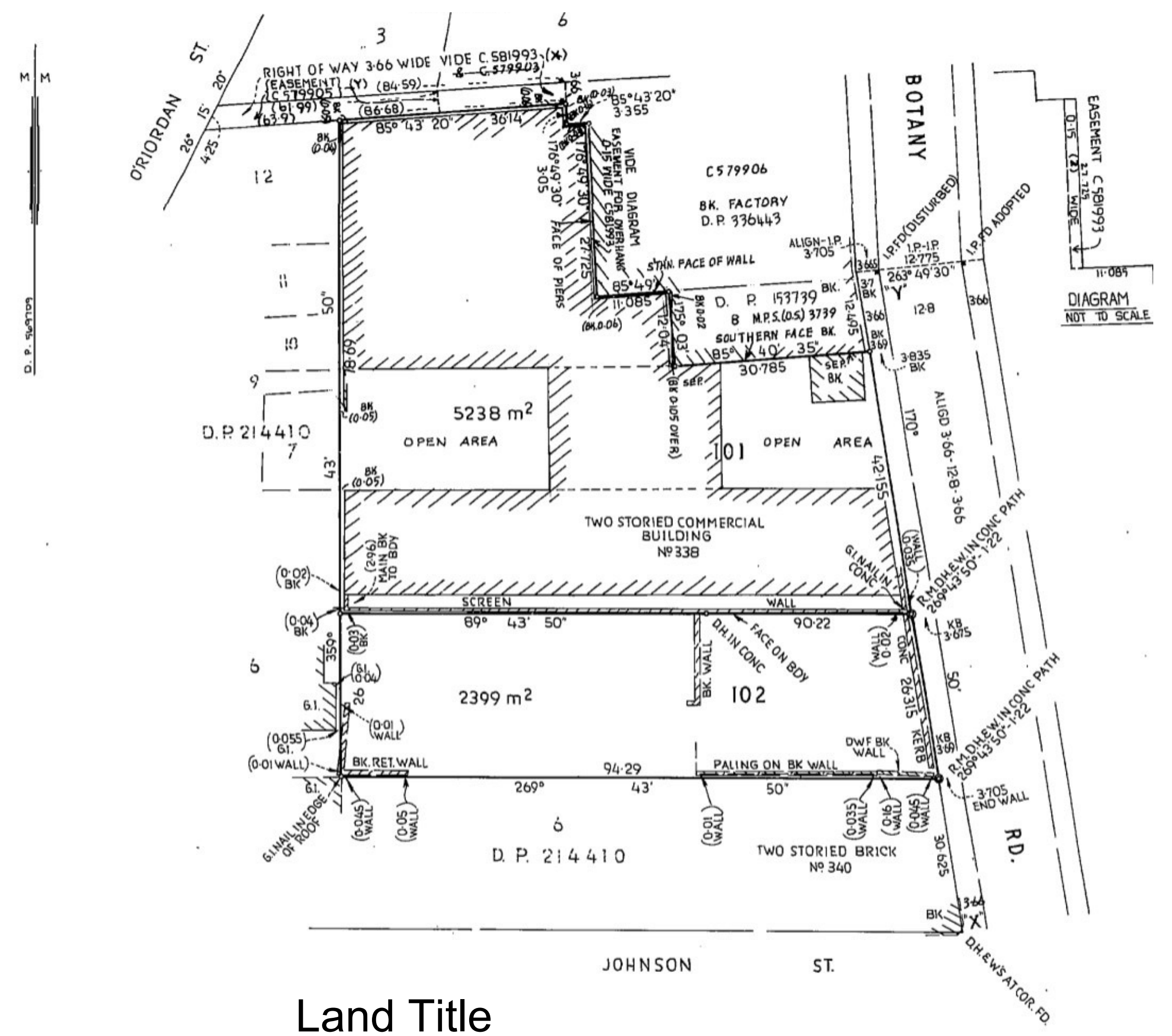
Generously supported by:



# The Project Site

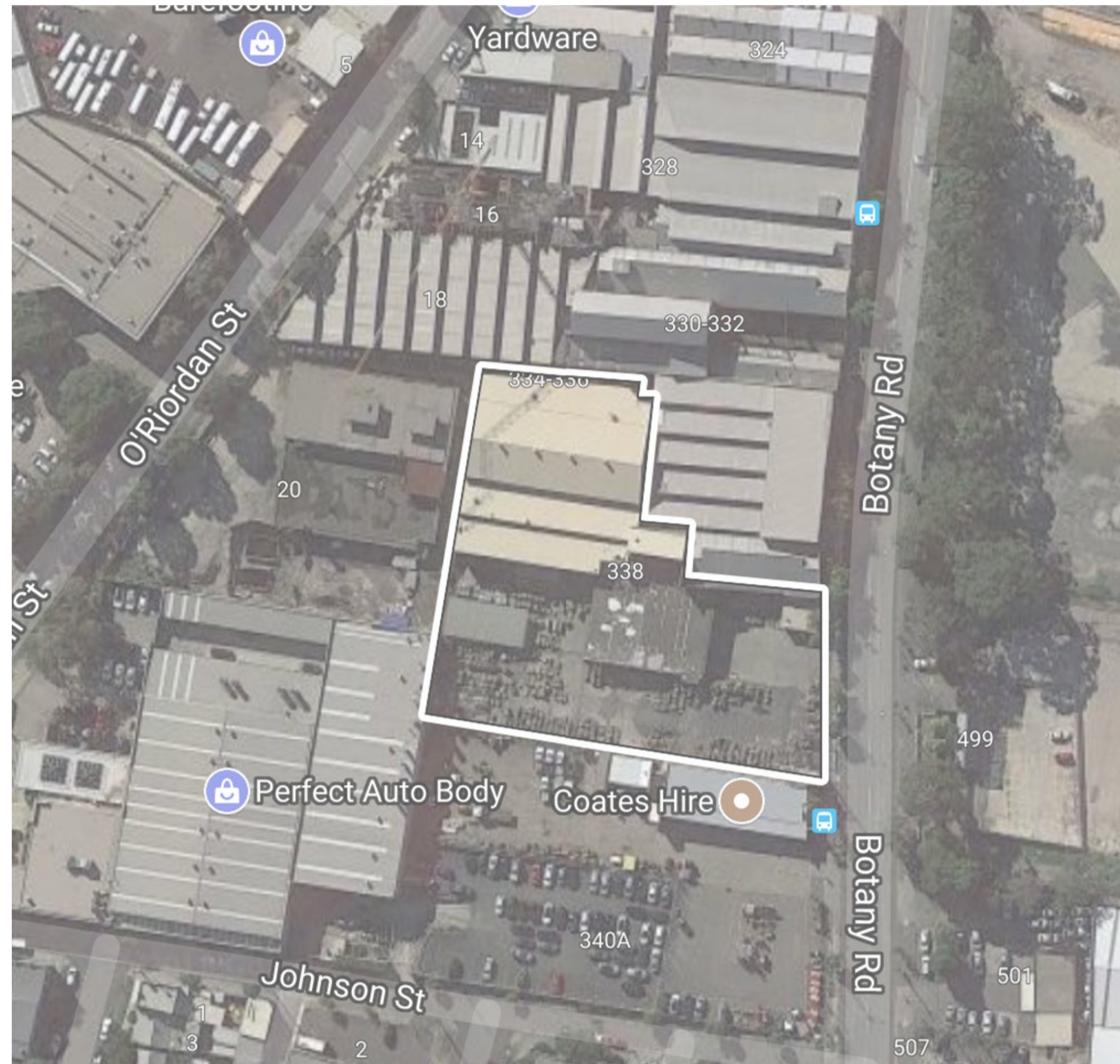


Google map of location



Land Title

# Step 1: Project Initiation



- The Surveyor gets a request from the Designer to supply a “site model” (**not** a survey *drawing*) in a local ground coordinate system and not in a Map projection.
- The surveyor needs to convert the Map Grid survey he undertakes into a local ground coordinate dataset for the local BIM applications
- The surveyor will select a minimum of 2 reference points in both the map and local coordinate systems. The more points the better.
- Using the selected reference points in each coordinate system, the surveyor can then compute the parameters that enable the map coordinates to be transformed using a Helmet transformation

## Step 2: Creating Helmert Parameters

Two reference points (**Ref1** and **Ref2**) have been defined at opposite ends of the site. The points have been connected to local survey control by the Land Surveyor.

The resulting coordinates of the reference points in the national map grid coordinate system (Map Grid of Australia Zone 56) are:

Ref1 E = 333,835.128 N = 6,246,577.686 H = 12.310

Ref2 E = 333,757.028 N = 6,246,668.415 H = 12.358

where E is Easting, N is Northing and H is orthometric height (AHD).

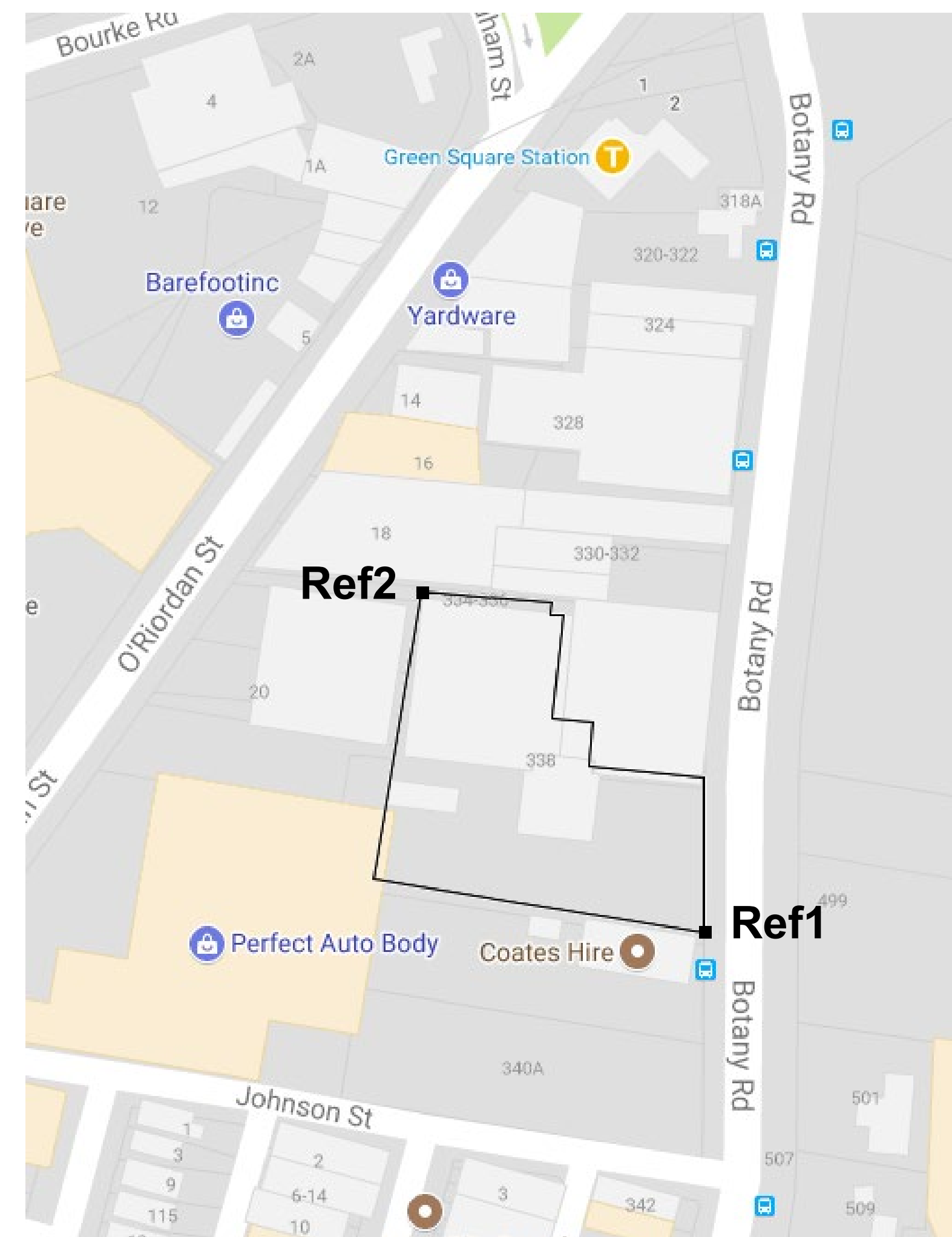
A local grid coordinate system has been made for the site to reduce the size of the coordinates and to align the site to better fit on paper plans. The resulting coordinates (in metres) of the reference points in the local grid coordinate system are:

Ref1 X = 1,090.219 Y = 2,000.424 Z = 10.000

Ref2 X = 999.622 Y = 2,078.688 Z = 10.048

where X, Y, Z represent a right handed Cartesian coordinate system with Z equivalent to up.

All values are in metres.



## Step 3: MSI IFC2x3 format Export

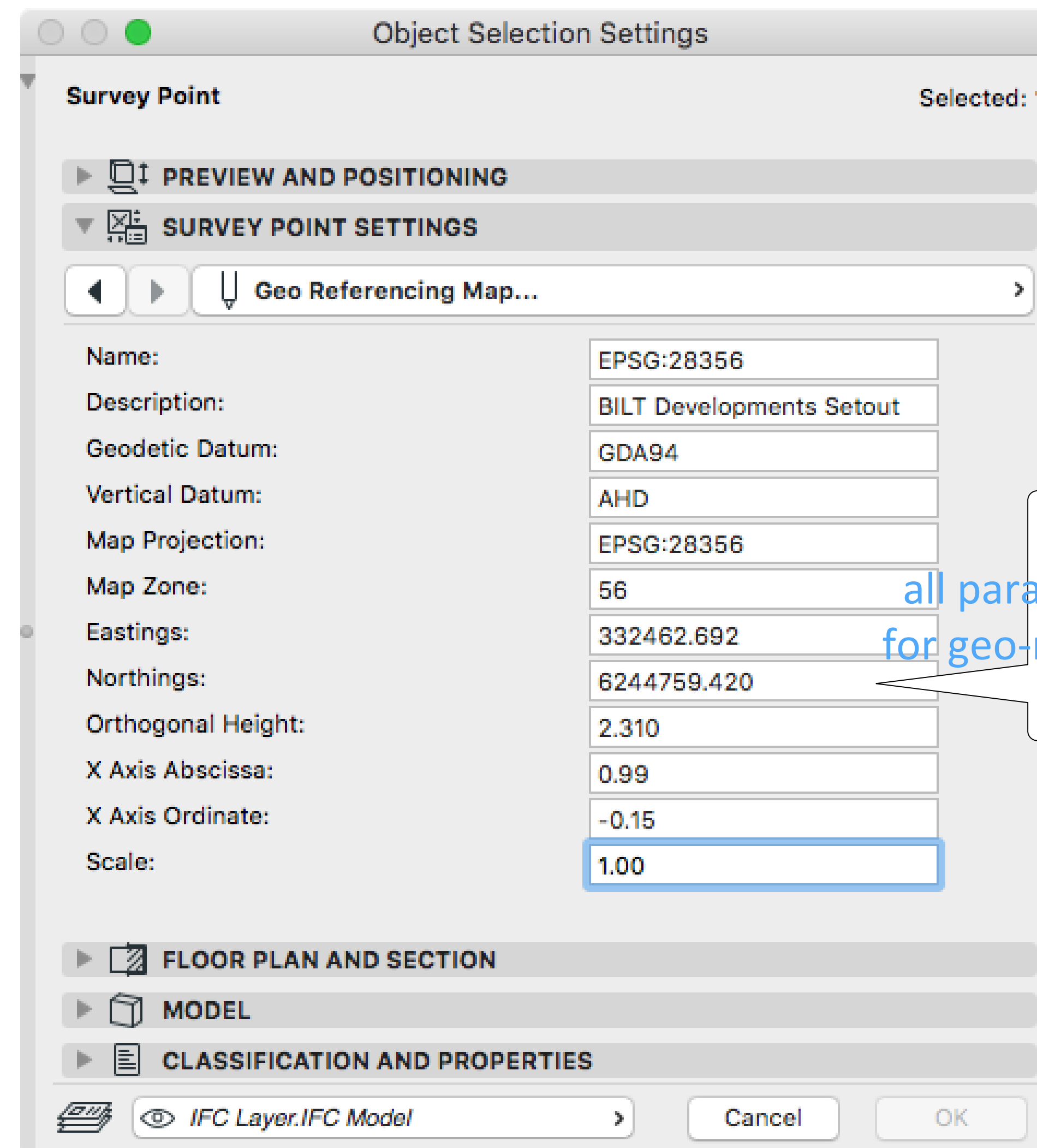
```

/* MSI ePSETS linked to ifcProject */
#2104= IFCPROPERTY SINGLEVALUE ('Eastings', $, IFCLENGTHMEASURE (332462.692), $);
#2105= IFCPROPERTY SINGLEVALUE ('Northings', $, IFCLENGTHMEASURE (6244759.420), $);
#2106= IFCPROPERTY SINGLEVALUE ('OrthogonalHeight', $, IFCLENGTHMEASURE (2.310), $);
#2107= IFCPROPERTY SINGLEVALUE ('XAxisAbscissa', $, IFCREAL (0.989130221837803), $);
#2108= IFCPROPERTY SINGLEVALUE ('XAxisOrdinate', $, IFCREAL (-0.147042185263616), $);
#2109= IFCPROPERTY SINGLEVALUE ('Scale', $, IFCREAL (0.999941534119322), $);
#2110=
IFCPROPERTYSET ('1fGe0kVbn4FBs3IHwYeWZd', #14, 'ePSet_MapConversion', $, (#2104, #2105, #2106, #2107,
#2108, #2109));
#2111= IFCRELDEFINESBYPROPERTIES ('3TRPLf4PRqe6MnLh0NewrQ', #14, $, $, (#2), #2110);
#2113= IFCPROPERTY SINGLEVALUE ('Name', $, IFCIDENTIFIER ('EPSG:28356'), $);
#2114= IFCPROPERTY SINGLEVALUE ('Description', $, IFCIDENTIFIER ('BILT Developments Setout'), $);
#2115= IFCPROPERTY SINGLEVALUE ('MapProjection', $, IFCIDENTIFIER ('EPSG:28356'), $);
#2116= IFCPROPERTY SINGLEVALUE ('GeodeticDatum', $, IFCIDENTIFIER ('GDA94'), $);
#2117= IFCPROPERTY SINGLEVALUE ('VerticalDatum', $, IFCIDENTIFIER ('AHD'), $);
#2118= IFCPROPERTY SINGLEVALUE ('MapZone', $, IFCIDENTIFIER ('56'), $);
#2119=
IFCPROPERTYSET ('BSACJLSES1yp2mSEUYvRfA', #14, 'ePSet_ProjectedCRS', $, (#2113, #2114, #2115, #2116, #
2117, #2118));
#2120= IFCRELDEFINESBYPROPERTIES ('0WrHrtZaf0SwBpZetw1zvr', #14, $, $, (#2), #2119);

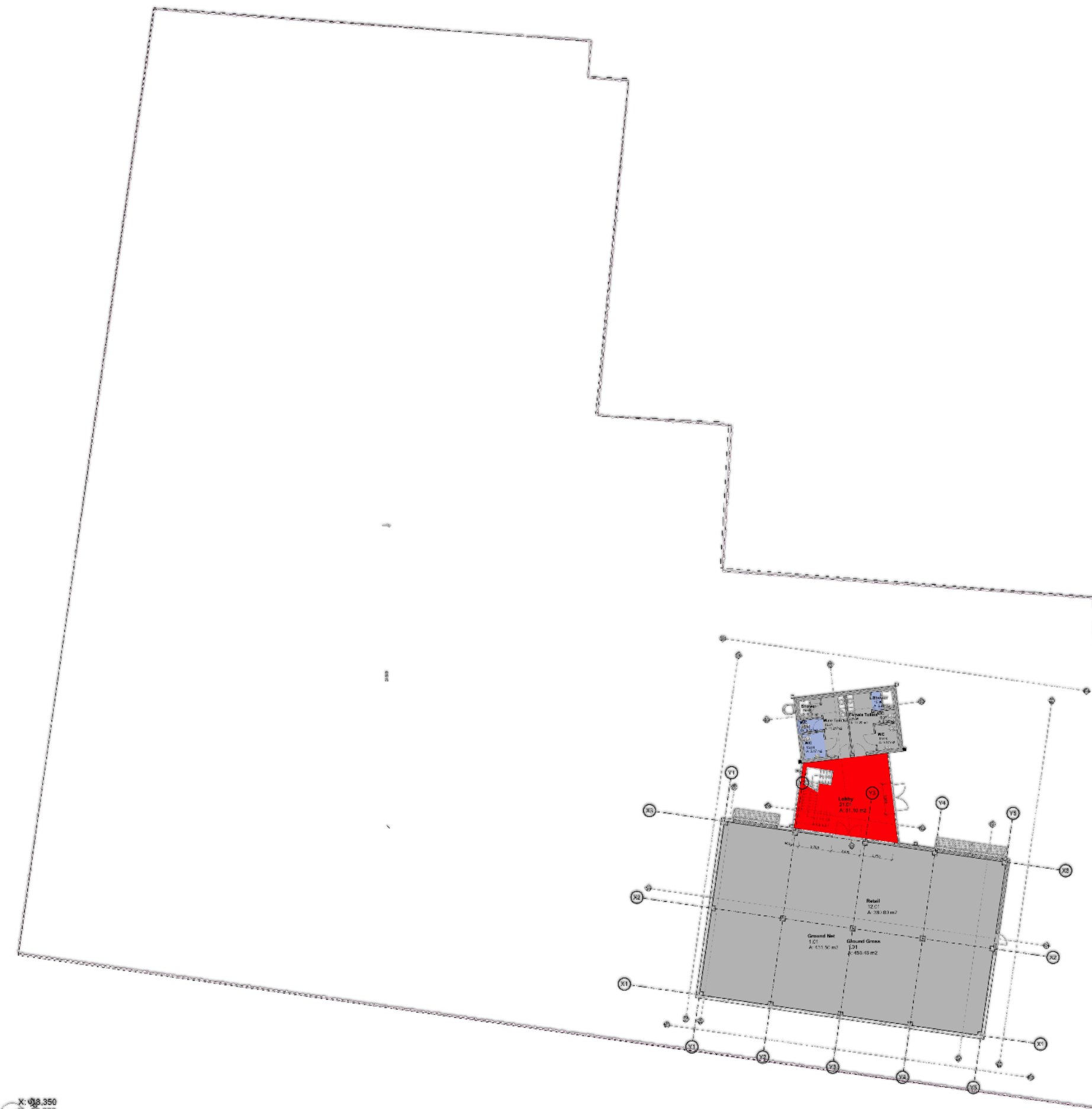
```

# Step 4: Designer imports initial survey file

- The Surveyor has applied the Helmert transformation to convert to local coordinates and exports an IFC2x3 (or IFC4) format file
- Designer imports Surveyor's site model
  - Survey Point object extended to include
    - ePSet\_ProjectedCRS:** Name, Description (opt), MapProjection, GeodeticDatum, VerticalDatum & MapZone
    - ePSet\_MapConversion:** Eastings, Northings, OrthogonalHeight, XAxisAbscissa, XAxisOrdinate & Scale parameters



# Step 5: Designer selects model location

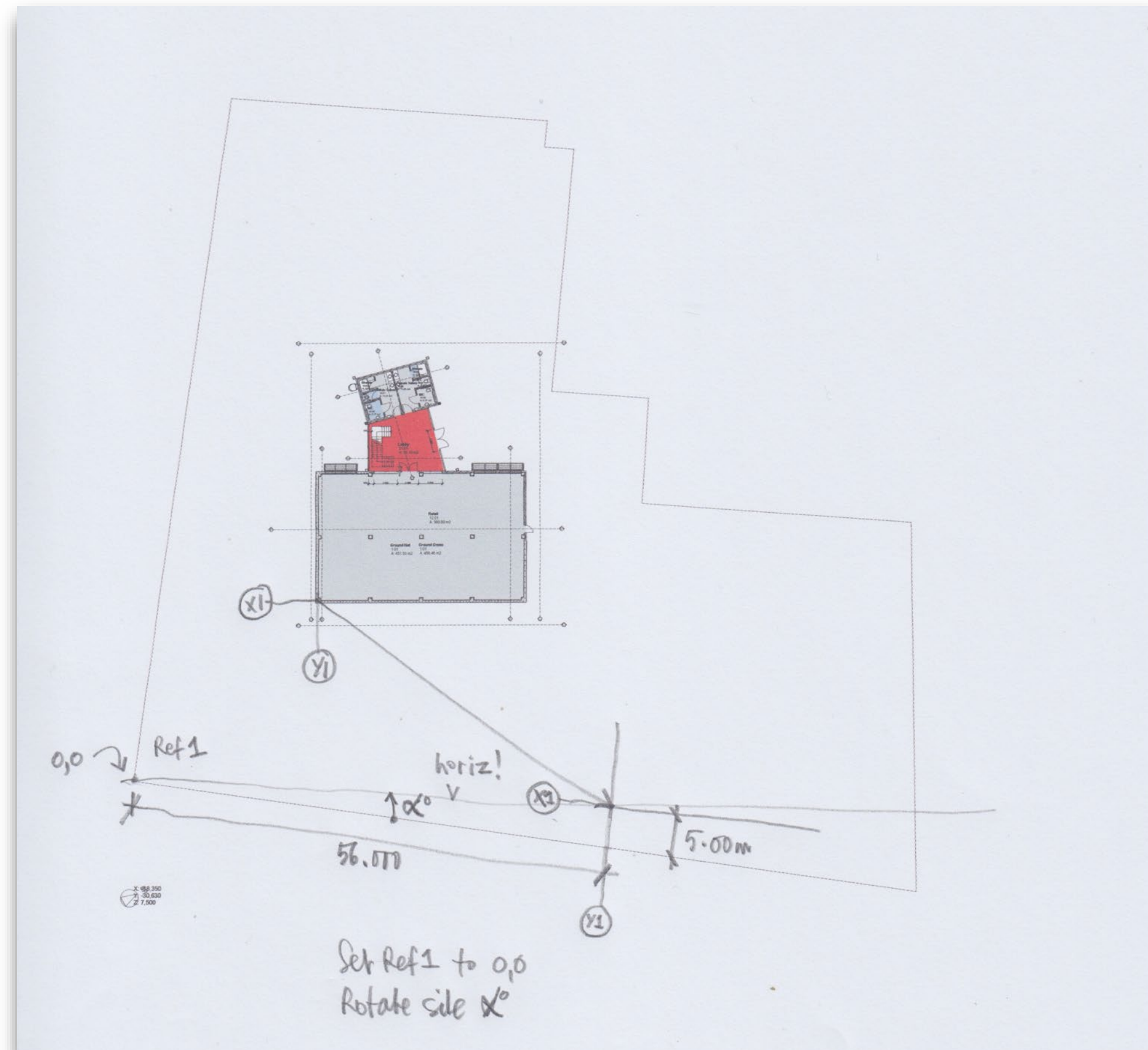


Ref 1 0/0/AHD

X: 99,350  
Y: 39,830  
Z: 7,500

- The Surveyor's site file has
  - “as is” orientation with Local coordinates
  - the model origin has been shifted to a local point (Ref 1) so that the coordinates do not compromise computation or visualisation for BIM authoring tools
- Designer develops their design proposal

# Step 5: Designer's site setout request



The Surveyor's site file has:

- “as is” orientation with Local coordinates
- the model origin has been shifted to a local point so that the coordinates do not compromise computation or visualisation for BIM authoring tools
- The Designer has developed a site layout proposal and now requests a **new site model** based on
  - *Southern boundary to be horizontal*
  - *Local Origin required at **Ref1***

For an infrastructure project there will be multiple setups for each local site, along say a new railway with stations and bridges each having a custom geo-reference in the context of the master MapGrid based model

Revised 12 Sep 2018



# Step 6: Surveyor creates project specific setout

A revised **Helmet transformation** is created using the Designers setout request

X Shift = **-333,745.832**

Y Shift = **-6,246,590.531**

Z Shift = **-1.759**

Z Rotation = **8°11'10"**

Scale = **1.0000584693**

The corresponding IFC parameters are:

Eastings = **333,745.832**

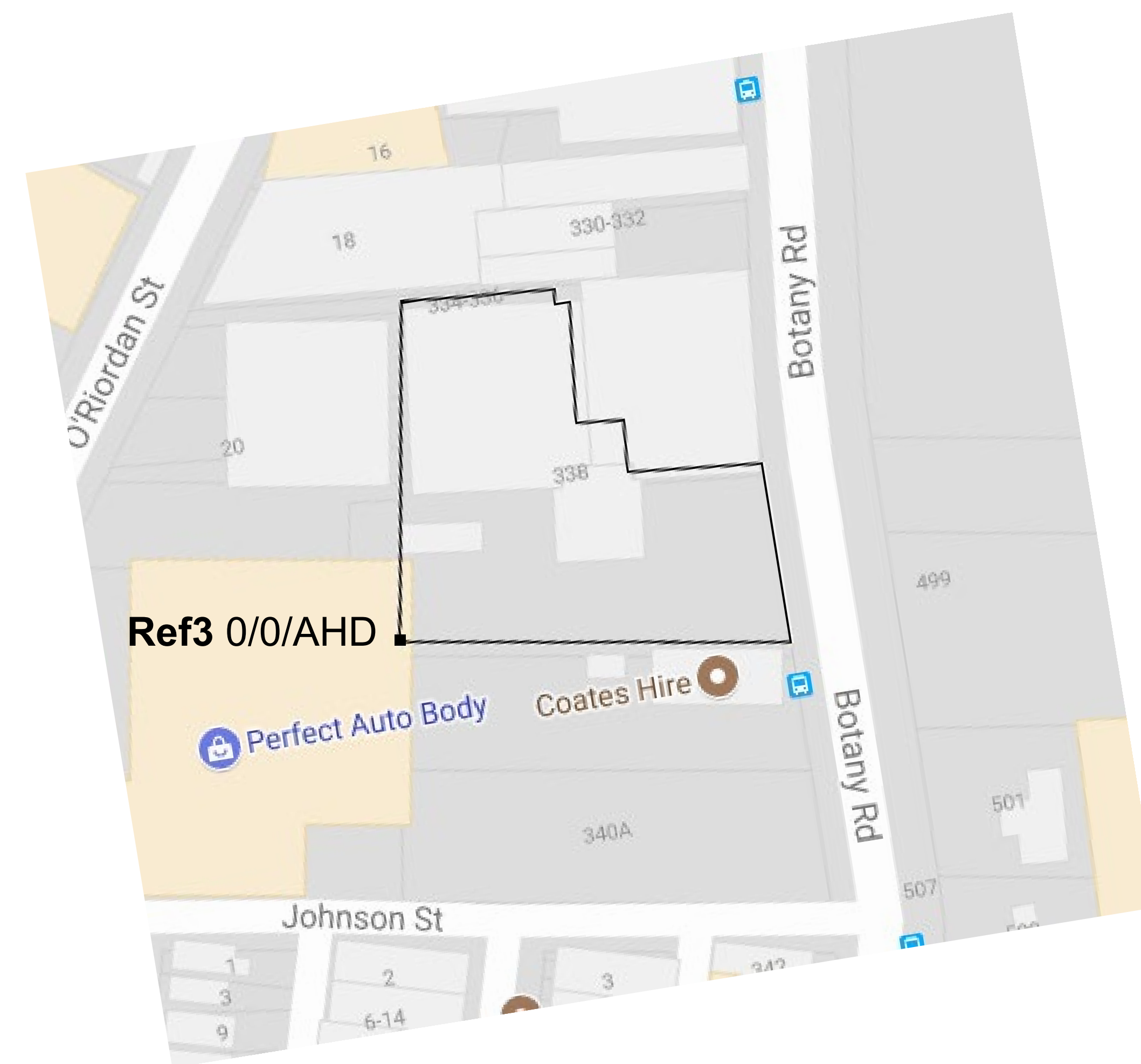
Northings = **6,246,590.531**

OrthogonalHeight = **1.759**

XAxisAbscissa = **0.989810776056595**

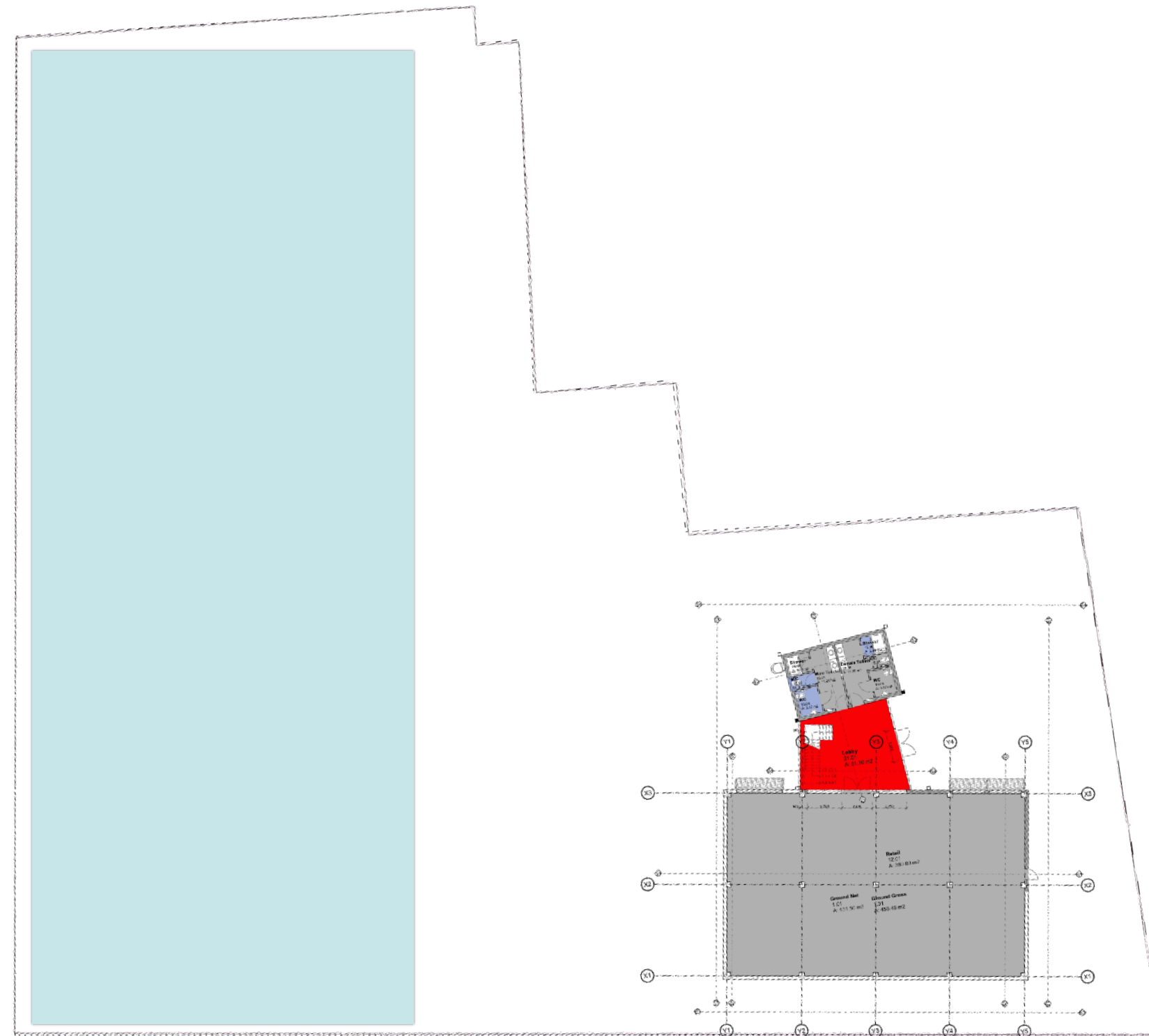
XAxisOrdinate = **-0.142389000987578**

Scale = **0.999941534120026**



# Step 7: Designer develops design model

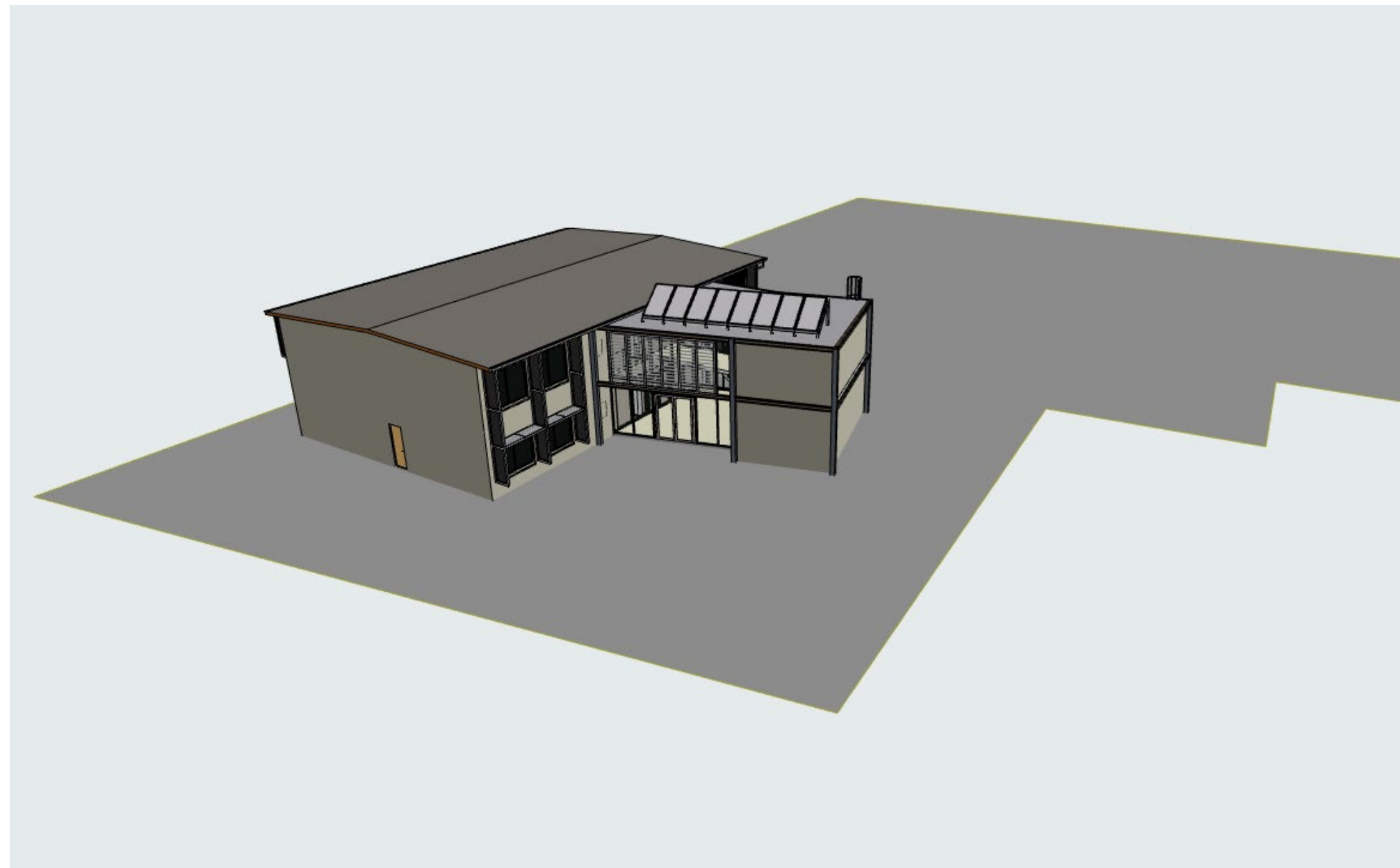
Stage 2  
Factory



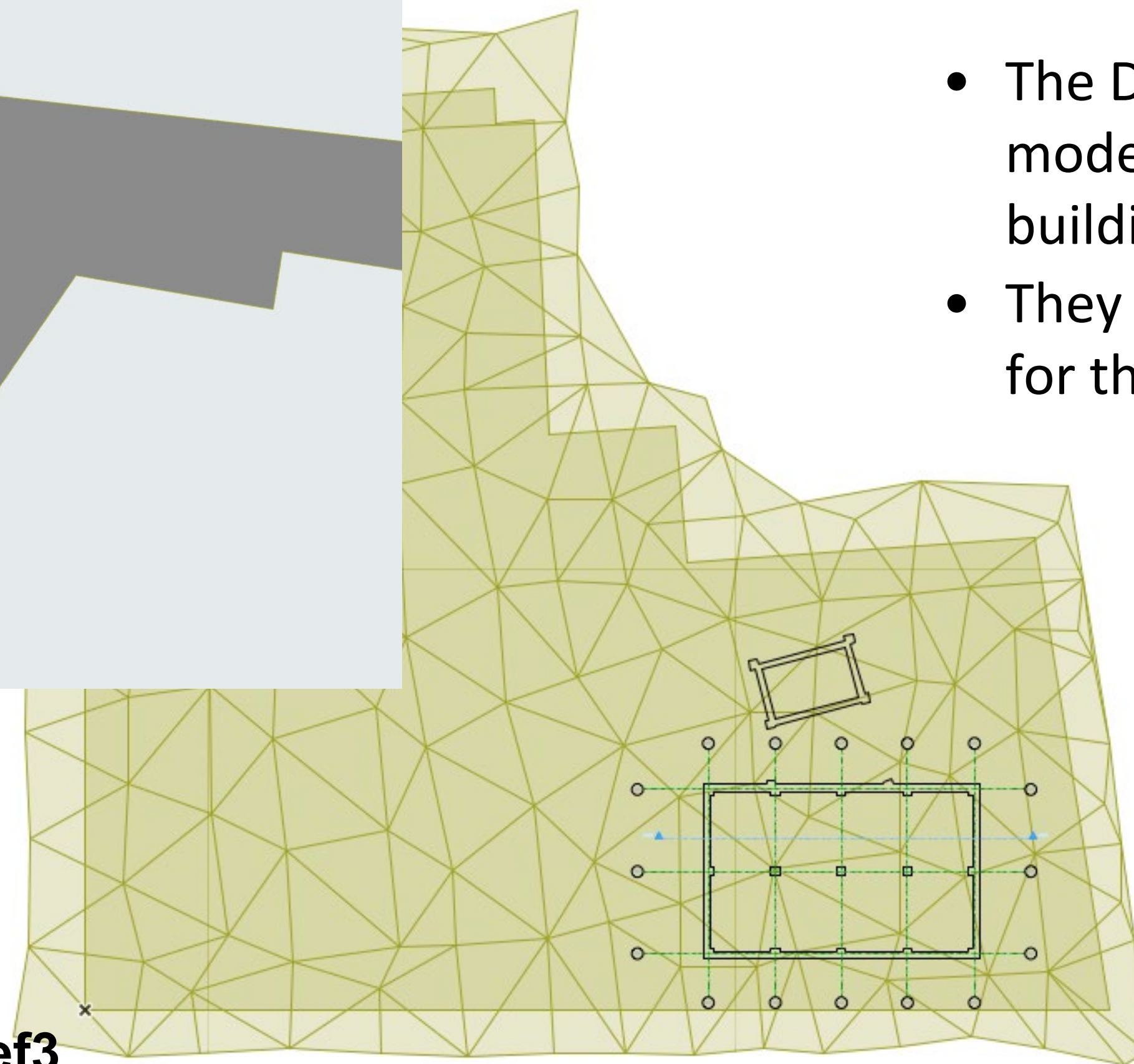
Stage 1 Offices

- The Designer now works on the project Site model & develops final design, documentation etc
- At the appropriate phase(s) of the project, the designer can export the current model data for the Surveyor using IFC4 (or IFC2x3)

## Step 8: Designer exports final design



3D View on cadastre



Local Origin - Ref3

Foundations plan & terrain

- The Designer now filters the project model to include the cadastre and final building design
- They now export the current model data for the Surveyor using IFC4 (or IFC2x3)

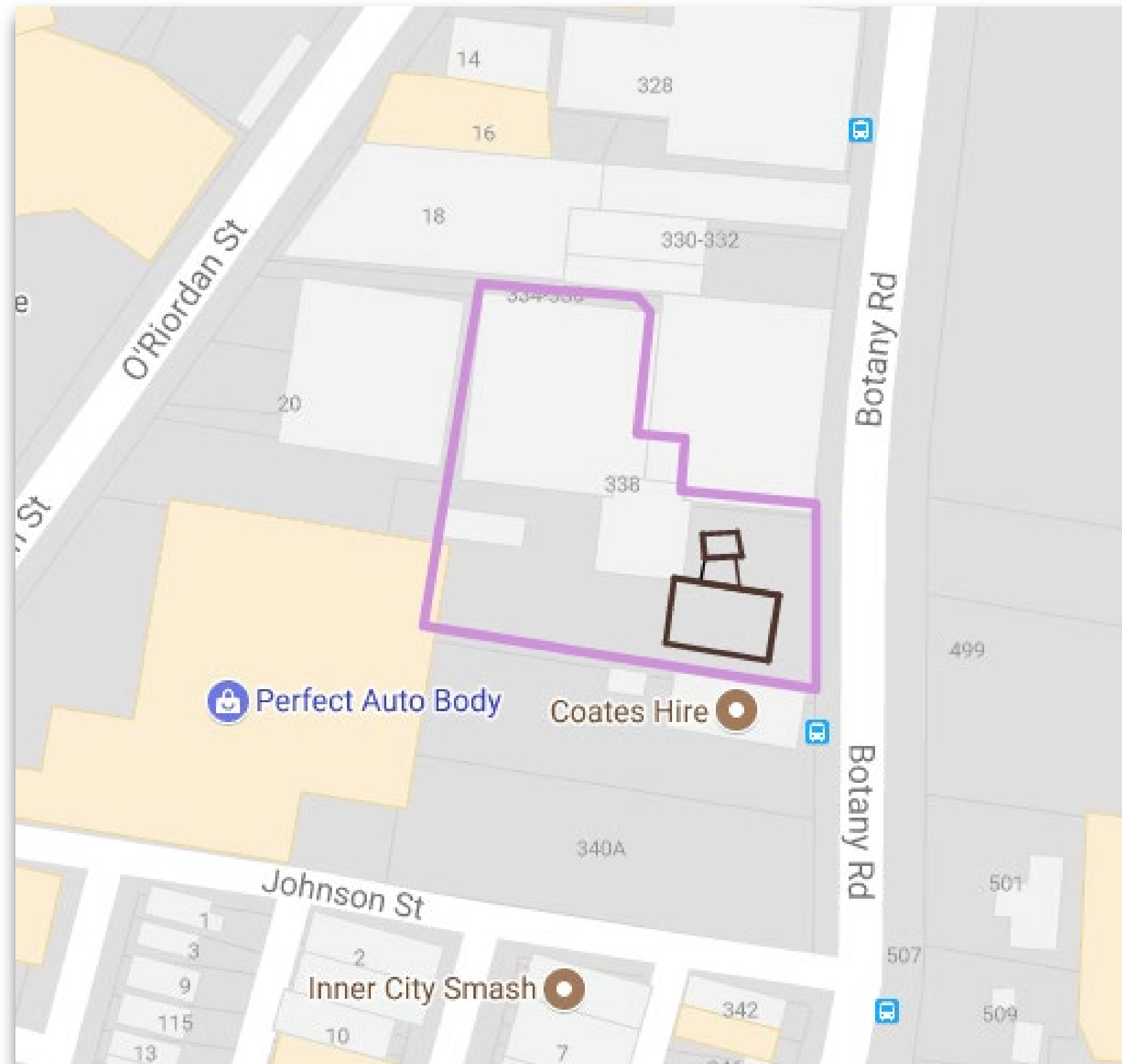
## Step 9: MSI IFC4 format Export

```
#13= IFCLOCALPLACEMENT ($, #12);
#14= IFCGEOMETRICREPRESENTATIONCONTEXT (*, 'Model', 3, 0.0000100000000000, #11, $);
/* definition of coordinate reference system (CRS) */
#15= IFCPROJECTEDCRS ('EPSG:28356', 'BILT Developments Setout', 'GDA94', 'AHD', 'EPSG:28356', '56', $)
/* definition of Helmert parameters */
#500= IFCMAPCONVERSION (#14, #15, 333745.832, 6246590.531, 1.759, 0.989810776056595, -
0.142389000987578, 0.999941534120026);
#16= IFCOWNERHISTORY (#5, #6, $, .NOTDEFINED., $, $, $, 1526267506);
#17= IFCSIUNIT (*, .LENGTHUNIT., $, .METRE.);
```

### Note:

- geo-referencing data is fixed in the local model and should not be edited. If the project site setout needs altering then the Surveyor has to create a new transformation and the design model amended or recreated as necessary.
- the IFC4 version format shows improved implementation with explicit *ifcProjectedCRS* and *ifcMapConversion* entities

# Final Step: Overlay of asset on Development Site



- Surveyor imports new Design model automatically transforming during the IFC import process (if the geo-referencing data is present in the file) to original orientation and location

# Model Geo-referencing - industry solution not single vendor

- Surveyor imports new Design model automatically transforming during the IFC import process (if the geo-referencing data is present in the file) to original orientation and location

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```



## MSI Summary...

- This is a small but significant technical problem, having unexpected outcomes
- The project is an excellent role model of the benefits to be part of the buildingSMART community
- For further information please contact:
  - buildingSMART Australasia
  - buildingSMART International at [contact@buildingsmart.org](mailto:contact@buildingsmart.org)