ISPRS EuroSDR GeoBIM benchmark[1]
2019

Task 3 – The **support for CityGML** within GIS (and other) software

Results of the tests delivered by participants

[1] https://3d.bk.tudelft.nl/projects/geobim-benchmark/

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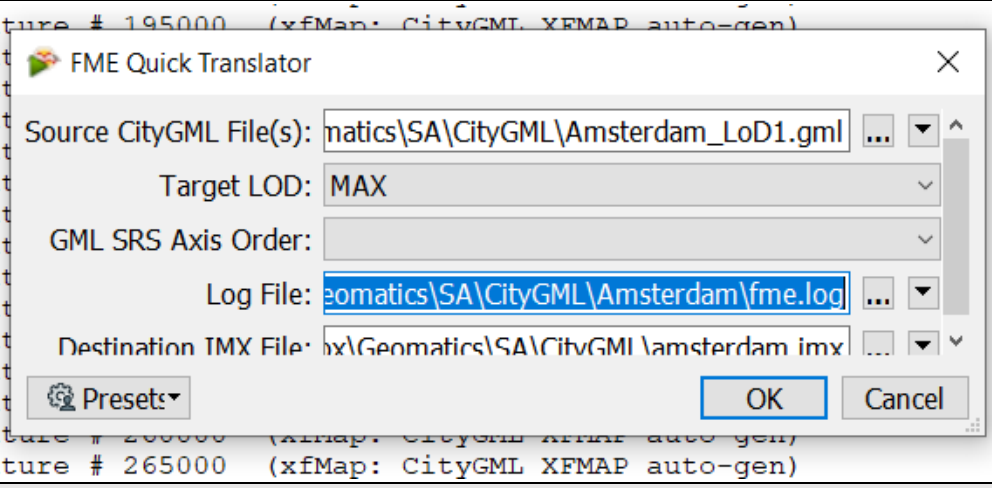
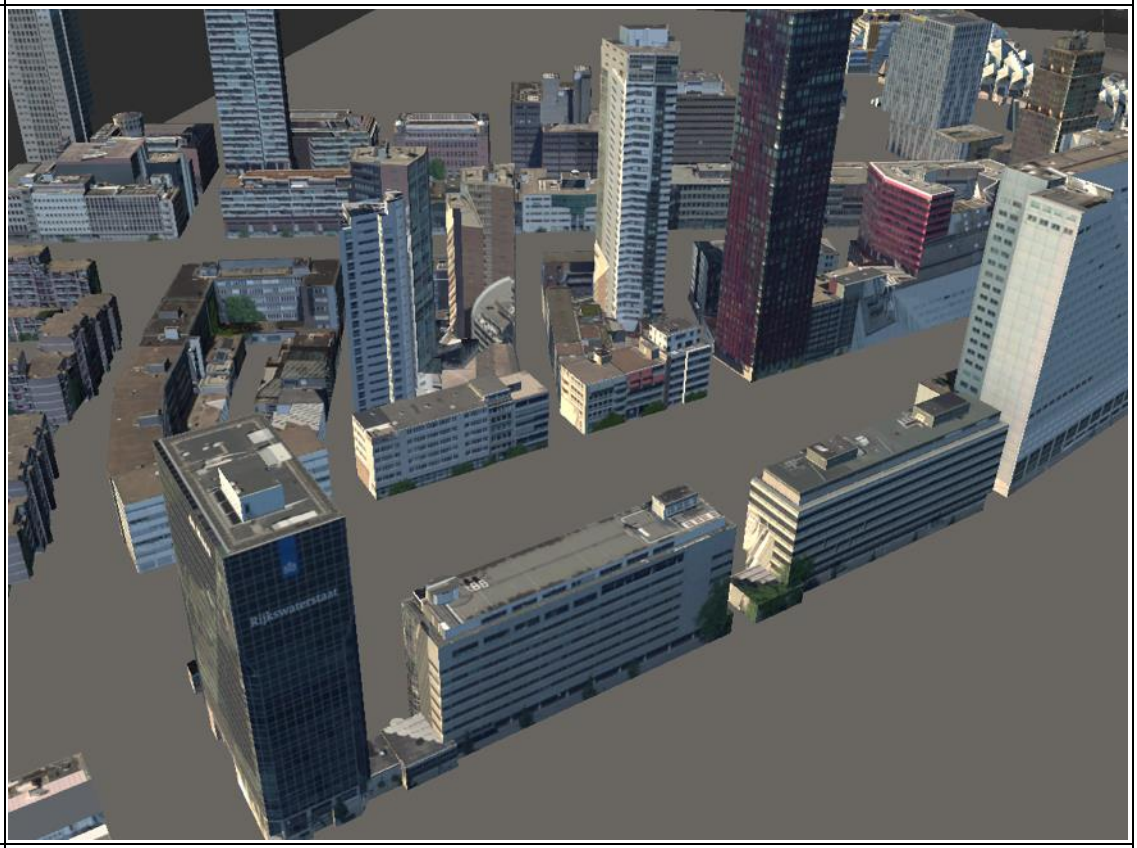
Autodesk Infraworks 2020

Software	Software Name [version]	**Infraworks [2020]**		Software house		**Autodesk**	
	Proprietary or open source software?			Kind of software			
	proprietary			Infrastructure design			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	Lenovo Thinkpad P1 Gen 2 (2019)	Windows 10 Home	i7-9750H @ 2.60GHz	Nvidia Quadro T1000	16	512	220
ADE	1.1) Does it support CityGML ADEs?	No					
Needed Data Format and conversion	2.1) Does it support this CityGML dataset in native format?	Yes, but I used one specific tool/plugin/procedure/different implementation format than GML (explain why and how does it work in the next questions)					
	2.1.1) Which one of the following is true?	Some specific translation through specific tool/plugin is necessary, or other kind of formats are used.					
	2.1.1.2) What processing and/or tools/plugins are necessary to import the CityGML file?	It needs to be converted to .imx using an FME importer					
	2.1.1.3) Attach screenshots Image 1.1						

Test with Rotterdam.gml		
How long does it	Import (and visualise, if the software allows it) the model	1-5 minutes
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate

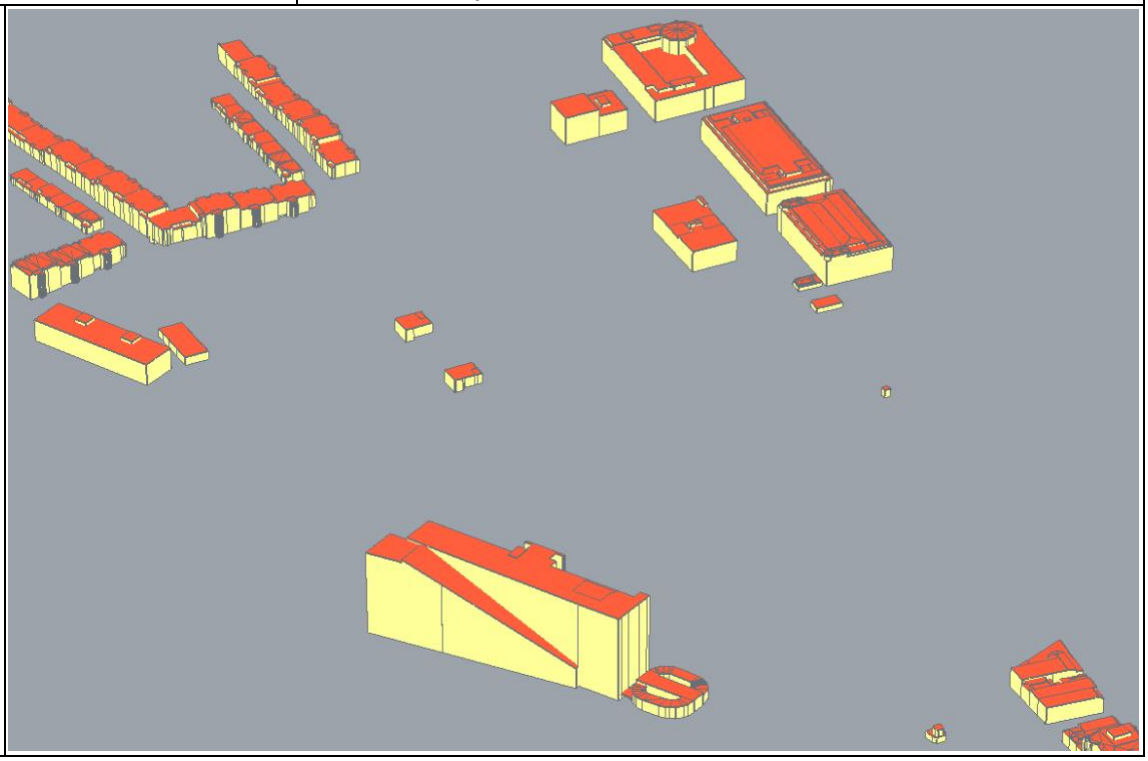
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	the software does not allow this
LoDs	4.1) How are the different LoDs read /managed?	Seemingly, only LoD2 is loaded
	4.3) Attach screenshots Image 1.2	
Texture	Can textures be visualised correctly?	Yes (see image 1.2)
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	The software does not have the necessary tools for checking it
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	No
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	The software does not have the necessary tools for checking it
	10.2) short comments to the previous question (optional)	Can't see any info or attributes
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	The software does not have the necessary tools to determine this information
	12.1) Are the attributes present in the CityGML entities retained and consistent?	The software does not have the necessary tools to determine this information

	13.1) Are the relationships between the objects retained?	The software does not have the necessary tools to determine this information
Geometry	14.1) Is geometry read correctly?	Yes
	Are you able to visualise textures	Yes
	15.1) Did normals change?	No
View	16.1) Is it possible to view the model in 3D?	Yes
	17.1) Is it possible to view the model in 2D?	No
Editing	18.1) Is it possible to edit the model?	No
Query	19.1) Is it possible to query the model and the attributes?	No
Analyse	20.1) Is it possible to analyse the objects and the model?	No
Export	You arrived at the end of the phase 1: "Import and manage the file in the software".Now choose:	The software cannot export to CityGML, therefore skip the phase 2
Test with BuilsdingsLOD3.gml[2]		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	less than a minute
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	the software does not allow this
Georef	24.1) Does the model maintain its correct dimensions and proportions?	Yes
Test with amsterdam.gml		
	How long does it take, approximately, to: Import the model	it crashes without completing the operation
Final notes		
	Kind of CityGML management possible	• Import • view

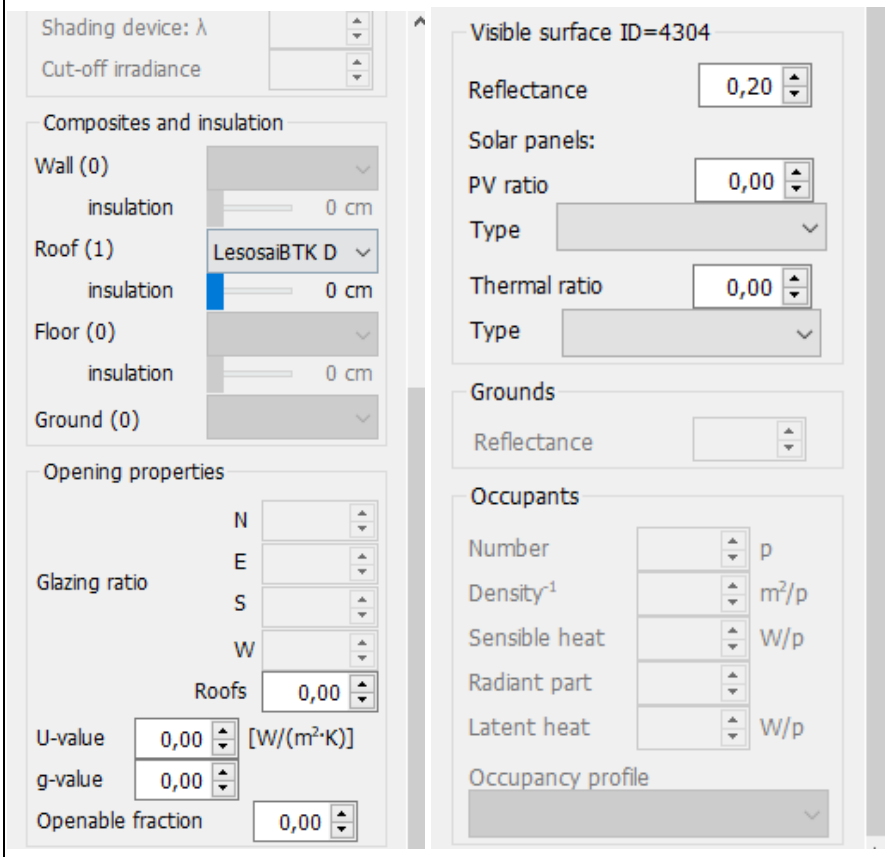
[2] The information already reported for the Rotterdam dataset is not repeated, unless there is any noticeable difference.

Kaemco City Sim Pro

Software	Software Name [version]	**CitySim Pro**		Software house		kaemco	
	Proprietary or open source software?			Kind of software			
	proprietary			Energy Analyser			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	Lenovo Thinkpad P1 Gen 2 (2019)	Windows 10 Home	i7-9750H @ 2.60GHz	Nvidia Quadro T1000	16	512	220
ADE	1.1) Does the software support CityGML ADEs?		No				
Formats	2.1) Does the software support this CityGML data in native format?		Yes				

Test with Rotterdam.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	less then a minute
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	the software does not allow this
LoDs	4.1) How are the different LoDs read/managed in the software?	Only LoD2 is loaded: It can only load LoD2 and LoD3, so for Rotterdam, only LoD2 is loaded
	4.3) Attach screenshots Image 2.1	

Texture	Can the textures be visualised correctly?	No, the software does not support the texture visualization (see image 2.1)
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	No, the software does not have the necessary tools for checking it.
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	The software does not have the necessary tools to check this information
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	The software does not have the necessary tools for checking it
	8.1) Is the model oriented correctly with respect to the true North?	The software does not have the necessary tools to determine this information
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	No
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	The software does not have the necessary tools for checking it
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	The software does not have the necessary tools to determine this information
	12.1) Are the attributes present in the CityGML entities retained and consistent?	The software does not have the necessary tools to determine this information
	13.1) Are the relationships between the objects retained?	The software does not have the necessary tools to determine this information
Geometry	14.1) Is geometry read correctly?	Yes
	15.1) Did normals change?	No
View	16.1) Is it possible to view the model in 3D?	Yes
	17.1) Is it possible to view the model in 2D?	No
Edit	18.1) Is it possible to edit the model?	Yes, You can edit some energy-related attributes of parts of the building (u-value, glazing ratio)

	18.1.2) Attach screenshots	

Query	19.1) Is it possible to query the model and the attributes?	No
Analysis	20.1) Is it possible to analyse the objects and the model?	No, Nothing works at least - no buttons to click. Can only export a .rad (radiance) file, not sure if an analysis is performed for this.
Export	You arrived at the end of the phase 1: "Import and manage the file in the software".Now choose:	The software cannot export to CityGML, therefore skip the phase 2 The export button is greyed out

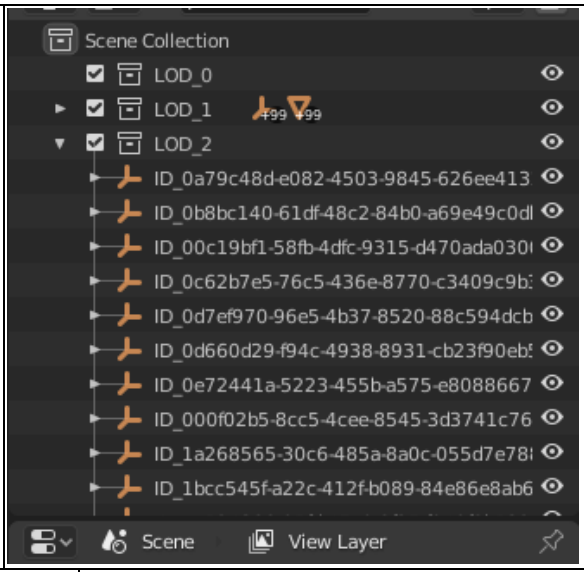
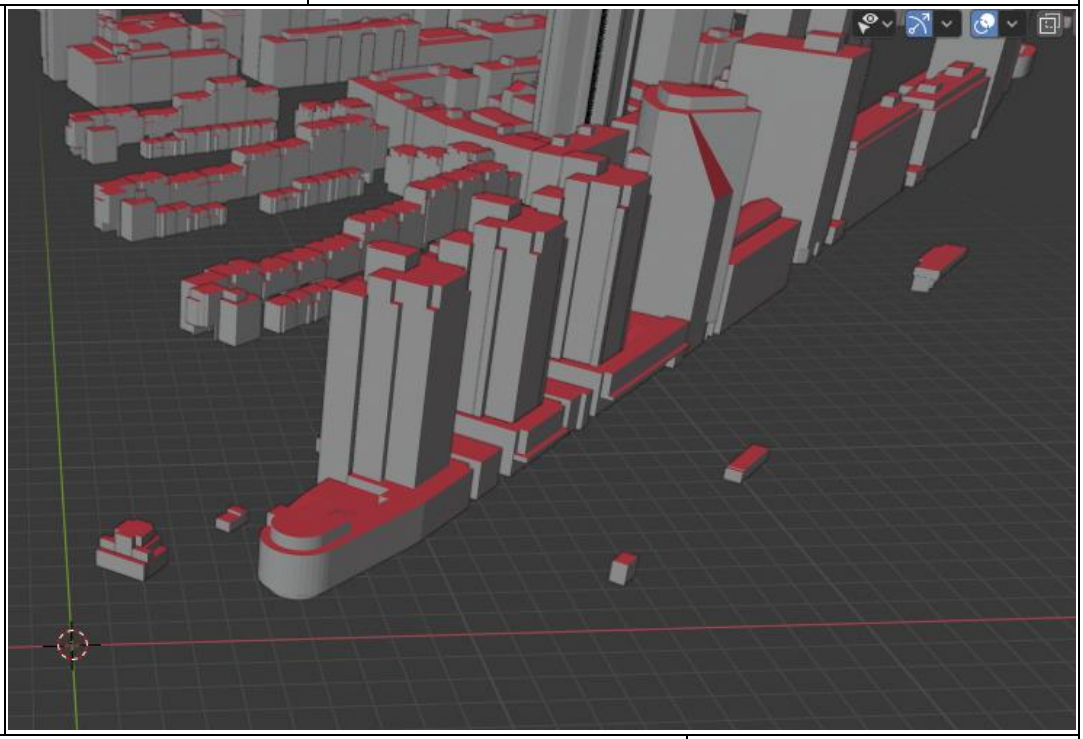
Test with BuildingsLOD3.gml[3]		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	the software does not allow this
Geometry	24.1) Does the model maintain its correct dimensions and proportions?	The software does not have the necessary tools to determine this information

[3] The information already reported for the Rotterdam dataset is not repeated, unless there is any noticeable difference.

Test with amsterdam.gml		
	How long does it take, approximately, to:Import (and visualise, if the software allows it) the model	it crashes without completing the operation
Final notes		
	Kind of CityGML management possible	• Import • View • edit
	58) Would you like to share any other comments or observations?	The software couldn't do much. I couldn't see any attributes for example, besides something built into the software related to energy (U-value for example), but this didn't come from the original files.

Blender

Software	Software Name [version]	**Blender [2.81a]**		Software house		https://www.blender.org	
	Proprietary or open source software?			Kind of software			
	Open source			3D modeling suite			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	Lenovo Thinkpad P1 Gen 2	Windows 10 Home	i7-9750H @ 2.60GHz	Nvidia Quadro T1000	16	512	220
ADE	1.1) Does the software support CityGML ADEs?			Yes			
	1.1.1) Are they directly managed without any change in the settings / specific tools / plugins?			Yes			
	Kind of management of ADE information			• it can be viewed and inspected • it can be queried			
Data formats	2.1) Does the software support this CityGML data in native format?			No Some specific translation through specific tool/plugin is necessary, or other kind of formats are used.			
	2.1.1.2) What processing and/or tools/plugins are necessary to import the CityGML file?Please justify your choices.			It is converted to CityJSON using citygml-tools			
Test with RotterdamLOD3.gml							
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model			less then a minute			
	Zoom into the model to see more detail			it's almost immediate			
	Pan the model			it's almost immediate			
	Rotate the model			it's almost immediate			
	Query an object			it's almost immediate			
	Inspect the objects linked to the queried one through a relationship			the software does not allow this			
LoDs	4.1) How are the different LoDs read/managed in the software?		They are all read and managed in the software and a consistent multi-LoD view and management is possible by visualising / managing / analysing the objects in the different connected LoDs.				
	4.2) Please, give more details and examples		The LoDs are loaded into different layers. You can remove layers or make them invisible. You can see which objects belong to every layer.				

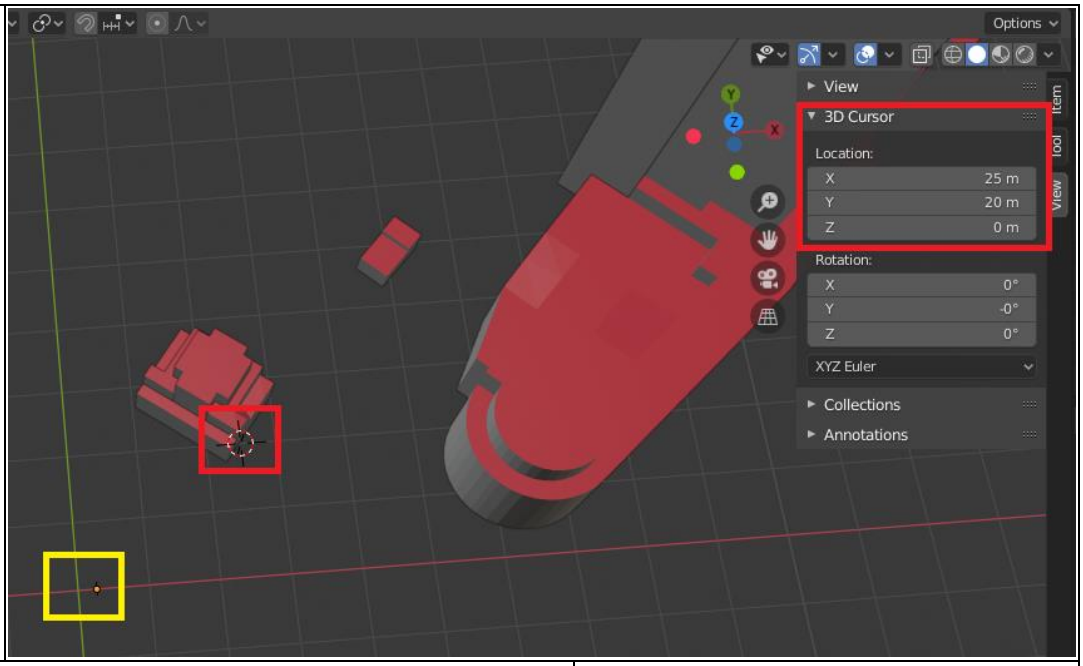
	4.3) Attach screenshots Image 3.1	
Textures	Can the textures be visualised correctly?	No, the software does not support the texture visualisation
	Attach screenshots Image 3.2	
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	No
	6.1.1) Where is the origin of the model coordinate reference system as imported in the software?	The origin starts at (0, 0), in the bottom left of the dataset

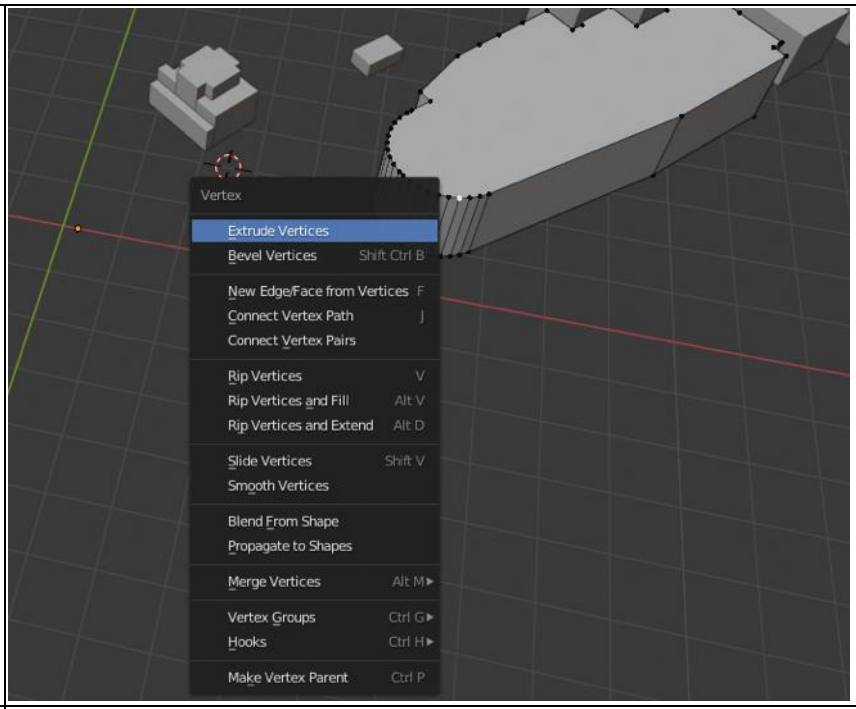
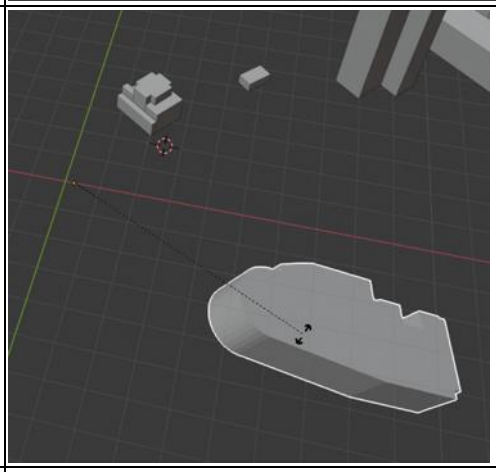
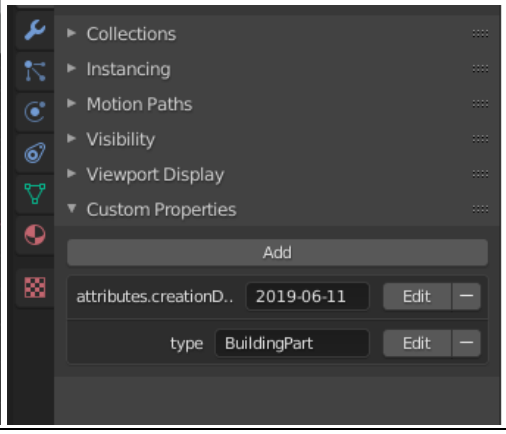
Blender – Windows 10 Home

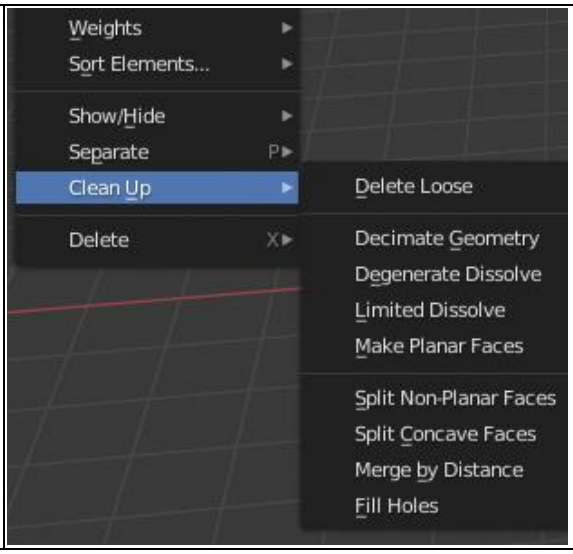
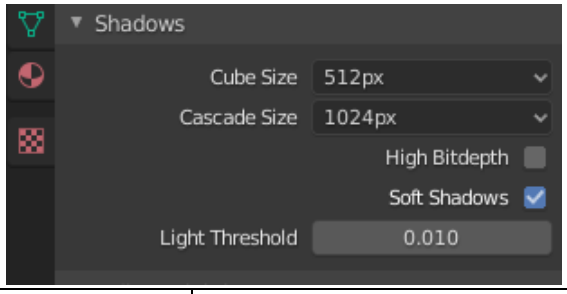
Open source software

3D modeler

Level of tester expertise: 1 - Very beginner user (it is nearly the first time you use the software)

	6.1.2) Attach screenshots Image 3.3 – Coordinates of the round cursor, origin in the yellow box.	
	6.1.3) What is the coordinate reference system and projection and what the unit of measure is used for the representation?	Local right-handed system with metres as unit of measurement (see image 3.3)
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	No
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	Yes
	12.1) Are the attributes present in the CityGML entities retained and consistent?	Yes
	13.1) Are the relationships between the objects retained?	Yes
Geometry	14.1) Is geometry read correctly?	Yes
	15.1) Did normals change?	No
View	16.1) Is it possible to view the model in 3D?	Yes
	17.1) Is it possible to view the model in 2D?	No
Edit	18.1) Is it possible to edit the model?	Yes
	18.1.1) What editing is possible (attributes, geometry, georeferencing, please add details)?	You can edit attributes and geometry (move, rotate, scale, edit vertices) (See images 3.4-3.6).

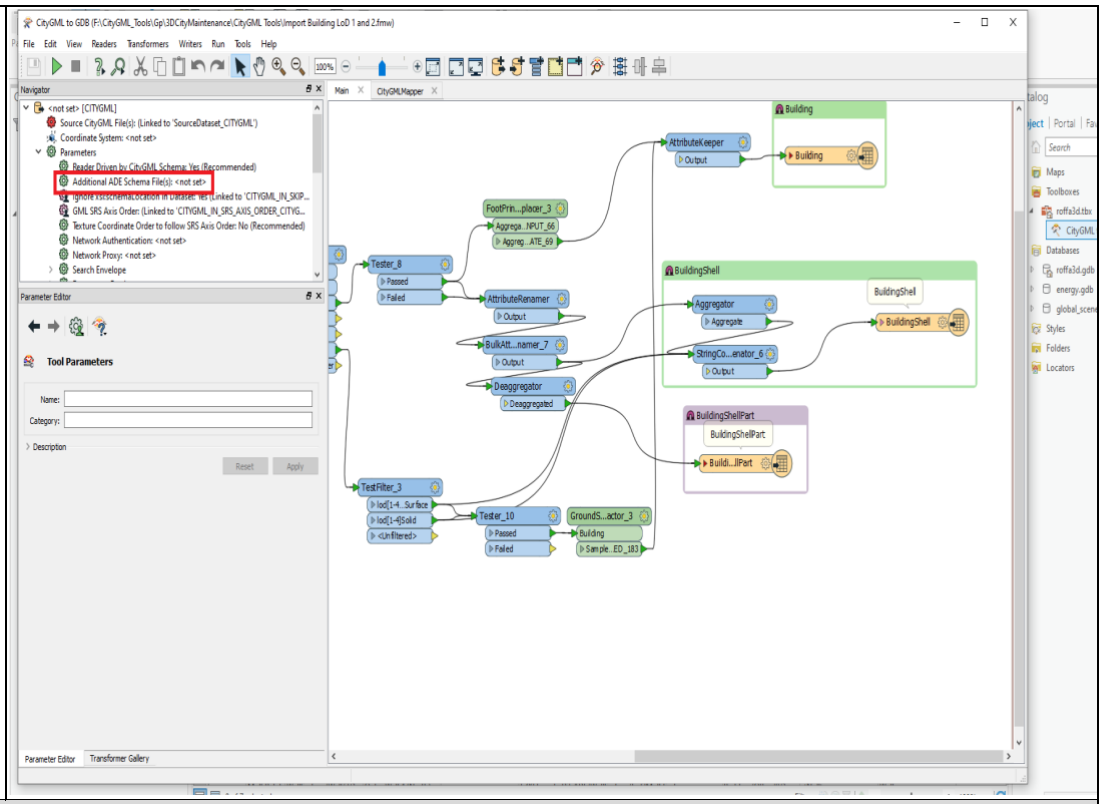
	18.1.2) Attach screenshots Image 3.4 – Editing vertices	
	Image 3.5 – Rotating objects Image 3.6 – Editing attributes	 
Query	19.1) Is it possible to query the model and the attributes?	Yes
	19.1.1) What kinds of query are possible?	Any query (spatial and on attributes), but you have to write it in Python (https://blender.stackexchange.com/questions/122878/selecting-objects-with-the-same-property-values-without-python)
Analysis	20.1) Is it possible to analyse the objects and the model?	Yes, analysis about the validity and features of the model are possible (geometry, semantics, validity...) (type 1)
	20.1.1) What analysis are possible? Do you know if the results are reliable? How much time is needed to perform them?	You can clean the geometries. It is also possible to create (visual) shadows, but I don't think that counts as actual shadow analysis.

	20.1.2) Attach screenshots Image 3.7 – Clean geometries Image 3.7 – Create shadows	 
	20.1.3) Time required to perform the analysis about the model itself (type 1)	it's almost immediate
	20.1.4) Time required to perform the analysis about the model itself (type 2)	No analysis of type 2 are possible
Export	You arrived at the end of the phase 1: "Import and manage the file in the software".Now choose:	The software has also export-to-CityGML abilities However, The output file is basically empty.
Test with BuildingsLOD3.gml[4]		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	the software does not allow this
View	31.1) Is it possible to view the model in 3D?	Yes
	32.1) Is it possible to view the model in 2D?	Yes
Test with Amsterdam.gml		
	How long does it take, approximately, to:Import (and visualise, if the software allows it) the model	it crashes without completing the operation
Final notes		
	Kind of CityGML management possible	• Import • View • Query • Edit • analysis

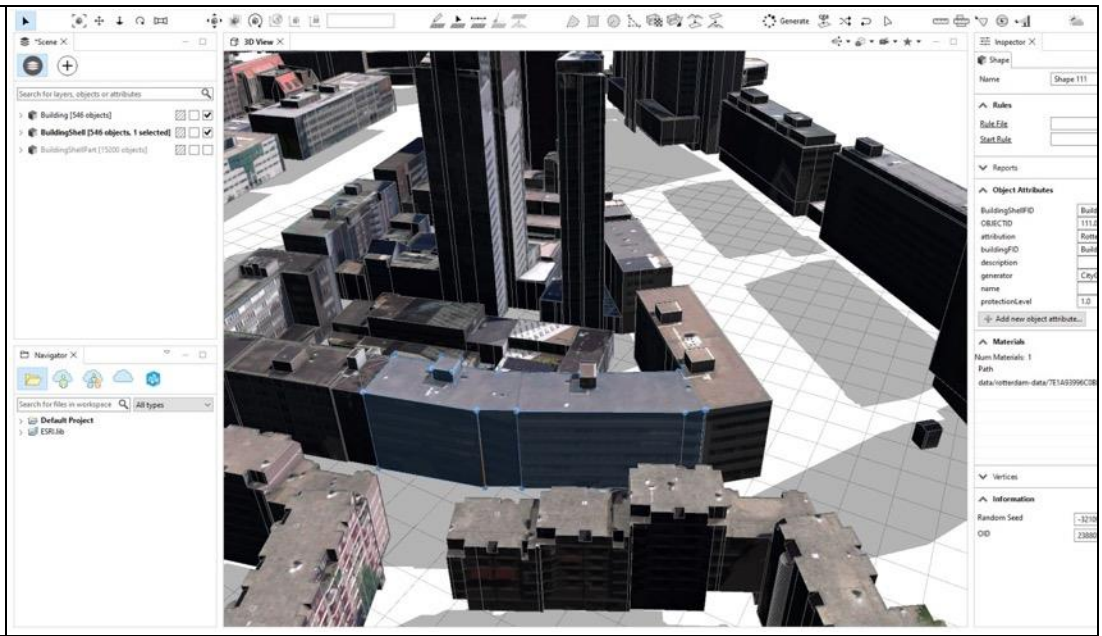
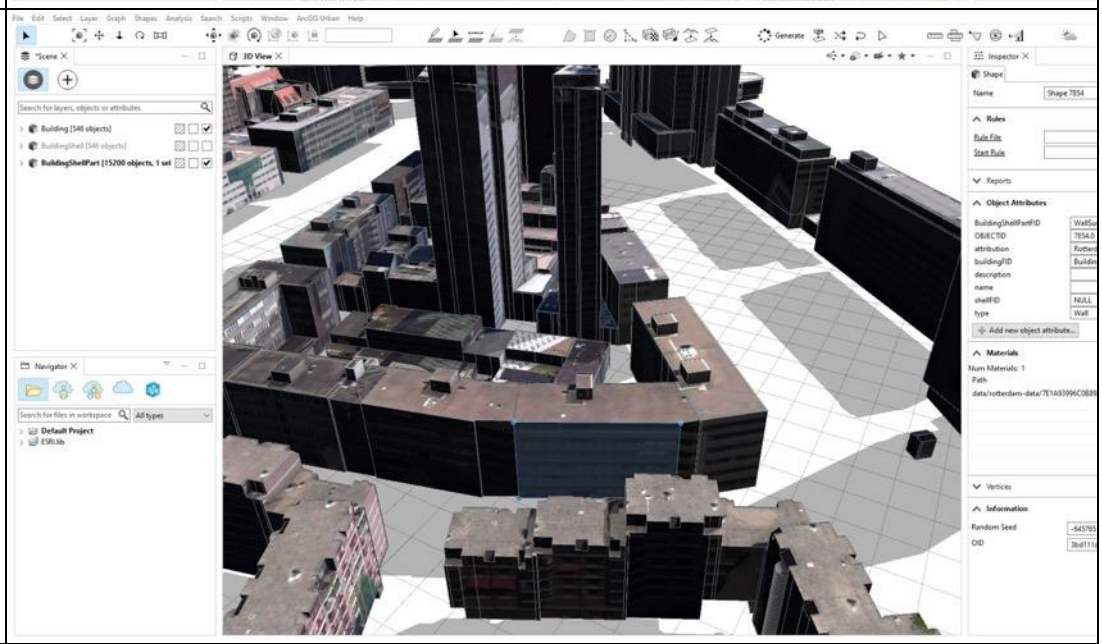
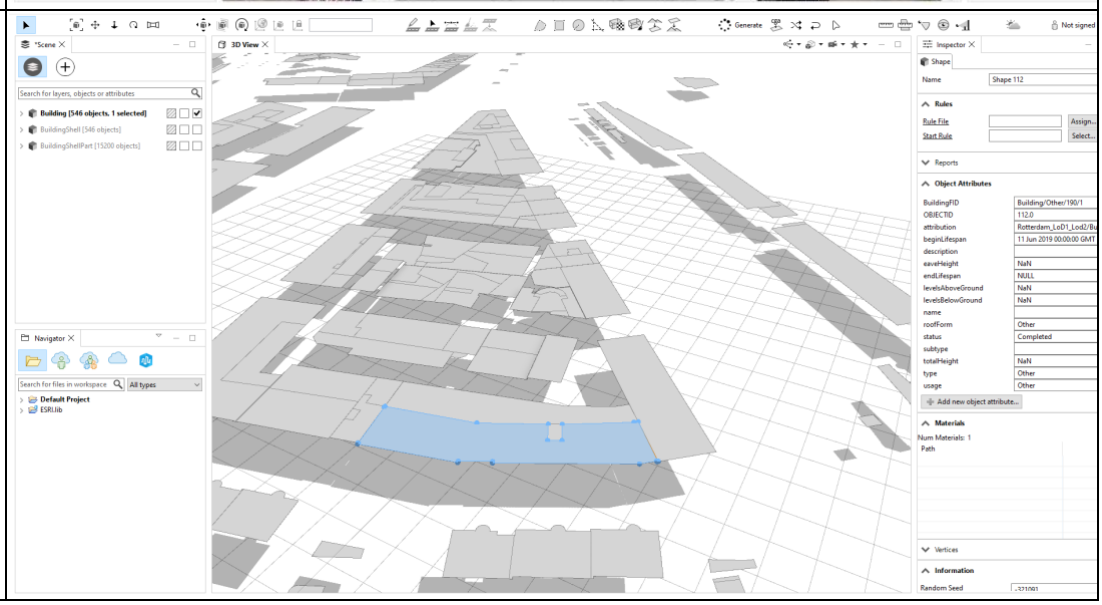
[4] The information already reported for the Rotterdam dataset is not repeated, unless there is any noticeable difference.

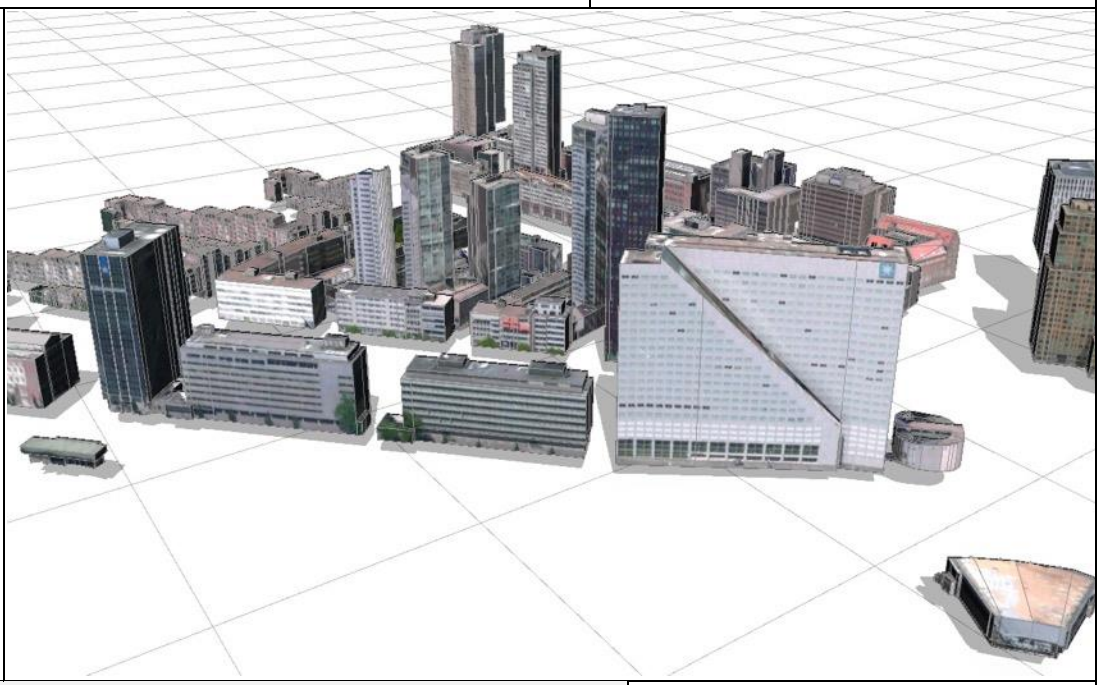
ESRI CityEngine

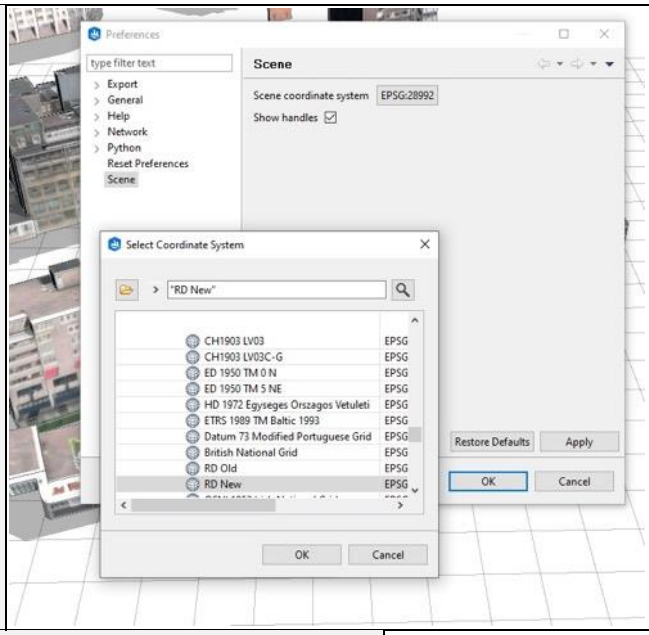
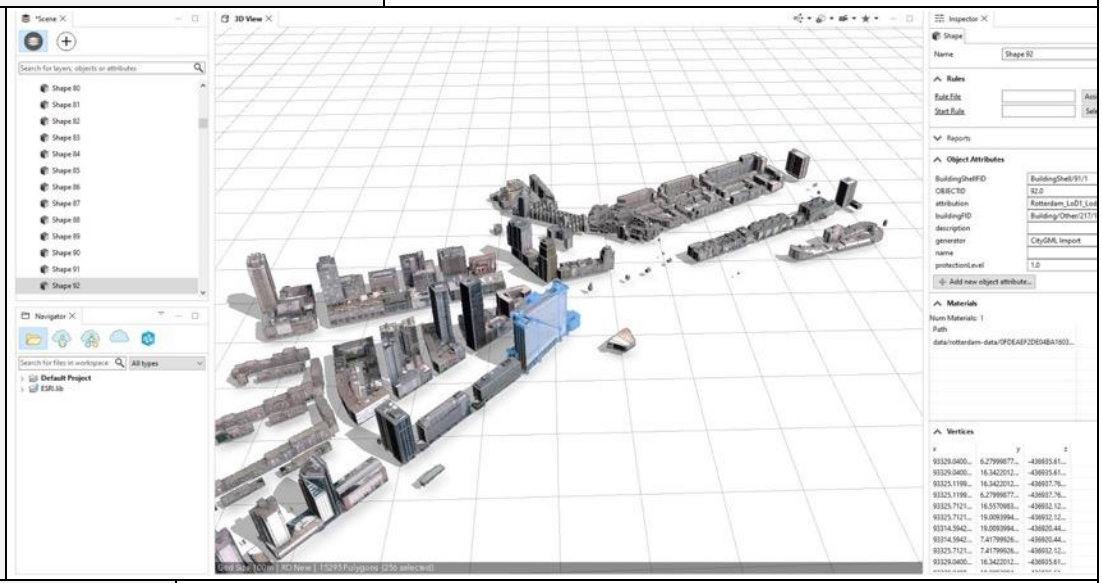
Software	Software Name [version]	**CityEngine [2019.1]**		Software house		ESRI	
	Proprietary or open source software?			Kind of software			
	proprietary			3D modeling software			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	self-built desktop (2013)	Windows 10 Home 64-bit	Intel i5-4570 @ 3.20GHz	AMD Radeon HD 7800 Series	8 GB	120 GB	20 GB
ADE	1.1) Does the software support CityGML ADEs?	No					
	1.2) Add short comments to the previous questions (optional)	First of all, you have to use the Data Interoperability extension for ArcGIS (so this is done outside of CityEngine!). You need a license for it. Then, within the extension, you need to specify the path to an ADE schema (.xsd file), which you have to download yourself. In the end, you'll have a geodatabase that include an attribute table with ADE attributes, but this can't be opened in CityEngine. (See image 4.1)					
Data formats	2.1) Does the software support this CityGML data in native format?	No					
	2.1.1) Which one of the following is true?	Some specific translation through specific tool/plugin is necessary, or other kind of formats are used.					
	2.1.1.2) What processing and/or tools/plugins are necessary to import the CityGML file?Please justify your choices.	You have to use the Data Interoperability extension for ArcGIS (so this is done outside of CityEngine!). You need a license for it. Then, within the extension, you can create a toolbox and convert CityGML to a geodatabase. This can be opened in CityEngine.					

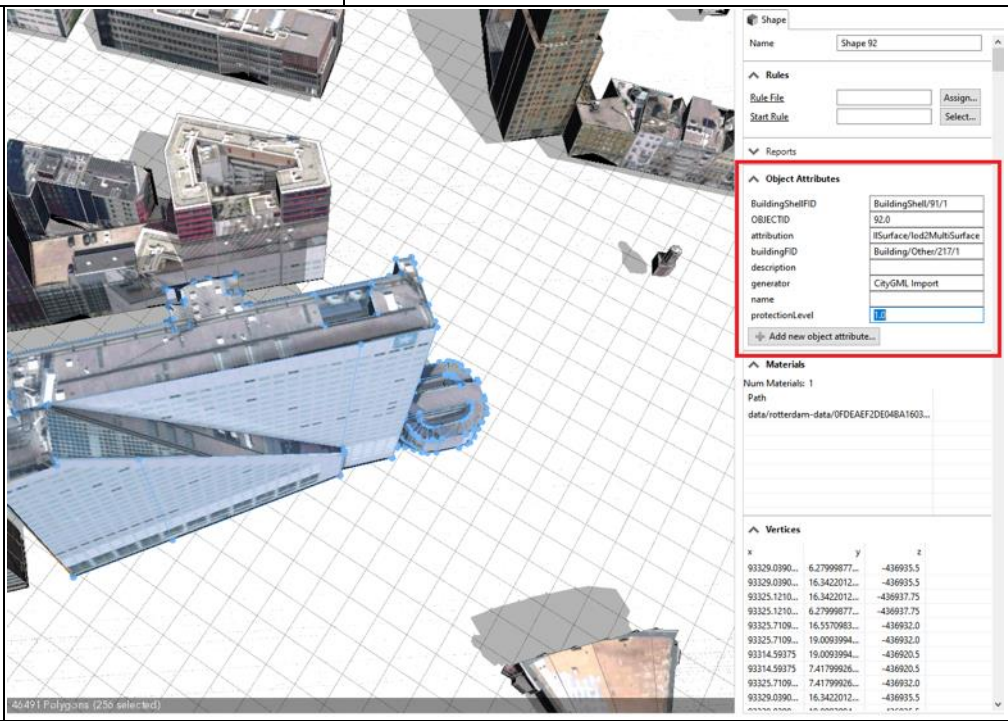
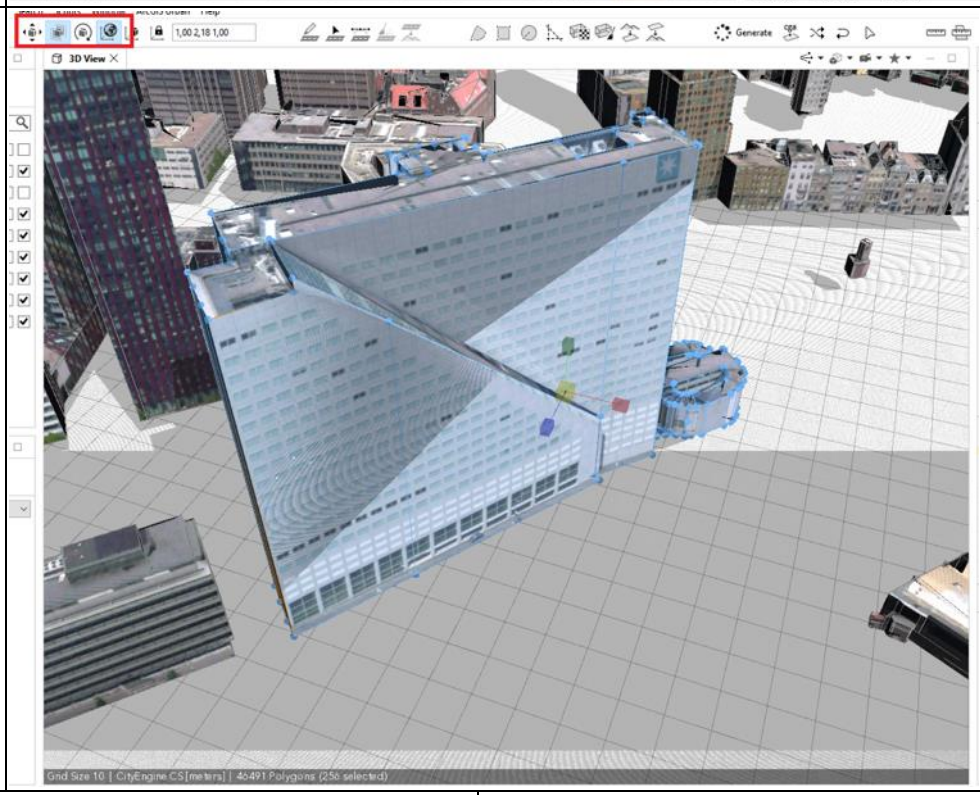
	2.1.1.3) Attach screenshots Image 4.1 – CityGML to ESRI geodatabase converter and setting for ADE	

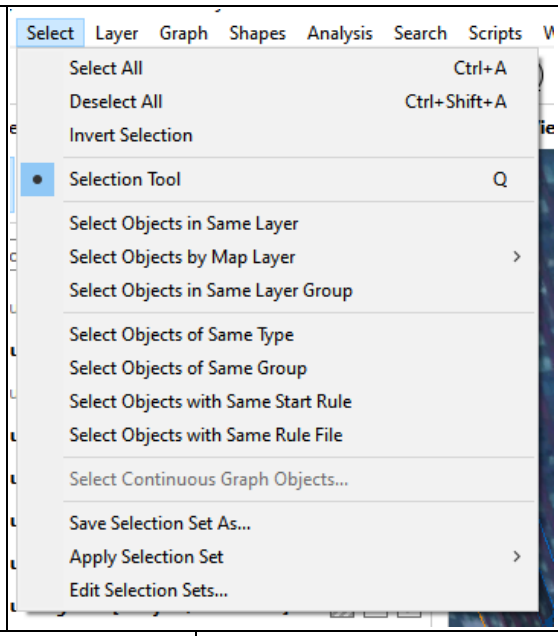
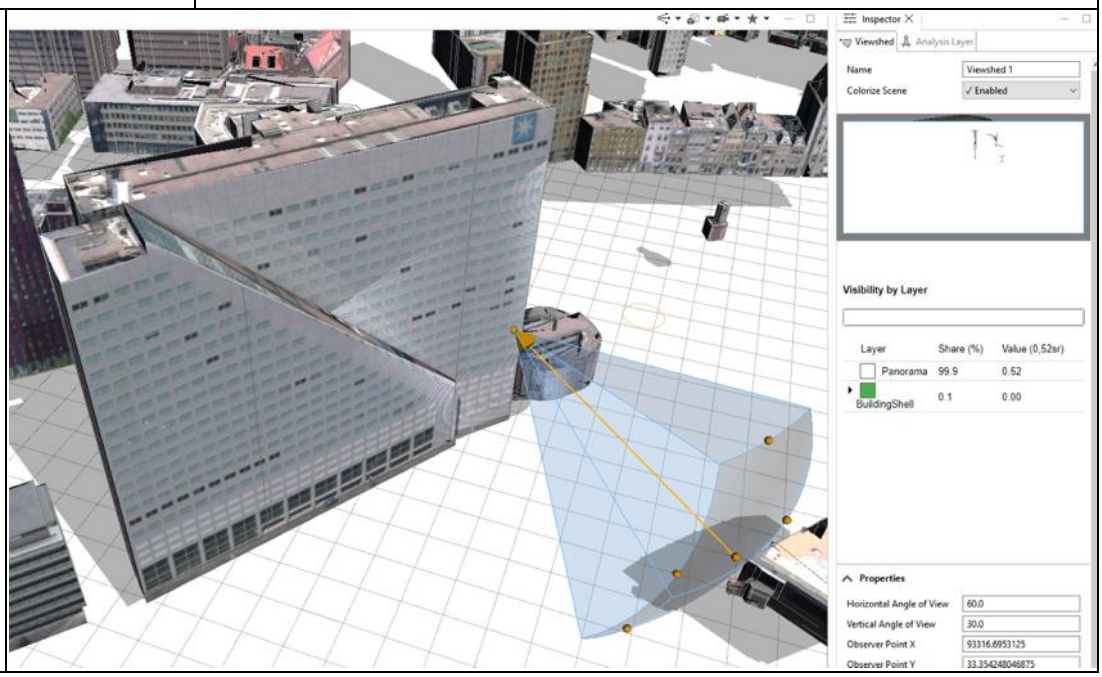
Test with Rotterdam.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	20 minutes-1 hour
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	the software does not allow this
LoDs	4.1) How are the different LoDs read/managed in the software?	Only LoD0 (footprints) and LoD2 are imported There are three layers: Buildings - the building footprints (LoD0) BuildingShell - full buildings in LoD2 BuildingShellPart - the separate parts of buildings in LoD2

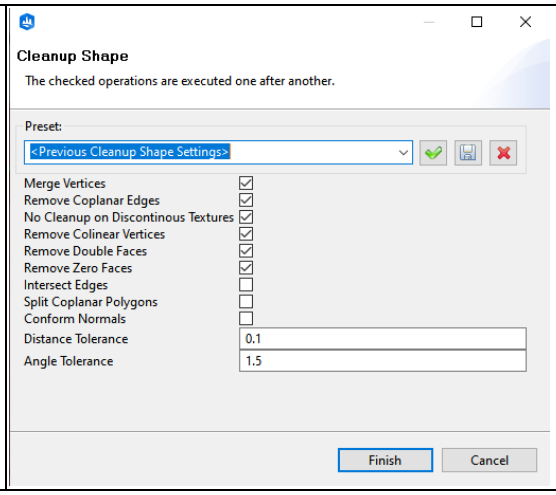
	4.3) Attach screenshots Image 4.2 – Full buildings in LoD2, with texture	
	4.3) Attach screenshots Image 4.3 – Building part in LoD2, with texture	
	4.3) Attach screenshots Image 4.4 – Building footprint (LoD0).	

Textures	Can the textures be visualised correctly?	Yes
	Attach screenshots Image 4.5 – building textures	
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	7.2) short comments to the previous question (optional)	This is demonstrated by buildings floating in the air. The floors of buildings are not move to height 0.
	8.1) Is the model oriented correctly with respect to the true North?	Yes There is no north arrow, but by inspecting the coordinates (and grid lines), you can check that it's oriented correctly.
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	Yes
	9.1.1) What are the tools needed to set the correct CRS, or where is it possible to set it in the software?	You need to set the CRS of the scene first. Then you can import the model which will use the scene CRS.

	9.1.2) Attach screenshots Image 4.6 – Setting CRS	
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	Yes Parts are linked to their parents through an attribute field containing an ID.
	12.1) Are the attributes present in the CityGML entities retained and consistent?	No
	12.1.1) What changes / inconsistencies / errors / other issues were noted?	Only LoD2 can be checked. The yearOfConstruction attribute that is shown can't be found.
	12.1.2) Attach screenshots Image 4.7 – attributes and semantics	
	13.1) Are the relationships between the objects retained?	The software does not have the necessary tools to determine this information The relationships can't be seen.
Geometry	14.1) Is geometry read correctly?	Yes
	15.1) Did normals change?	No
> ·–	16.1) Is it possible to view the model in 3D?	Yes

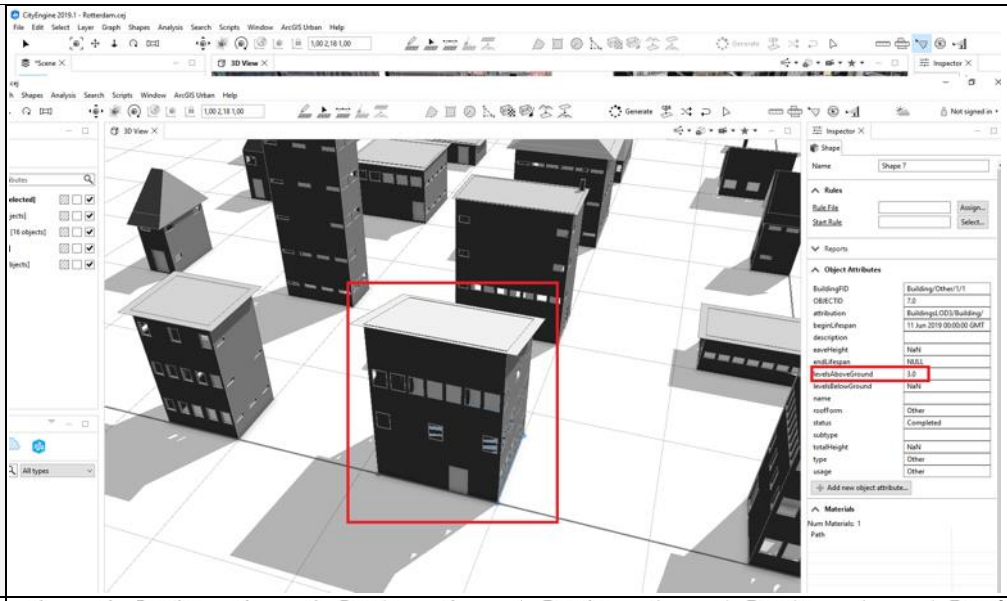
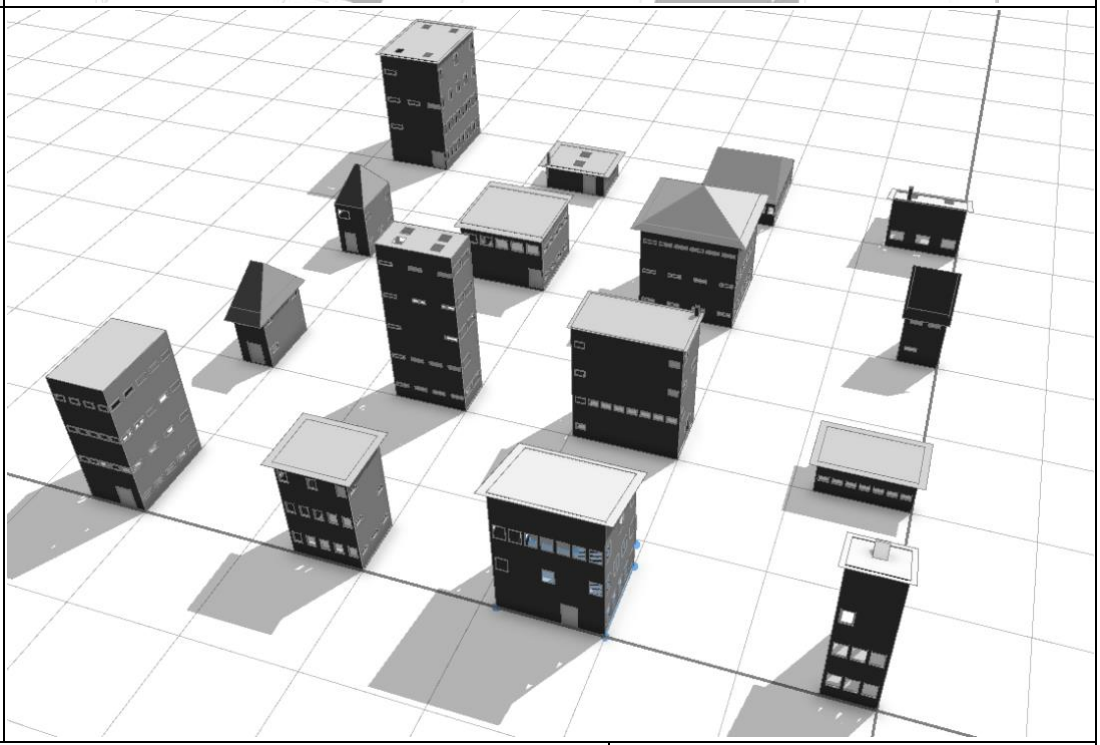
	17.1) Is it possible to view the model in 2D?	No
Editing	18.1) Is it possible to edit the model?	Yes
	18.1.1) What editing is possible (attributes, geometry, georeferencing, please add details)?	You can edit the attributes of all features. You can move, scale and rotate geometries. Georeferencing can't be edited (only for the whole scene, but this does not affect the data).
	18.1.2) Attach screenshots Image 4.8 – Editing attributes	
	Image 4.9 – Editing geometry	
Query	19.1) Is it possible to query the model and the attributes?	No
	19.1.1) What kinds of query are possible?	You can query only based on same layer/group/type of an already selected object

	19.1.2) Attach screenshots Image 4.10 – Selection tool	
Analysis	20.1) Is it possible to analyse the objects and the model?	Yes, both analysis about the model and the model performaces are possible (type 1 and 2)
	20.1.1) What analysis are possible? Do you know if the results are reliable? How much time is needed to perform them?	Type 1: you can clean shapes up (merge vertices, remove coplanar edges, remove double faces etc.). Takes a few seconds. Type 2: viewshed, view dome, and view corridor analysis. Takes about ten seconds.
	20.1.2) Attach screenshots Image 4.11 – Viewshed analysis	

	20.1.2) Attach screenshots Image 4.12 – clean up geometries	
	20.1.3) Time required to perform the analysis about the model itself (type 1)	it's almost immediate
	20.1.4) Time required to perform the analysis about the model itself (type 2)	less than a minute
Export	You arrived at the end of the phase 1: "Import and manage the file in the software".Now choose:	The software cannot export to CityGML, therefore skip the phase 2

Test with BuildingsLOD3.gml[5]		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	1-5 minutes
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	the software does not allow this
Geometry	24.1) Does the model maintain its correct dimensions and proportions?	Yes
Se	27.1.1) What changes / inconsistencies / errors / other issues were noted?	Only storeysAboveGround is kept

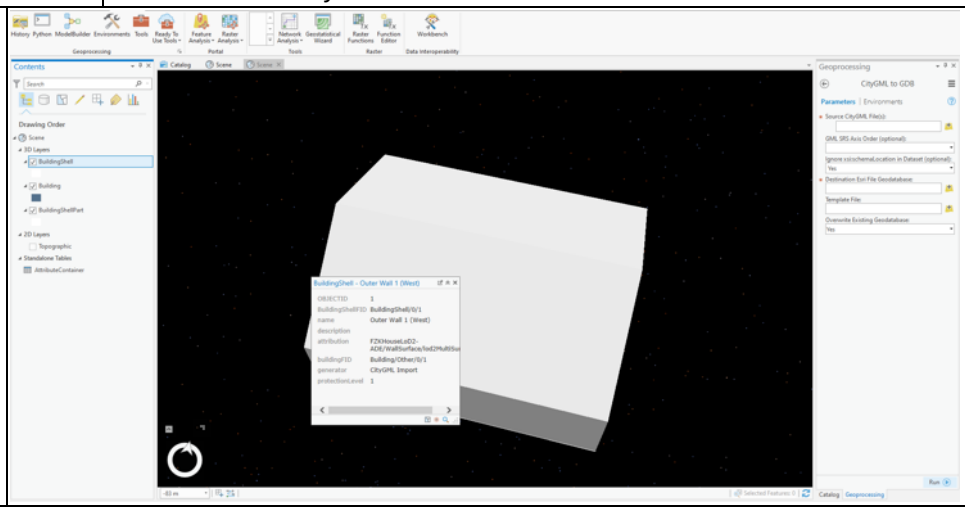
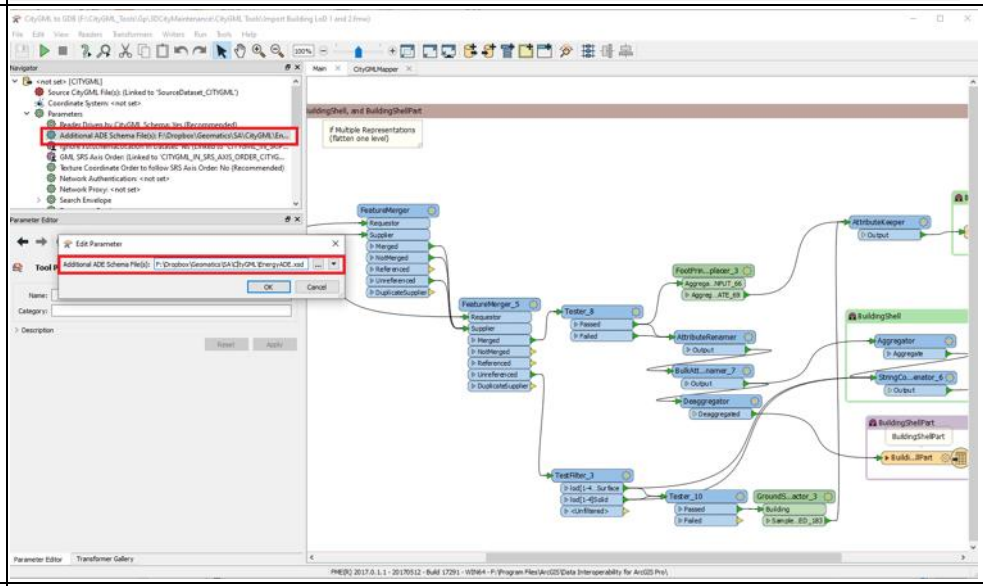
[5] The information already reported for the Rotterdam dataset is not repeated, unless there is any noticeable difference.

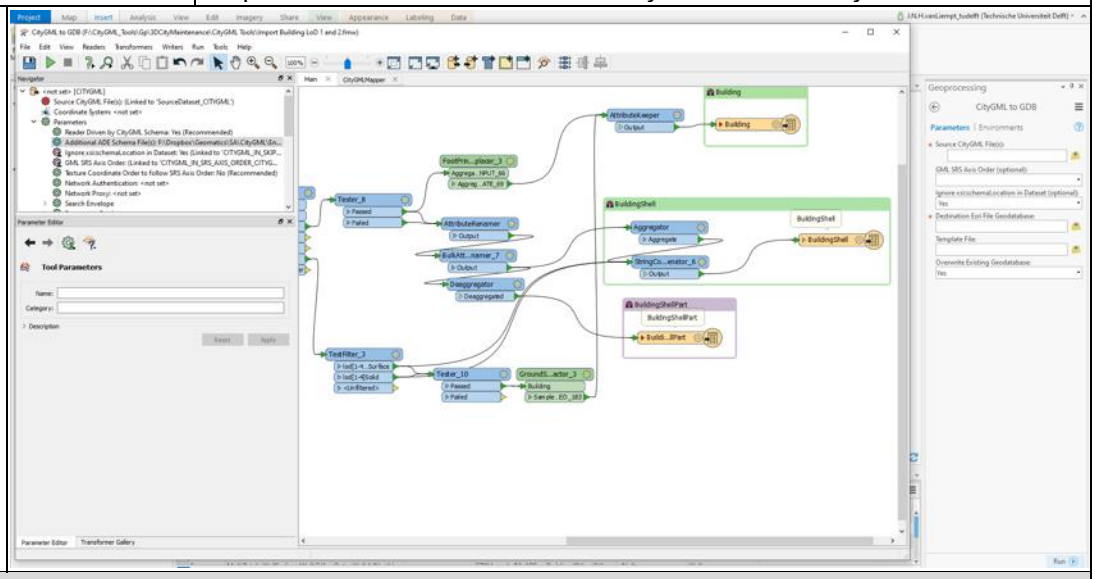
	27.1.2) Attach screenshots Image 4.13 – semantics in BuildingsLOD3.gml	
	30.1.2) Attach screenshots Image 4.14 – Normals and appearance in BuildingsLOD3.gml	

Export	You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:	It is possible to export to CityGML
	37) How long does it take for the data to be exported to CityGML?	less then a minute

Test with Amsterdam.gml		
	How long does it take, approximately, to:Import (and visualise, if the software allows it) the model	the software was not able to import the model, even without crushing

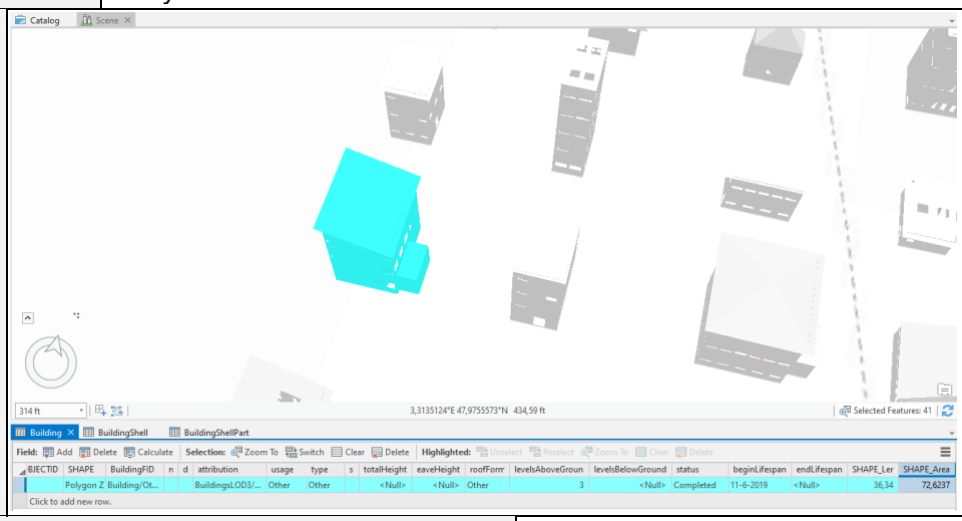
ESRI ArcGIS Pro – Test 1

Software	Software Name [version]	**ArcGIS Pro [2.0.0]**		Software house		**ESRI**	
	Proprietary or open source software?			Kind of software			
	proprietary			GIS			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	self-built desktop (2013)	Windows 10 Home 64-bit	Intel i5-4570 @ 3.20GHz	AMD Radeon HD 7800 Series	8 GB	120 GB	20 GB
ADE	1.1) Does the software support CityGML ADEs?			Yes			
	1.1.1) Are they directly managed without any change in the settings / specific tools / plugins?	No, some specific settings / tools / plugins are necessary First of all, you have to use the Data Interoperability extension. Then, within the extension, you need to specify the path to an ADE schema (.xsd file), which you have to download yourself.					
	1.1.1.2) Attach screenshots Image 5.1 – Query of an element (outer wall) defined within the Energy ADE.						
	Image 5.2 – Configuration needed to use an ADE schema						
	Kind of management of ADE information	• it can be viewed and inspected • it can be queried • it is possible to use the ADE information for analysis in the software					

Data formats	2.1) Does the software support this CityGML data in native format?	Yes, but I used one specific tool/plugin/procedure/different implementation format than GML (explain why and how does it work in the next questions)
	2.1.1) Which one of the following is true?	Some specific translation through specific tool/plugin is necessary, or other kind of formats are used.
	2.1.1.2) What processing and/or tools/plugins are necessary to import the CityGML file?	You need to use the ArcGIS Data Interoperability extension, which works with FME. Then you have to download FME models that convert CityGML to a geodatabase. https://github.com/Esri/3d-cities-template/tree/master/Workflows/3DCityMaintenance/CityGML%20Tools
	2.1.1.3) Attach screenshots Image 5.3 – In the left, the FME model, on the right a built toolbox function which uses the FME script.	

Test with RotterdamLoD12.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	20 minutes-1 hour
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it crashes without completing the operation
	Rotate the model	it crashes without completing the operation
	Query an object	it crashes without completing the operation
	Inspect the objects linked to the queried one through a relationship	it crashes without completing the operation
LoDs	4.1) How are the different LoDs read/managed in the software?	The software gives problems importing a multi-LoD CityGML file and crashes The model visualizes, but when I try to do anything, the whole computer freezes

Test with BuildingsLoD3.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	1-5 minutes
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	the software does not allow this
Georeferencing	24.1) Does the model maintain its correct dimensions and proportions?	Yes
	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes

	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes However, the features are located somewhere in France. I don't know if this is correct.
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes But when importing the data, the heights were negative, and as the features show up in France they would be under the ground. I therefore had to set the layers to be placed above the ground based on their height values, rather than being placed at their absolute height values.
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	No
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes Yes, but only as far as I could check. The importer only works with LOD1/LOD2 data, so Windows, Doors and BuildingInstallations seem to be ignored.
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	Yes The hierarchy is retained. There are different layers for full Buildings and for BuildingShellParts. However, the BuildingShellParts refer to their parent Building with an attribute.
	12.1) Are the attributes present in the CityGML entities retained and consistent?	No
	12.1.1) What changes / inconsistencies / errors / other issues were noted?	Element 3 and Element 4: roofTye (or roofForm in the software) has the value Other rather than the correct Flat. yearOfConstruction and function are not there.
	12.1.2) Attach screenshots Image 5.4 – Test with element 4	
	13.1) Are the relationships between the objects retained?	Yes Yes, by means of attributes that refer to others
Geometry	29.1) Is geometry read correctly?	Yes
	30.1) Did the normals change?	No

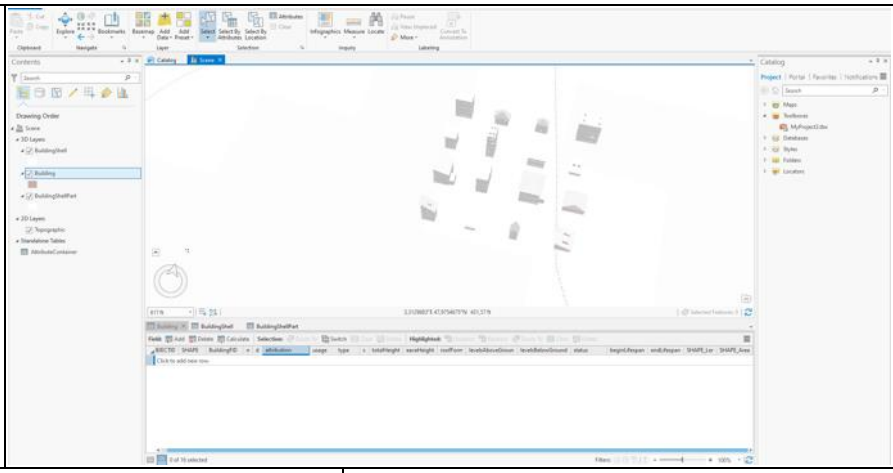
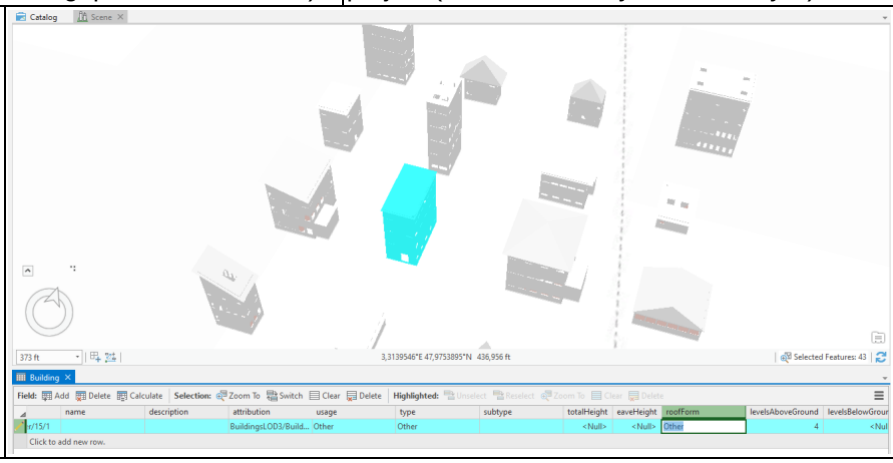
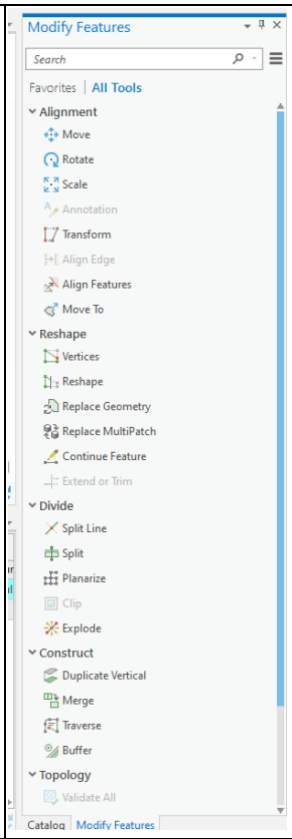
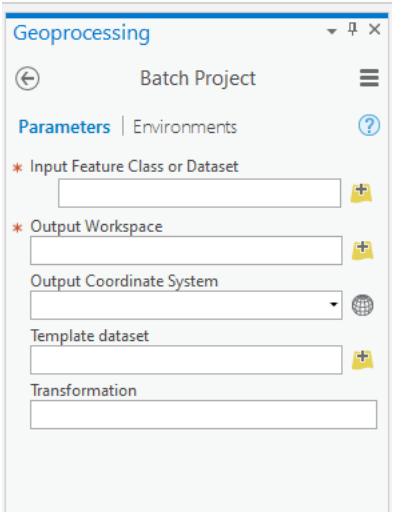
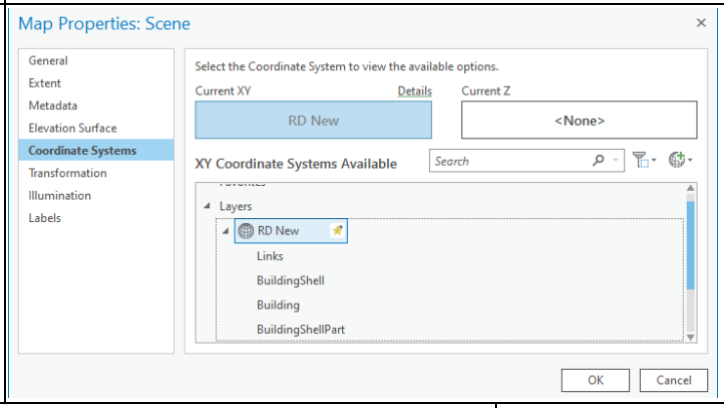
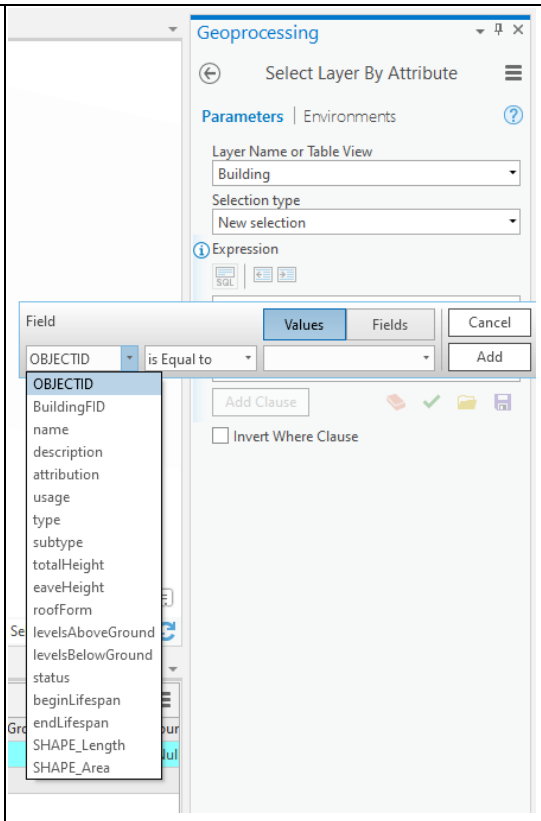
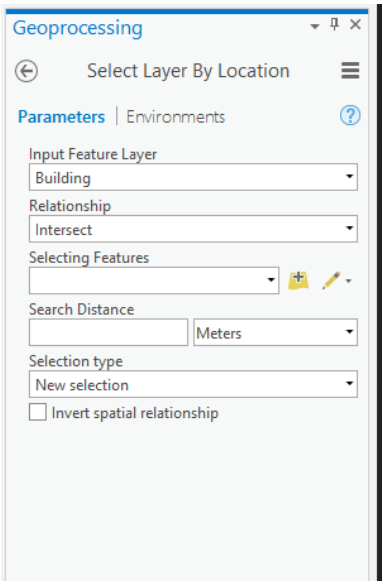
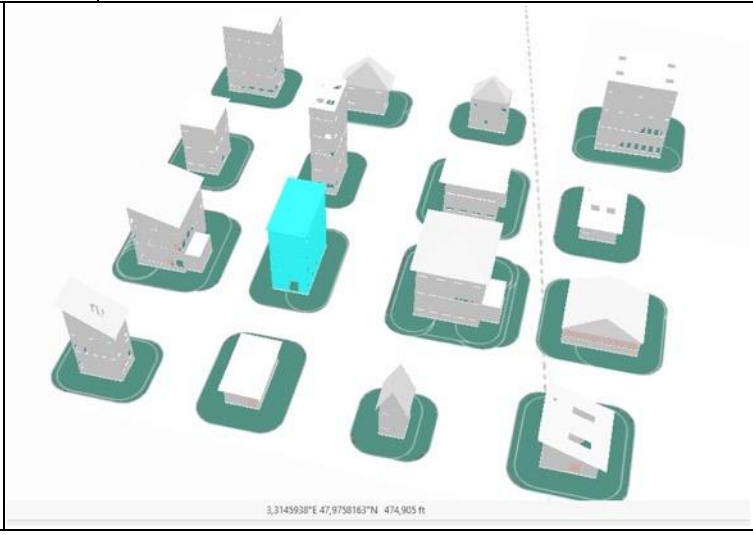
	30.1.2) Attach screenshots Image 5.5 – LoD3 model	
View	31.1) Is it possible to view the model in 3D?	Yes
	32.1) Is it possible to view the model in 2D?	Yes
Editing	33.1) Is it possible to edit the model?	Yes
	33.1.1) What editing is possible (attributes, geometry, georeferencing, please add details)?	You can edit the attributes, geometry and georeferencing of project (or coordinate system of a layer) however you want.
	33.1.2) Attach screenshots Image 5.6 – Editing attributes	

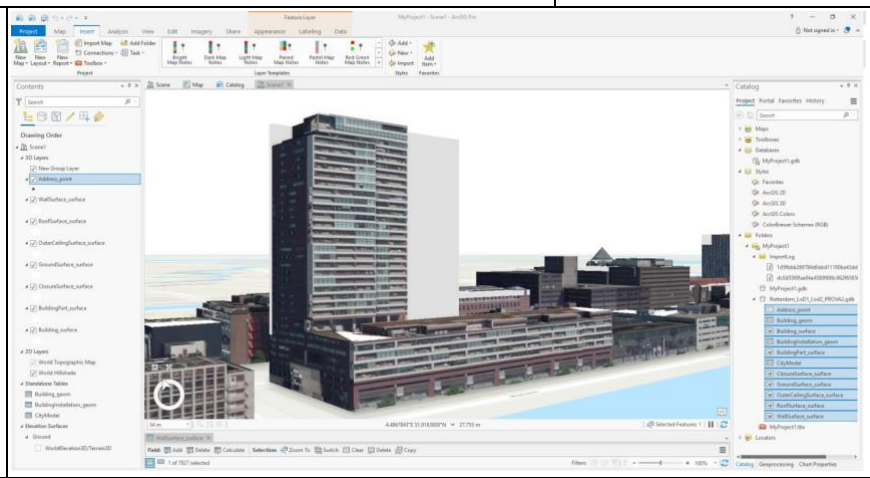
	Image 5.7 – Editing geometry Image 5.8– Editing coordinate system	 5.7  5.8
	Image 5.9 – Editing georeferencing of the whole project	
Query	34.1) Is it possible to query the model and the attributes?	Yes
	34.1.1) What kinds of query are possible?	Select by attributes or select by location

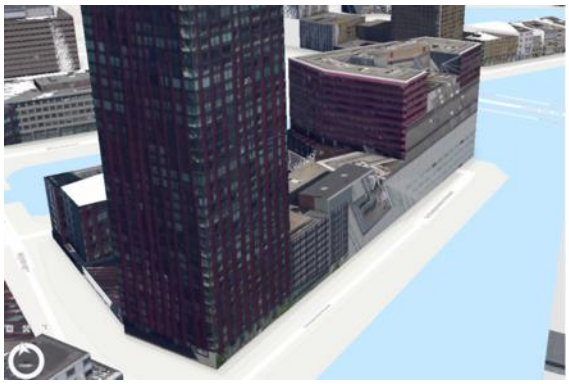
	34.1.2) Attach screenshots Image 5.10 – Select by attribute Image 5.11 – Select by location	 5.10  5.11
Analysis	35.1) Is it possible to analyse the objects and the model?	Yes
	35.1.1) What analysis are possible? Do you know if the results are reliable?	Basically any kind of GIS analysis. I did a 3 metre (2D) buffer around all buildings and it works reliably (I've measure the buffers). Others didn't work well (such as spatial join and intersect). It seems like you need the ArcGIS 3D Analyst extension for this.
	35.1.2) Attach screenshots Image 5.12 – Buffer 2D around building parts	
	35.1.3) Needed time to perform the analysis about the model itself (type 1)	less then a minute
	35.1.4) Needed time to perform the analysis about the model performance (type 2)	less then a minute
Export	You arrived at the end of the phase 1: "Import and manage the file in the software".Now choose:	The software has also export-to-CityGML abilities
	36.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?36	No
	37) How long does it take for the data to be exported to CityGML?	less then a minute
Test with Amsterdam.gml		

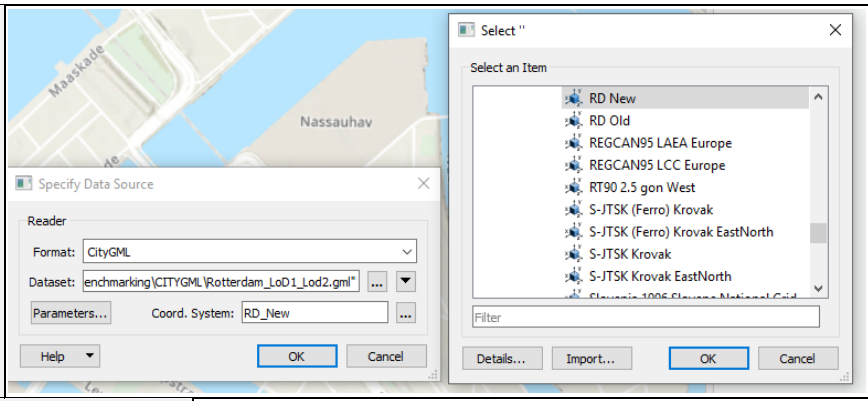
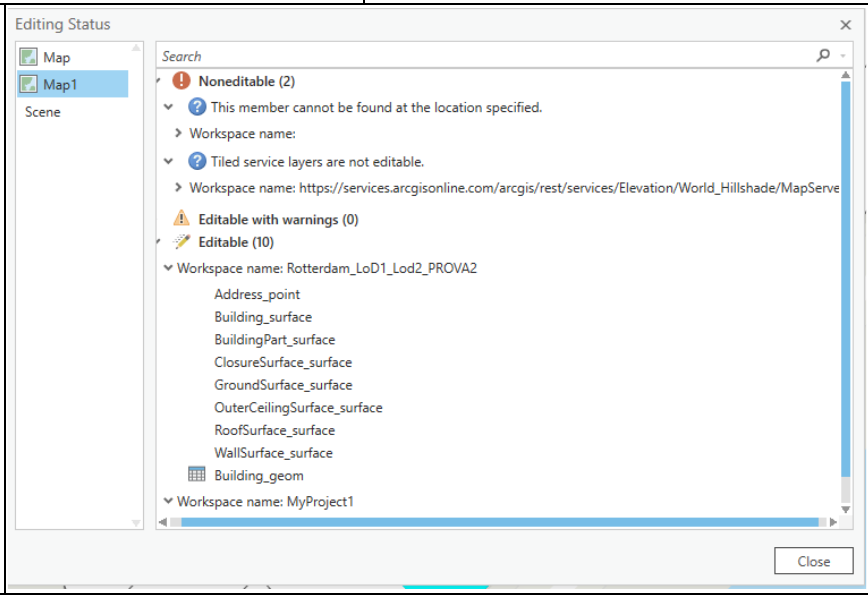
	How long does it take, approximately, to:Import (and visualise, if the software allows it) the model	the software was not able to import the model, even without crushing
Final notes		
	Kind of CityGML management possible	• Import • Export • View • Query • Edit • analysis

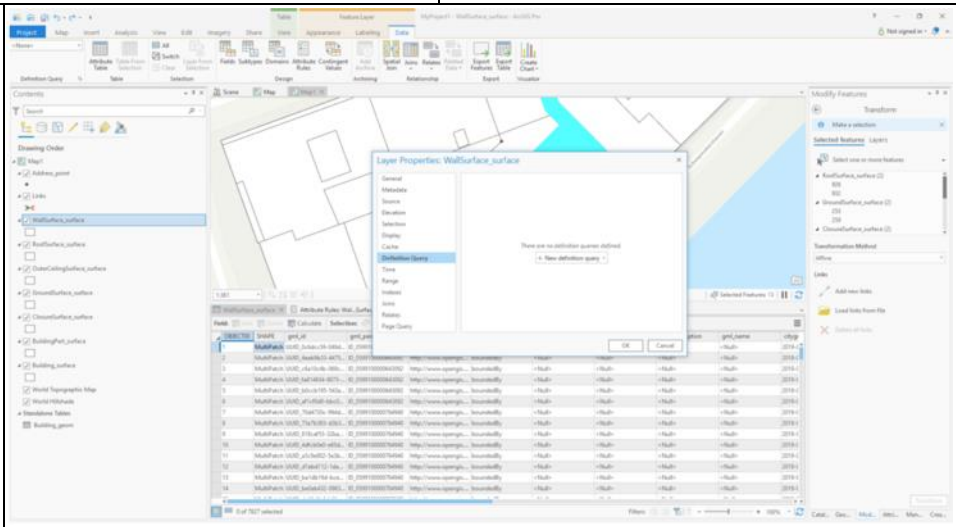
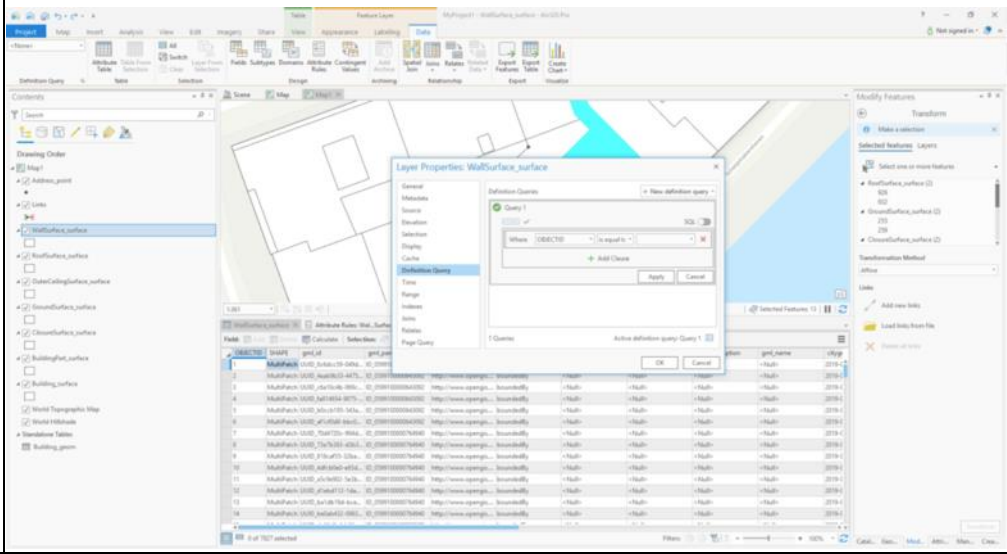
ESRI ArcGIS Pro – Test 2

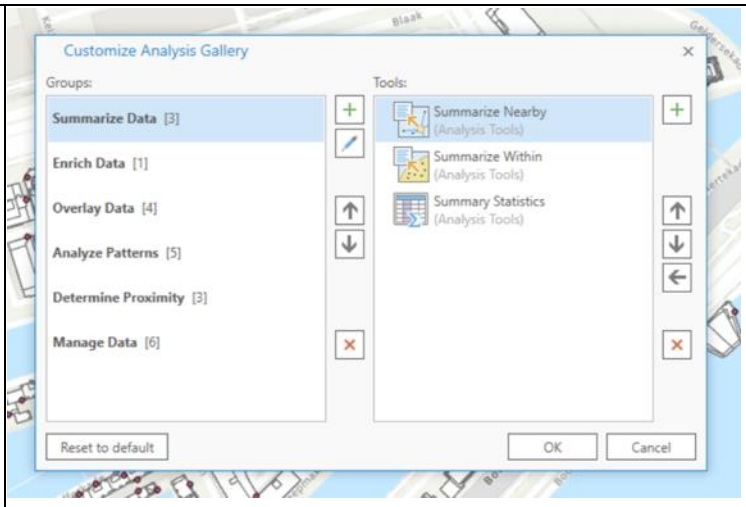
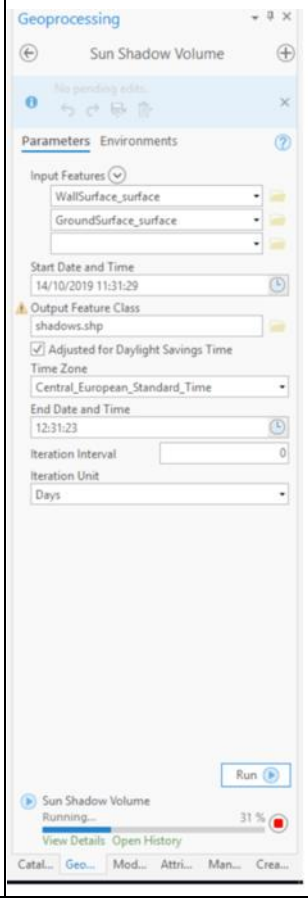
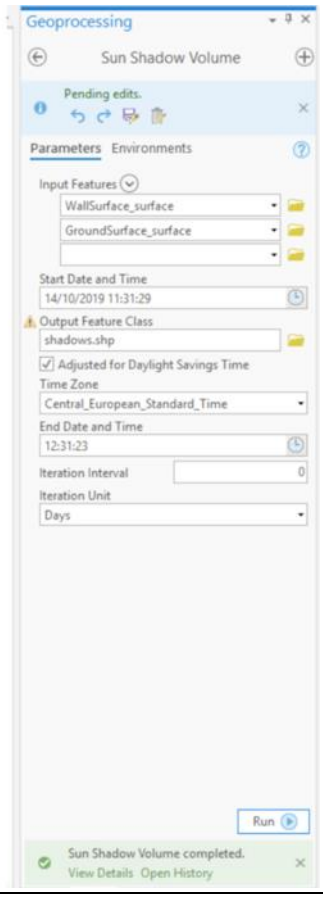
Software	Software Name [version]	**ESRI ArcGis [Pro 2.4]**		Software house		ESRI	
	Proprietary or open source software?			Kind of software			
	proprietary			GIS			
Computer	Model and year	Operating system and version	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	Assembled (Motherboard TUF Z390-PRO GAMING)	Windows 10 Pro version 1809	Intel (R) Core (TH) i7-9700K CPU @3.60GHz 3.60GHz	Nvidia Geforce GTX 1660Ti	64 GB	465 GB + 3630 GB	353 GB + 77.9 GB
ADE	1.1) Does the software support CityGML ADEs?						Yes
	1.1.1) Are they directly managed without any change in the settings / specific tools / plugins?						Yes
	Kind of ADE information management:	• it can be viewed and inspected • it is possible to use the ADE information for analysis in the software					
Data format	2.1) Does the software support this CityGML data in native format?	Yes, but I used one specific tool/plugin/procedure/different implementation format than GML (explain why and how does it work in the next questions)					
	2.1.1) Which one of the following is true?	Some specific translation through specific tool/plugin is necessary, or other kind of formats are used.					
	2.1.1.2) What processing and/or tools/plugins are necessary to import the CityGML file?	Quick import from the toolbox					
	2.1.1.3) Attach screenshots Software log of import phase	https://api.typeform.com/responses/files/0f6e739eabf072ff2f732a9f5a472c477c514436b241c626d27f92f0d7438770/Report_Rotterdam_Cristina_Leoni.pdf					
	2.2) short comments to the previous question (optional)	I found some warnings after the quick import tool which are shown in the report.					
Test with RotterdamL0D12.gml							
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	5-20 minutes					
	Zoom into the model to see more detail	it's almost immediate					
	Pan the model	it's almost immediate					
	Rotate the model	it's almost immediate					
	Query an object	it's almost immediate					
	Inspect the objects linked to the queried one through a relationship	it's almost immediate					
Import	Was any error reported when importing the file?	1. NOT changing coordinate system of reader identified by keyword `R_1' from `_Netherlands-RDNew-2008_0' to `EPSG:28992' -- mapping file setting of `_Netherlands-RDNew-2008_0' overrides coordinate system `EPSG:28992' read from file; 2. The feature class 'Address_point' will be created to store multipoint features rather than point features, since the first feature destined for this feature class is a multipoint.					

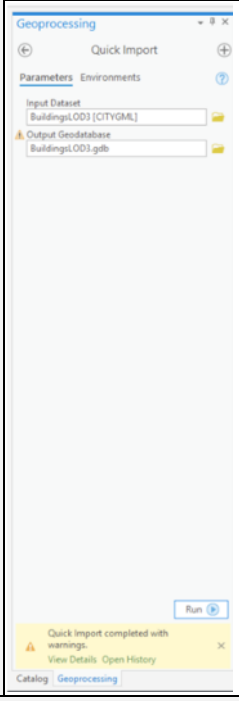
LoDs	4.1) How are the different LoDs read/managed in the software?	All the LoDs are imported at the same level.
	4.3) Attach screenshots	
⊢ ex	Can the textures be visualised correctly?	Yes

	Attach screenshots	
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes After the import, data are located on the software's map.
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	Yes
	9.1.1) What are the tools needed to set the correct CRS, or where is it possible to set it in the software?	Geoprocessing, quick import tool asked me to put the right CRS.

	9.1.2) Attach screenshots	
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes, but some of the CityGML entities are not imported. Even if I can see the features, my report said: "Geodatabase Writer: The field 'OBJECTID' in table 'ClosureSurface_surface' will not be updated since it is not editable".
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	Yes the class-subclass relationships are maintained
	12.1) Are the attributes present in the CityGML entities retained and consistent?	Partially
	12.2) short comments to the previous question (optional)	For example for the building_geom attribute's table are missed some information as citygml_feature_role, gml_description, gml_name and so on.
	13.1) Are the relationships between the objects retained?	Yes
Geometry	14.1) Is geometry read correctly?	Yes
View	16.1) Is it possible to view the model in 3D?	Yes
	16.2) short comments to the previous question (optional)	I can see the 3D model in ArcScene.
	17.1) Is it possible to view the model in 2D?	Yes
	17.2) short comments to the previous question (optional)	I can see 2D model thank in ArcMap.
Editing	18.1) Is it possible to edit the model?	Yes
	18.1.1) What editing is possible (attributes, geometry, georeferencing, please add details)?	It is possible to modify attributes, move, merge, split, explode the geometries.
	18.1.2) Attach screenshots	

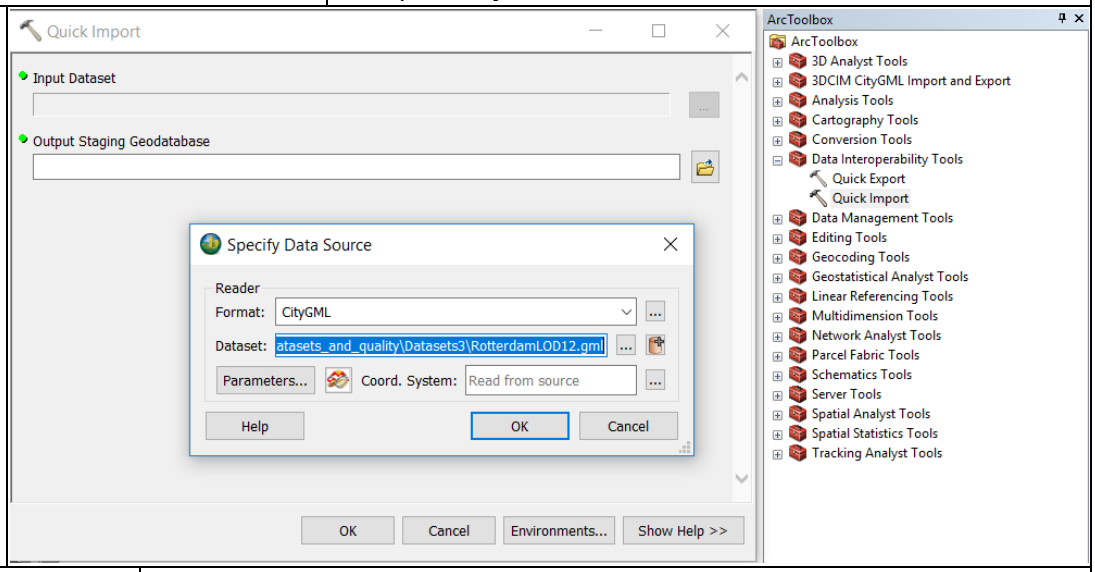
	18.2) short comments to the previous question (optional)	Time needed for editing was not much, a couple of seconds
Query	19.1) Is it possible to query the model and the attributes?	Yes
	19.1.1) What kinds of query are possible?	Create a new definition query, create a new definition query in SQL, Add definition queries from files.
	19.1.2) Attach screenshots	 
Analysis	20.1) Is it possible to analyse the objects and the model?	Yes, both analysis about the model and the model performances are possible (type 1 and 2)
	20.1.1) What analysis are possible? Do you know if the results are reliable? How much time is needed to perform them?	Different analysis are possible from data analysis tools: summarize data, enrich data, overlay data, analyze patterns, determine proximity and manage data. I tried to put shadows of buildings, to modify geometries and so on. The time needed for the changes were not much, a couple of minutes. (1-2 minutes).

	20.1.2) Attach screenshots	  	
	20.1.3) Time required to perform the analysis about the model itself (type 1)		it's almost immediate
	20.1.4) Time required to perform the analysis about the model itself (type 2)		it's almost immediate
Export	You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:	The software has also export-to-CityGML abilities	
	21.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	No	
	21.2) short comments to the previous question (optional)	Through the quick export tool I can export my layers in different expansion files.	
	22) How long does it take for the data to be exported to CityGML?	less than a minute	
Test with BuildingsLoD3.gml			
H o	Import (and visualise, if the software allows it) the model		less than a minute

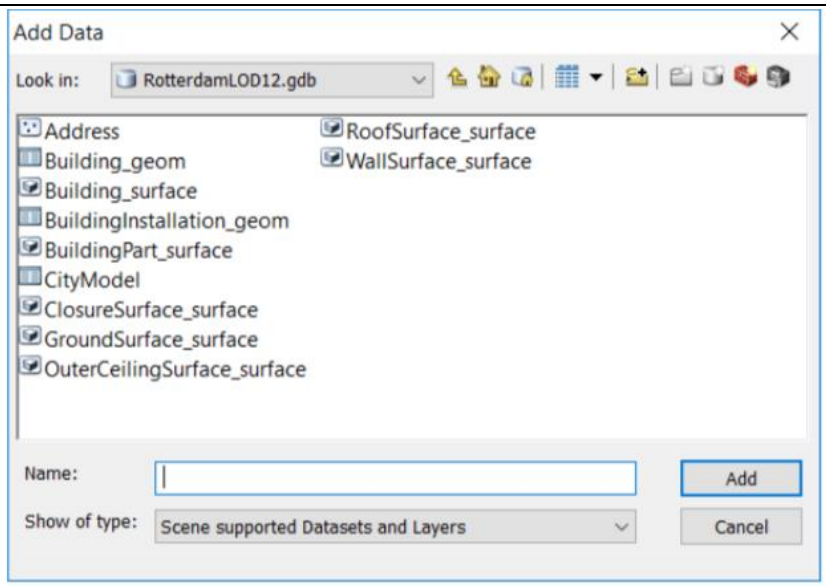
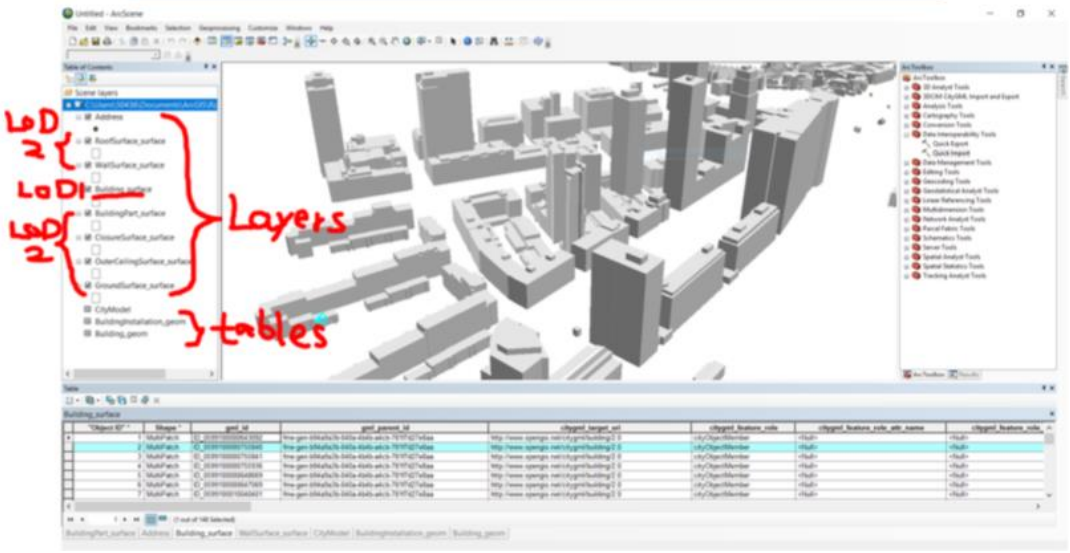
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	it's almost immediate
Import	Does the software support this CityGML data in native format?	Yes but I used one specific tool/plugin/procedure/different implementation format than GML (explain why and how does it work in the next questions)
	Which one of the following is true?	Some specific translation through specific tool/plugin is necessary, or other kind of formats are used. Quick import tool
	Attach screenshots	
Georefe rencing	24.1) Does the model maintain its correct dimensions and proportions?	Yes
Export	37) How long does it take for the data to be exported to CityGML?	less than a minute
Test with Amsterdam.gml		
	How long does it take, approximately, to:Import (and visualise, if the software allows it) the model	it crashes without completing the operation
Final notes		
	Kind of CityGML management possible	• Import • Export • View • Query • edit • analysis

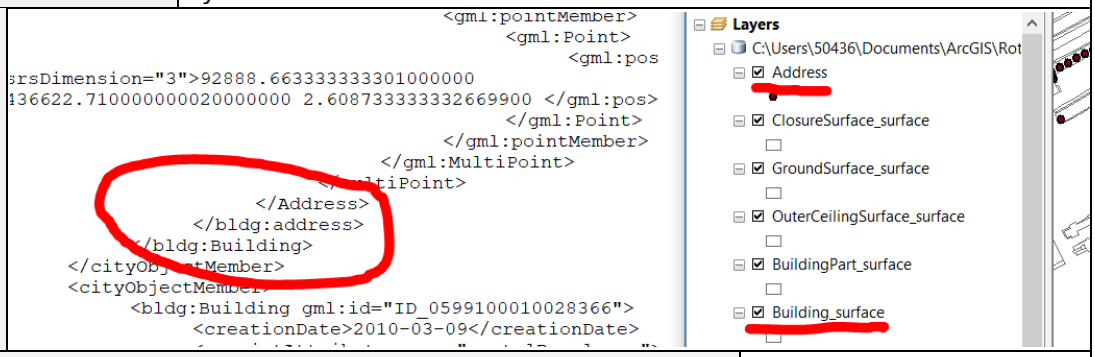
	58) Would you like to share any other comments or observations?	I was sure that my computer would have been able to open Amsterdam CityGML dataset because it's very performant. After 3/4 hours it crashed without importing the data.

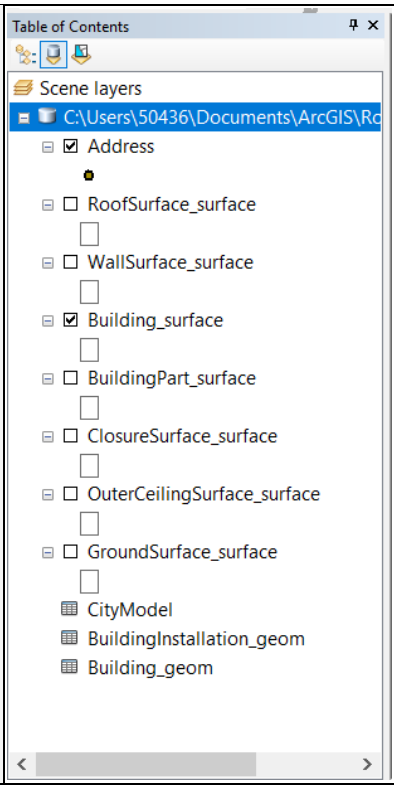
ESRI ArcGIS – Test 1

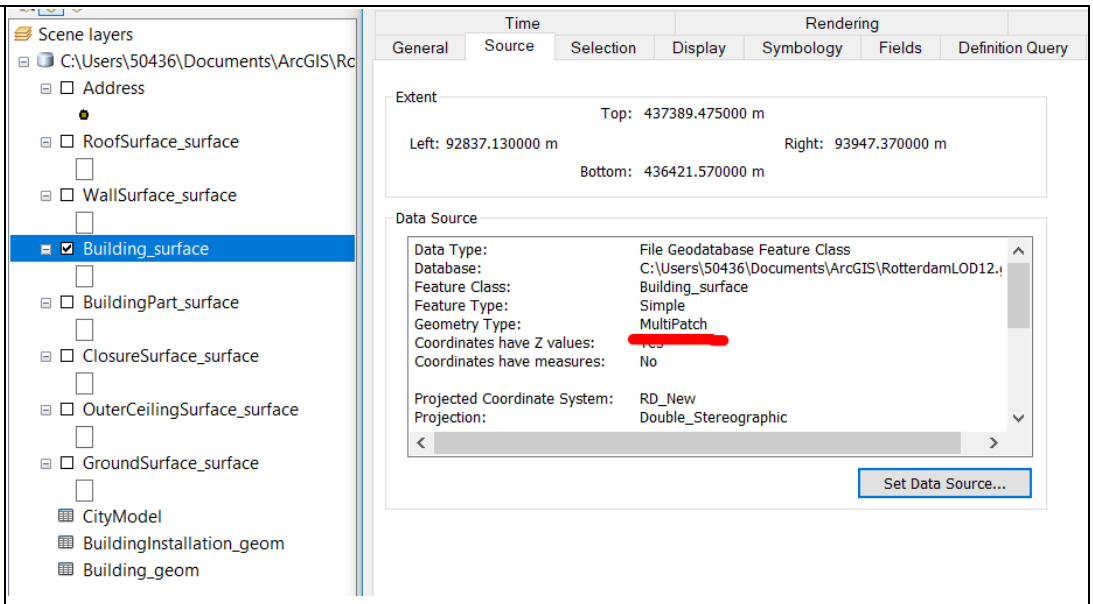
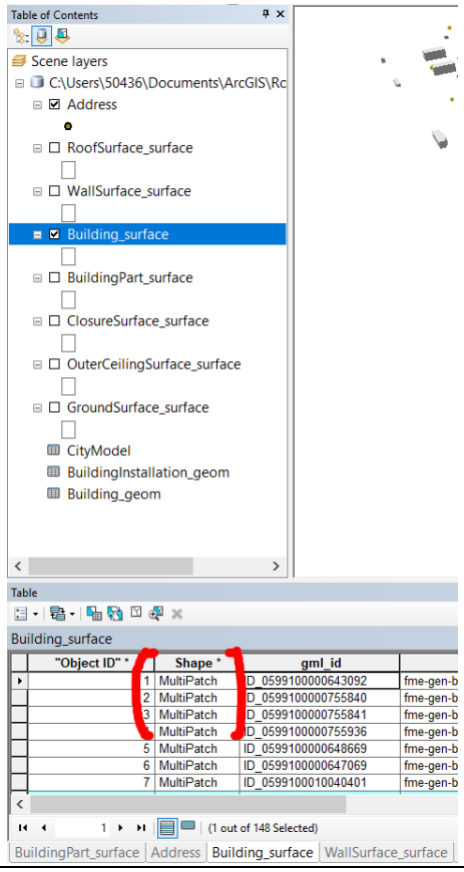
Software	Software Name	**ArcGIS [10.2]**		Software house		ESRI	
	Proprietary or open source software?			Kind of software			
	proprietary			GIS			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	HP ZBOOK STUDIO G5, 2018	Windows 10	i7-8750H	Intel UHD Graphics 630	16	476.81	270.5
ADE	1.1) Does the software support CityGML ADEs?						Yes
	1.1.1) Are they directly managed without any change in the settings / specific tools / plugins?						Yes
	Kind of ADE management possible:	• it can be viewed and inspected • it can be queried					
	1.2) Add short comments to the previous questions (optional)	We didn't see any ADEs used in RotterdamLOD12.gml. Instead, we downloaded one with energy ADE from http://www.citygmlwiki.org/index.php?title=KIT_Sample_files_Energy_ADE					
Data fotmat	2.1) Does the software support this CityGML data in native format?	No Some specific translation through specific tool/plugin is necessary, or other kind of formats are used.					
	2.1.1.2) What processing and/or tools/plugins are necessary to import the CityGML file?Please justify your choices.	CityGML files need to be transformed to geodatabases first in order to be imported into ArcGIS. The ETL tool we use is Data Interoperability extension.					
	2.1.1.3) Attach screenshots						
	2.2) short comments to the previous question (optional)	Some warnings appeared during validation. Besides, we think it would be better to have the transformation automatic and load the created gdb files directly.					

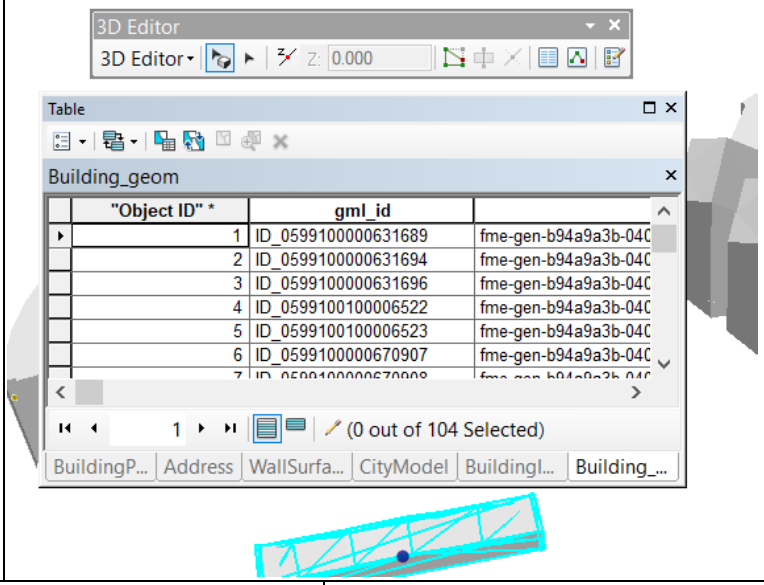
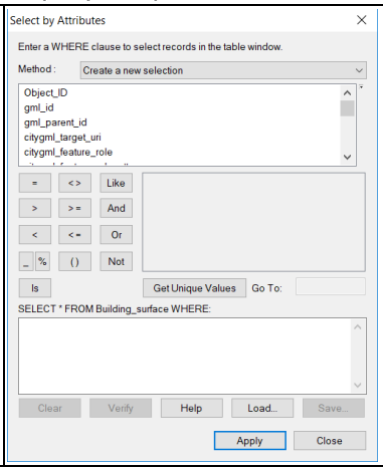
Test with RotterdamLoD12.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	less then a minute
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	it's almost immediate

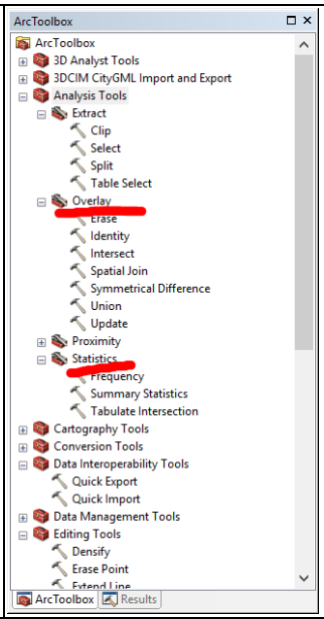
LoDs	4.1) How are the different LoDs read/managed in the software?	They are all read and managed in the software together.
	4.2) Please, give more details and examples	The ETL tool transformed CityGML file into several layers among which all LoDs existed. For example, LoD1 refers to layer 'Building_surface' and LoD2 refers to layer 'RoofSurface_surface', 'WallSurface_surface' and so on. Although we can't import objects according to LoD, we can decide which layers to be imported. In other words, if we know which layers belong to which LoD beforehand, it is possible to load one specific LoD.
	4.3) Attach screenshots	 
	4.4) short comments to the previous question (optional)	It would be great if the software could visualize different LoDs.
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	5.2) Add short comments to the previous questions (optional)	Right-click the layer, select 'Properties'->'Source', you can see it in the 'Data Source' dialog
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	6.2) short comments to the previous question (optional)	ArcMap is ideal for checking coordinates but bad at visualizing 3D objects. ArcScene is the opposite.

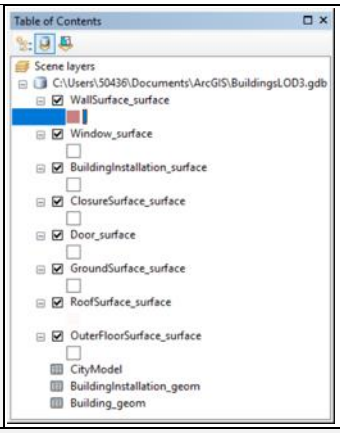
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	7.2) short comments to the previous question (optional)	Elevation information can be found by right-clicking the layer, and then selecting 'Properties'->'Base Height'.
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	8.2) short comments to the previous question (optional)	From my point of view, the orientation of the model keeps the same when the coordinates keep the same, i.e. not shifted
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	No
	9.2) short comments to the previous question (optional)	You can set the CRS manually, but it is not necessary.
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	No
	10.2) short comments to the previous question (optional)	In fact, the type of objects can be recognized from its layer name. For example, buildings are all stored and displayed in layer 'Building_surface'. Thus, it is consistent with the CityGML definitions seemingly. But the underlying geometry type is different.
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	No
	11.1.1) What changes / inconsistencies / errors / other issues were noted?	In RotterdamLOD12.gml, 'address' is included within 'Building'. However, after being translated, 'Address' and 'Building_surface' are two parallel layers.
	11.1.2) Attach screenshots	
	12.1) Are the attributes present in the CityGML entities retained and consistent?	Yes
	13.1) Are the relationships between the objects retained?	No
	13.1.1) What changes / inconsistencies / errors / other issues were noted?	'WallSurface', 'RoofSurface', and 'ClosureSurface' and so on which are integrated in 'Building' have been separated.

	13.1.2) Attach screenshots	
Geometry	14.1) Is geometry read correctly?	No
	14.1.1) What changes / inconsistencies / errors / other issues were noted?	'Solid' ('Building') has been translated to 'MultiPatch'

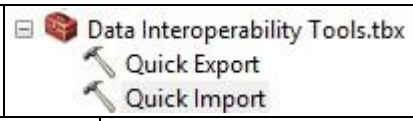
	14.1.2) Attach screenshots	 
View	16.1) Is it possible to view the model in 3D?	Yes
	16.2) short comments to the previous question (optional)	In ArcScene
	17.1) Is it possible to view the model in 2D?	Yes
	17.2) short comments to the previous question (optional)	In ArcMap.
Editing	18.1) Is it possible to edit the model?	Yes

	18.1.1) What editing is possible (attributes, geometry, georeferencing, please add details)?	Attributes can be edited (update, delete, relate...) in attribute table. Geometry can be edited by a built-in tool called '3D Editor'. For geometries, we can both edit placement and vertex. The former can move, rotate and scale the whole object while the latter move, delete and create vertices of an object. We haven't found any tools to edit georeferencing.
	18.1.2) Attach screenshots	
	18.2) short comments to the previous question (optional)	Saving edits in '3D Editor' will change the model/database permanently!
Query	19.1) Is it possible to query the model and the attributes?	Yes
	19.1.1) What kinds of query are possible?	SQL query to select features by attributes.
	19.1.2) Attach screenshots	
Analysis	20.1) Is it possible to analyse the objects and the model?	Yes
	20.1.1) What analysis are possible? Do you know if the results are reliable? How much time is needed to perform them?	For attributes, ArcGIS offers 'Statistics' in 'ArcToolBox'->'Analysis Tools' to calculate summary statistics (MIN, MAX, MEAN, AVG, STD, SUM...) for fields in a table. For geometries, extract (select, clip...) and overlay (intersect, union, spatial join...) can be performed in the same place which can perform intersect, spatial join, and union operations.

	20.1.2) Attach screenshots	
	20.2) short comments to the previous question (optional)	There are very likely other analyzing tools exist. Because we are new to ArcGIS and not familiar with it. There are many tools in the toolbox.
Export	You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:	The software has also export abilities
	21.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	No
	21.2) short comments to the previous question (optional)	The export is very similar with the import. It also offers a button named 'parameters' which enables settings. But it is not necessary. The default settings are consistent.
	22) How long does it take for the data to be exported to CityGML?	less then a minute
Test with BuildingsLoD3.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	it's almost immediate
Geo ref	24.1) Does the model maintain its correct dimensions and proportions?	Yes
Semanti cs	25.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	26.1.1) What changes / inconsistencies / errors / other issues were noted?	All the components of a building are separated. The same components are put into one specific layer.

	26.1.2) Attach screenshots	
	27.1) Are the attributes present in the CityGML entities retained and consistent?	Yes
	28.1) Are the relationships between the objects retained?	Yes
	28.2) short comments to the previous question (optional)	The relationships are stored in the attribute table. For example, all the components of a building (i.e. roof, groundsurface, and so on) have a field 'gml_parent_id' indicating the gml id of its superclass (i.e. building).
Geometry	29.1) Is geometry read correctly?	Yes
	29.2) short comments to the previous question (optional)	Surfaces are surfaces indeed. But the underlying geometry type is changed from 'MultiSurface' to 'MultiPatch'.
	30.1) Did the normals change?	Yes
Analysis	35.1.3) Needed time to perform the analysis about the model itself (type 1)	less then a minute
Export	37) How long does it take for the data to be exported to CityGML?	less then a minute
Test with Amsterdam.gml		
How long does it take, approximately,	Import (and visualise, if the software allows it) the model	more than one hour
	Zoom into the model to see more detail	5-20 minutes
	Pan the model	5-20 minutes
	Rotate the model	5-20 minutes
	Query an object	5-20 minutes
	Inspect the objects linked to the queried one through a relationship	5-20 minutes
Semantics	45.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	47.1) Are the attributes present in the CityGML entities retained and consistent?	Yes
Analysis	55.1) Is it possible to analyse the objects and the model?	Yes
	55.1.3) Needed time to perform the analysis about the model itself (type 1)	more than one hour
Export	You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:	The software has also export abilities
	56.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	No
	57) How long does it take for the data to be exported to CityGML?	more than one hour
Test with Amsterdam.gml		
	Kind of CityGML management possible:	• Import • Export • View • Query • Edit • Analyse
	58) Would you like to share any other comments or observations?	ArcScene cannot deal with massive data, every step takes ages to finish.

ESRI ArcGIS – Test 2

Software	Software Name [version]	**ArcGIS [10.2]**		Software house		ESRI	
	Proprietary or open source software?			Kind of software			
	proprietary			GIS			
	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	HP ZBook Studio G5 x360, 2018	Windows10	Intel Core i7-8750H	Nvidia Quadro P1000	16GB	512GB	210GB
ADE	1.1) Does the software support CityGML ADEs?	No					
Data format	2.1) Does the software support this CityGML data in native format?	No					
	2.1.1) Which one of the following is true?	Some specific translation through specific tool/plugin is necessary, or other kind of formats are used.					
	2.1.1.2) What processing and/or tools/plugins are necessary to import the CityGML file?Please justify your choices.	The Data Interoperability extension should be installed.					
	2.1.1.3) Attach screenshots						
	2.2) short comments to the previous question (optional)	We need to install ArcGIS's "Data Interoperability" extension to import the CityGML file, this extension can read CityGML files directly without any conversion.					
Test with RotterdamLoD12.gml							
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	1-5 minutes					
	Zoom into the model to see more detail	it's almost immediate					
	Pan the model	it's almost immediate					
	Rotate the model	it's almost immediate					
	Query an object	it's almost immediate					
	Inspect the objects linked to the queried one through a relationship	the software does not allow this					
LoDs	4.1) How are the different LoDs read/managed in the software?	They can only be imported and visualised all together, with overlaps in their view / management / analysis					
	4.2) Please, give more details and examples	The features of objects from different LoDs are put together, thus we cannot distinguish which LoD it is by the software.					

	4.3) Attach screenshots	
	4.4) short comments to the previous question (optional)	Features with different semantics are put into different groups, but the LoDs are not considered when making groups.
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	5.2) Add short comments to the previous questions (optional)	The coordinate reference system is still RD_New after importing.
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	6.2) short comments to the previous question (optional)	in ArcGlobe, the warning arises when importing data. But we can transform the model's CRS when importing data or transform the globe's CRS after importing data to make these two CRS as same.
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	No
	9.2) short comments to the previous question (optional)	Correct CRS is imported with the dataset.
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	10.2) short comments to the previous question (optional)	We can see the features are showed in groups which are divided according to the semantics.
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	Yes
	11.2) short comments to the previous question (optional)	The hierarchical relationships are stored in the attribute tables.
	12.1) Are the attributes present in the CityGML entities retained and consistent?	No
	12.1.1) What changes / inconsistencies / errors / other issues were noted?	The attributes are retained, but they are stored in different tables, thus they are not consistent, but we can get features of one entity by checking their parent_id,
	13.1) Are the relationships between the objects retained?	Yes, through parent ids

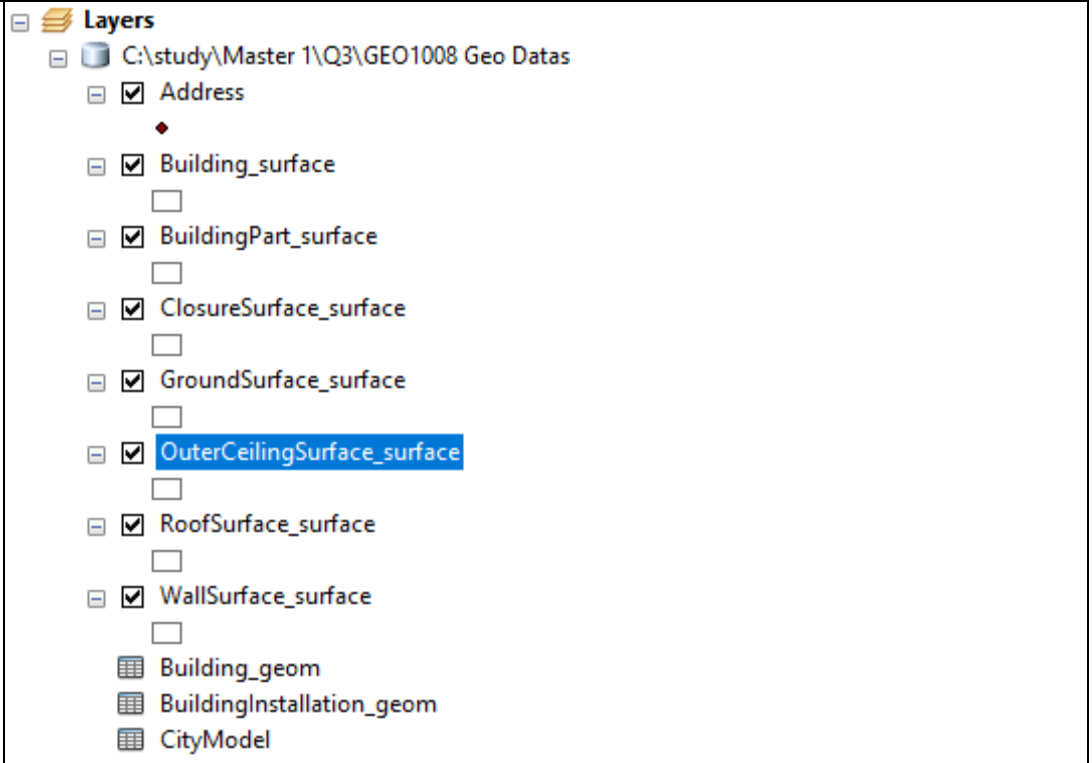
13.1.2) Attach screenshots

"Object ID" *	Shape *	gml_id	gml_parent_id
1	MultiPatch	ID_1447d95f-b7fd-4d23-8677-4a23cc4a0ba1	ID_0599100000631689
2	MultiPatch	ID_7615da92-346b-4e44-b4ca-f5451c879083	ID_0599100000631689
3	MultiPatch	ID_80598e6a-a8ad-4ca8-9b59-7a0bbf2ea703	ID_0599100000631689
4	MultiPatch	ID_6bae9357-3116-47a9-8c70-b9ec8641e4b3	ID_0599100000631694
5	MultiPatch	ID_a7246d00-5831-47cb-8dbf-10948b3425ae	ID_0599100000631694
6	MultiPatch	ID_d06b0adc-2faf-4846-8ad0-1d5dc2a37f85	ID_0599100000631694
7	MultiPatch	ID_4c6be014-8114-403c-92ed-22f74662e77b	ID_0599100000631696
8	MultiPatch	ID_fcd637a6-cd68-4963-9e97-2899ba13268d	ID_0599100000631696
9	MultiPatch	ID_26fe4c13-eb96-47d2-af6f-ba017ca26b0a	ID_0599100000631696
10	MultiPatch	ID_a39ed2a8-7d43-44d7-8aaf-e560cc8f2ac6	ID_0599100100006522
11	MultiPatch	ID_5f338ce7-1482-42ee-a561-167b7e3e7ccd	ID_0599100100006522
12	MultiPatch	ID_99be5667-ca9d-494f-a8bc-109e35a6fb6a	ID_0599100100006522
13	MultiPatch	ID_5503d6be-dcff-4e31-8954-64293b4f18e5	ID_0599100100006522
14	MultiPatch	ID_2880ce58-d55e-4275-9e4b-3f73e41e42b2	ID_0599100100006523
15	MultiPatch	ID_a557afb8-b9f3-4824-9dd0-9a9d6122610c	ID_0599100100006523
16	MultiPatch	ID_ad494157-2ac5-4e17-b57a-37b5545cdf2c	ID_0599100000670907
17	MultiPatch	ID_f48a528f-4e9d-4861-99a0-a59560769f8f	ID_0599100000670907
18	MultiPatch	ID_9a72c64d-540e-4e71-a745-f27e66dccb1b	ID_0599100000670907

Geometry

14.1) Is geometry read correctly?	No
14.1.1) What changes / inconsistencies / errors / other issues were noted?	All the features are divided into surfaces.

14.1.2) Attach screenshots



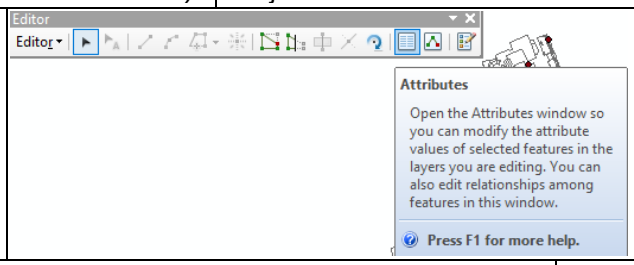
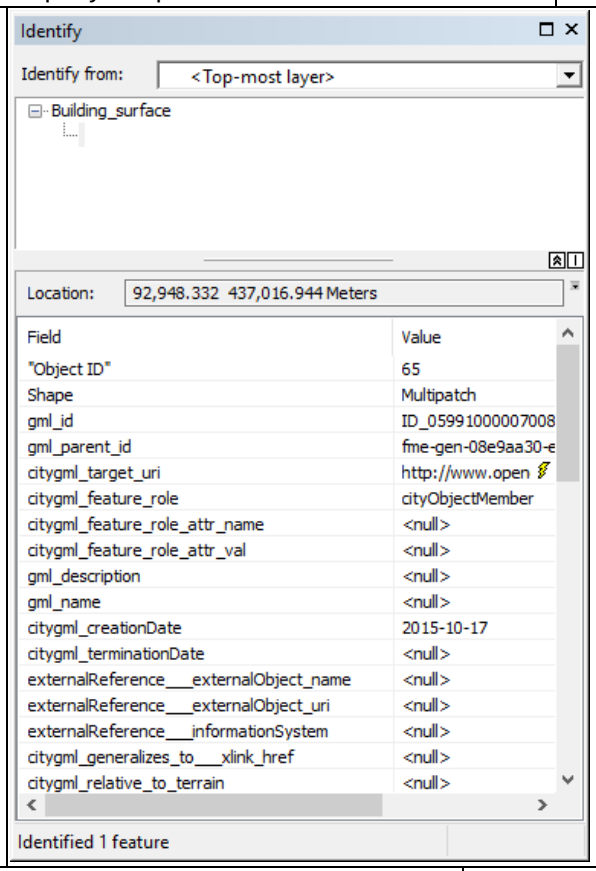
15.1) Did normals change?	No
15.2) short comments to the previous question (optional)	We compare the visualization results in FZKViwer with that in ArcGIS, we think the normal stay the same.

View

16.1) Is it possible to view the model in 3D?	Yes
16.2) short comments to the previous question (optional)	In ArcGlobe we can view the model in 3D.
17.1) Is it possible to view the model in 2D?	Yes
17.2) short comments to the previous question (optional)	In ArcMap we can view it in 2D.

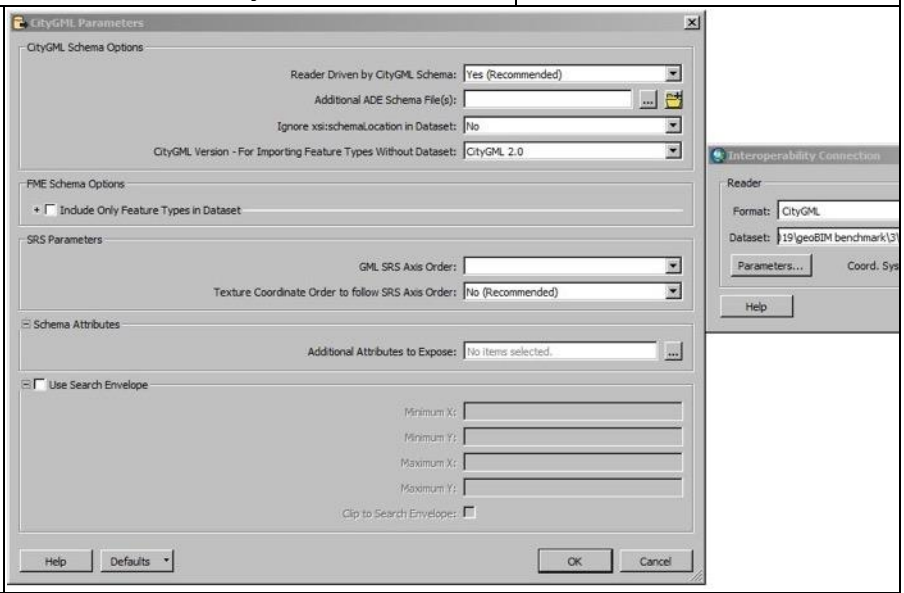
Editing

18.1) Is it possible to edit the model?	Yes

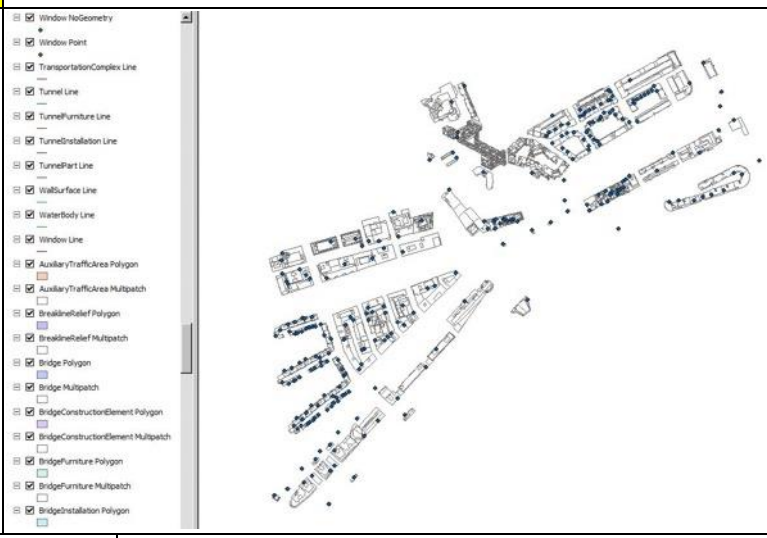
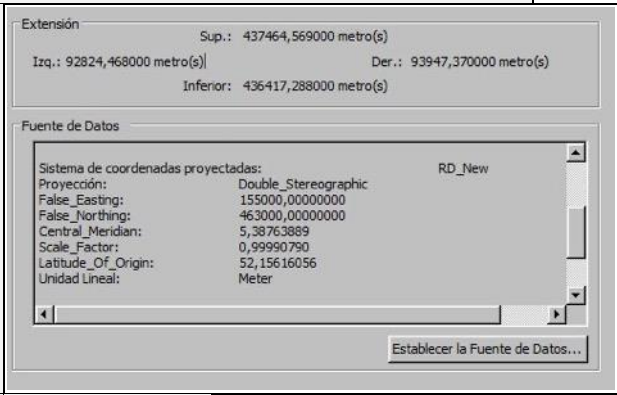
	18.1.1) What editing is possible (attributes, geometry, georeferencing, please add details)?	In the edit mode, we can edit the attributes and geometry. And the CRS can be changed with “Data Management Tools” - “Projections and Transformations” – “Feature” – “Project”.
	18.1.2) Attach screenshots	
Query	19.1) Is it possible to query the model and the attributes?	Yes
	19.1.1) What kinds of query are possible?	attributes query
	19.1.2) Attach screenshots	
	19.2) short comments to the previous question (optional)	The query can be easily finished by the identify tool.
Analysis	20.1) Is it possible to analyse the objects and the model?	No
	20.2) short comments to the previous question (optional)	But the python script is available so maybe the analysis can be made through python.
Export	You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:	The software has also export abilities
	21.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	No
	22) How long does it take for the data to be exported to CityGML?	less than a minute
Test with BuildingsLoD3.gml		
How long does it take,	Import (and visualise, if the software allows it) the model	less than a minute
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate

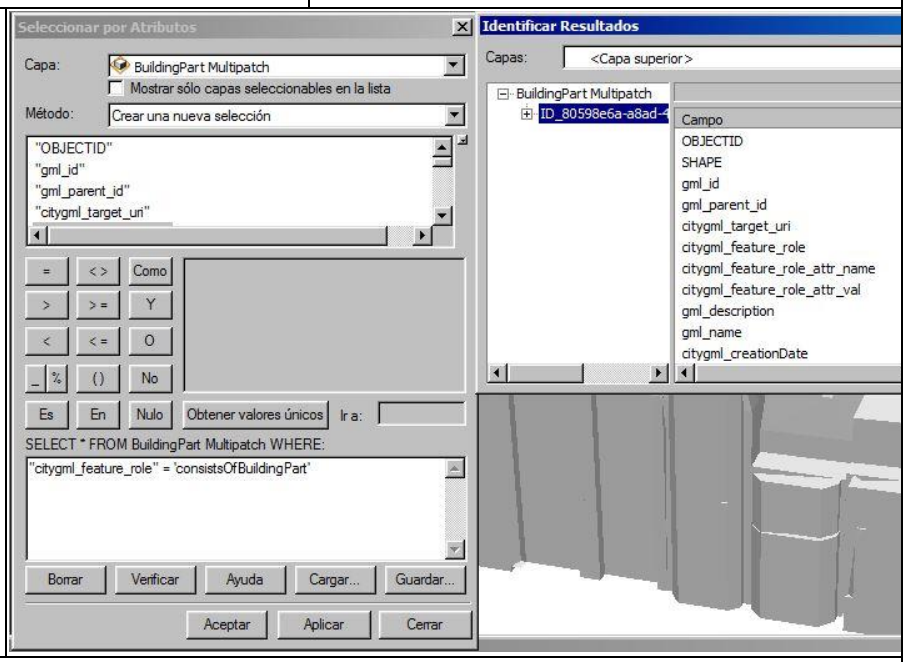
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	the software does not allow this
Georef	24.1) Does the model maintain its correct dimensions and proportions?	Yes
	24.2) short comments to the previous question (optional)	The dimensions and model are maintained.
Export	37) How long does it take for the data to be exported to CityGML?	less then a minute
Test with Amsterdam.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	more than one hour
	Zoom into the model to see more detail	less than a minute
	Pan the model	it's almost immediate
	Rotate the model	less than a minute
	Query an object	less than a minute
	Inspect the objects linked to the queried one through a relationship	the software does not allow this
Export	You arrived at the end of the phase 1: "Import and manage the file in the software".Now choose:	The software has also export abilities
	56.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	No
	57) How long does it take for the data to be exported to CityGML?	20 minutes-1 hour
Final notes		
	Kind of CityGML management possible	• Import • Export • View • Query • Edit • Analysis

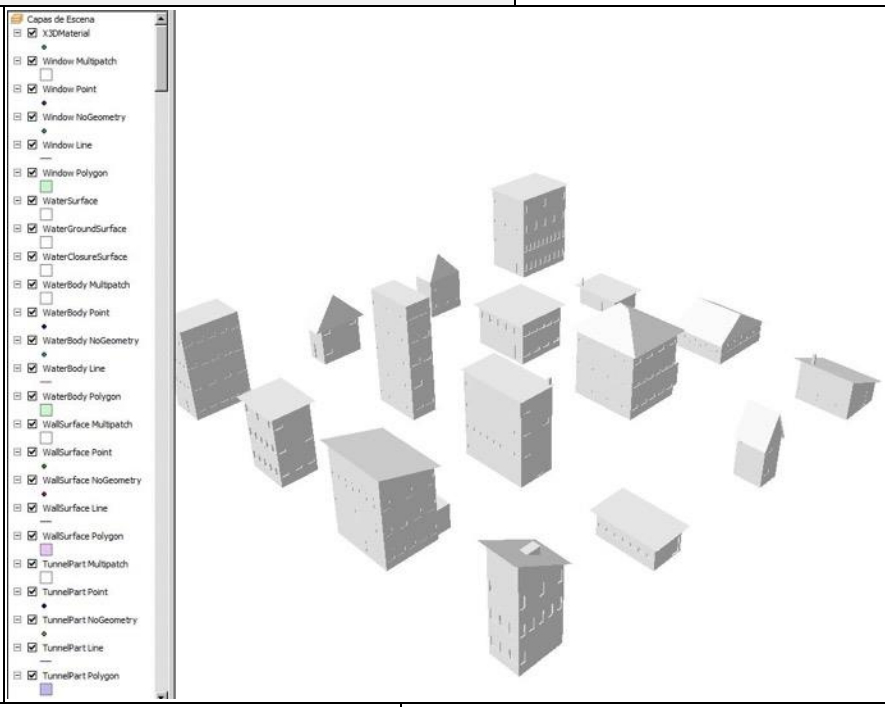
ESRI ArcGIS – Test 3

Software	Software Name	**ArcGIS 10.5**		Software house		ESRI	
	Proprietary or open source software?			Kind of software			
	proprietary			GIS			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	Intel ® Core ™ i5-6500 CPU @ 3.20GHz 3.20GHz	Windows 7 Professional	CPU @ 3.20GHz	Intel(R) HD Graphics 530	16 GB	476 GB	298 Gb
ADE	1.1) Does the software support CityGML ADEs?					Yes	
	1.1.1) Are they directly managed without any change in the settings / specific tools / plugins?					No, some specific settings / tools / plugins are necessary	
	1.1.1.1) Please give a description about how is it necessary to install the needed tool or plugin, or change the software settings, or any other intervention which is necessary to enable the functionality.					Data interoperability tools (parameters)	
	1.1.1.2) Attach screenshots Image 9.1 – Data Interoperability tool						
Data format	2.1) Does the software support this CityGML data in native format?	Yes, but I used one specific tool/plugin/procedure/different implementation format than GML (explain why and how does it work in the next questions)					
	2.1.1) Which one of the following is true?	Some specific translation through specific tool/plugin is necessary, or other kind of formats are used.					
	2.1.1.2) What processing and/or tools/plugins are necessary to import the CityGML file?Please justify your choices.	Data Interoperabity tools (See image 9.1)					

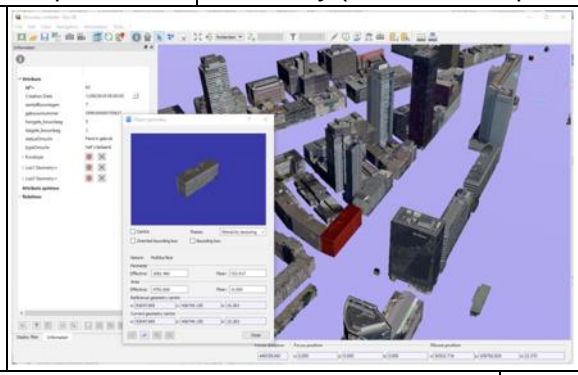
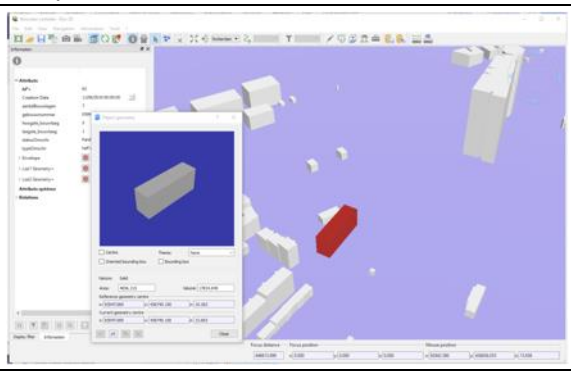
Test with RotterdamLoD12.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	1-5 minutes
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	the software does not allow this
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	less then a minute

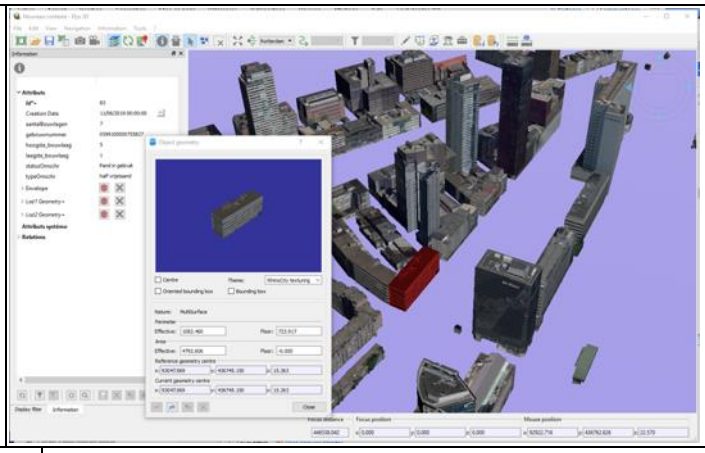
Import	Was any error reported when importing the file?	No
LoDs	4.3) Attach screenshots	
Texture	Can the textures be visualised correctly?	No, the software does not support the texture visualisation
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	Yes
	9.1.1) What are the tools needed to set the correct CRS, or where is it possible to set it in the software?	In the software (Data Interoperability parameters)
	9.1.2) Attach screenshots	
Semantic	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes It seems to be, mantains "gml parent id" on attibute table
Geometry	14.1) Is geometry read correctly?	Geometry is reinterpreted by the software (no geometry, points, multipatch)
	15.1) Did normals change?	Yes
View	16.1) Is it possible to view the model in 3D?	Yes
	16.2) short comments to the previous question (optional)	In ArcScene
	17.1) Is it possible to view the model in 2D?	Yes
	17.2) short comments to the previous question (optional)	With ArcMap

Editing	18.1) Is it possible to edit the model?	No
Query	19.1) Is it possible to query the model and the attributes?	Yes
	19.1.1) What kinds of query are possible?	Selection by attributes, identify
	19.1.2) Attach screenshots	
Analysis	20.1) Is it possible to analyse the objects and the model?	I tried but the only entities that the software (ArcScene) let me modify are the "noGeometry" and "points" ones and the analysis does not work properly
	20.1.1) What analysis are possible? Do you know if the results are reliable? How much time is needed to perform them?	It failed
	20.1.3) Time required to perform the analysis about the model itself (type 1)	No analysis of type 1 are possible
	20.1.4) Time required to perform the analysis about the model itself (type 2)	No analysis of type 2 are possible
Export	You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:	The software has also export-to-CityGML abilities
	21.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	Yes
	21.1.1) Can you add a short description of the steps involved in the pre-processing?	I can only export a feature, I guess that maybe certain pre-processing could facilitate more funcionalities
	22) How long does it take for the data to be exported to CityGML?	1-5 minutes
Test with BuildingsLoD3.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	1-5 minutes
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	5-20 minutes

Georef	24.1) Does the model maintain its correct dimensions and proportions?	Yes
Geometry	29.1.2) Attach screenshots	
Export	37) How long does it take for the data to be exported to CityGML?	1-5 minutes
	Short comments regarding the export functionality (optional)	I can only export a layer
Test with amsterdam.gml		
	How long does it take, approximately, to:Import (and visualise, if the software allows it) the model	it crashes without completing the operation
Final notes		
	Kind of CityGML management possible	• Import • Export • View • Query
	58) Would you like to share any other comments or observations?	Data Interoperability was not able to import the gml, I tried to importing it directly with ArcCatalog but it crashes

1Spatial Elyx 3D

Software	Software Name [version]	**1Spatial Elyx 3D [2.1]**		Software house	1Spatial		
	Proprietary or open source software?			Kind of software			
	proprietary			GIS			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	DELL XPS	Windows 10 Pro	Intel Core I7 2.6 GHz	NVIDIA GeForce GTX 960M	16G	384	7
ADE	1.1) Does the software support CityGML ADEs?			No			
Data form	2.1) Does the software support this CityGML data in native format?			Yes			
Test with RotterdamLoD12.gml							
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model			it's almost immediate			
	Zoom into the model to see more detail			it's almost immediate			
	Pan the model			it's almost immediate			
	Rotate the model			it's almost immediate			
	Query an object			it's almost immediate			
	Inspect the objects linked to the queried one through a relationship			it's almost immediate			
LoDs	4.1) How are the different LoDs read/managed in the software?	They are all read and managed in the software and a consistent multi-LoD view and management is possible by visualising / managing / analysing the objects in the different connected LoDs.					
	4.2) Please, give more details and examples	Each LOD is considered as a geometry attribute and could be manage individually (visualisation, queries, ...)					
	4.3) Attach screenshots						
Tex	Can the textures be visualised correctly?			Yes			

	Attach screenshots	
	short comments to the previous question (optional)	You could apply other thematic than texture, for exemple color depending on attribute or computed attribute (volume, area, ...)
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	No
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	Yes
	12.1) Are the attributes present in the CityGML entities retained and consistent?	Yes
	13.1) Are the relationships between the objects retained?	Yes
Geo metry	14.1) Is geometry read correctly?	Yes
	15.1) Did normals change?	Yes
View	16.1) Is it possible to view the model in 3D?	Yes
	17.1) Is it possible to view the model in 2D?	Yes Orthographic view
Editing	18.1) Is it possible to edit the model?	No
	18.2) short comments to the previous question (optional)	Import in DBMS is available in the software and then data could be edited
Query	19.1) Is it possible to query the model and the attributes?	Yes
	19.1.1) What kinds of query are possible?	Conditions on attribute value, computed attributes (area, volume, ...) and topology relation (Within, Intersect, ...)

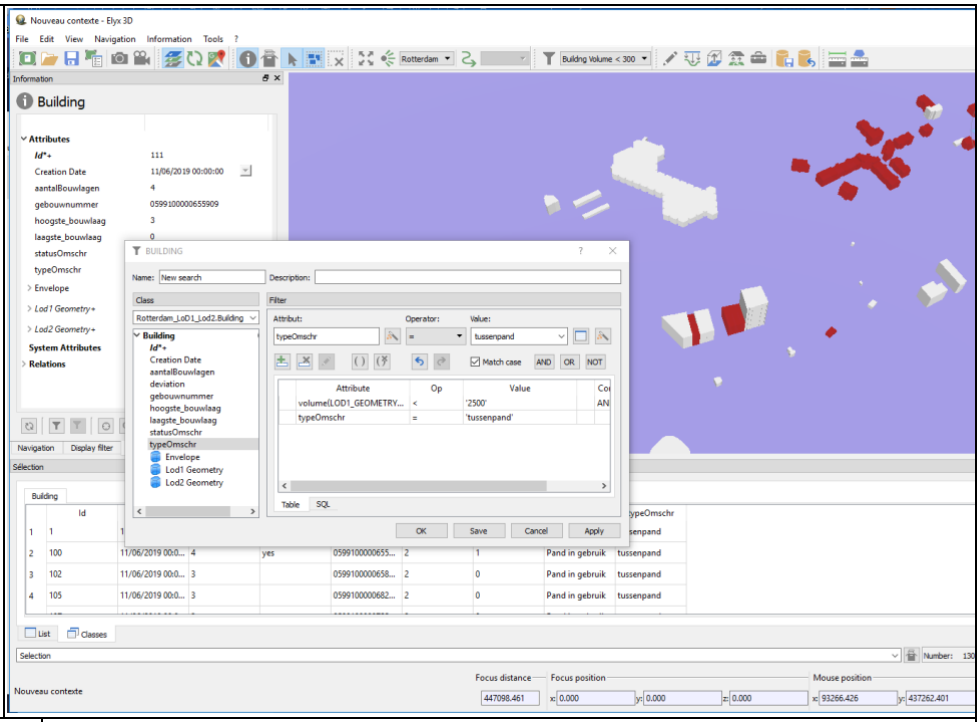
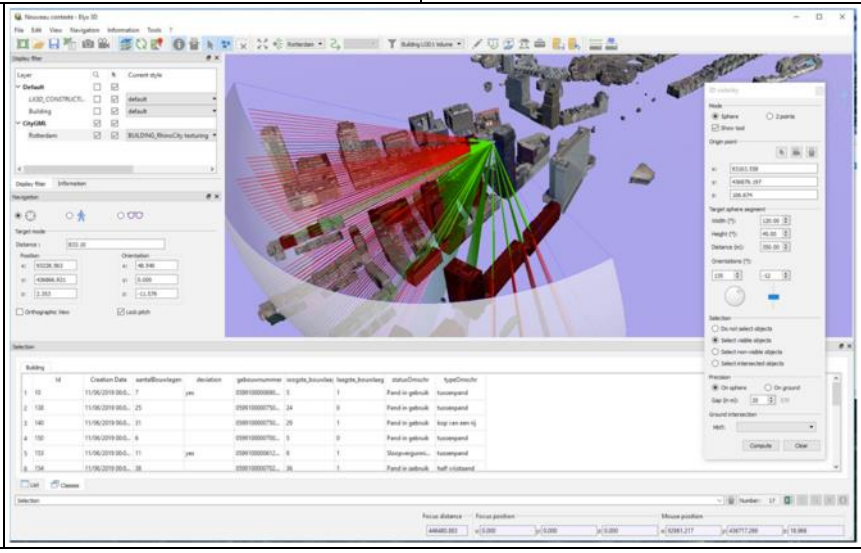
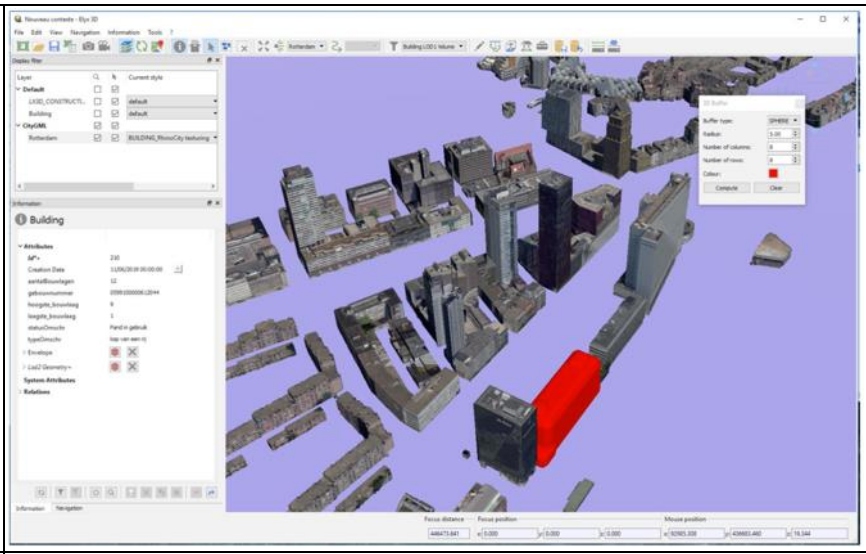
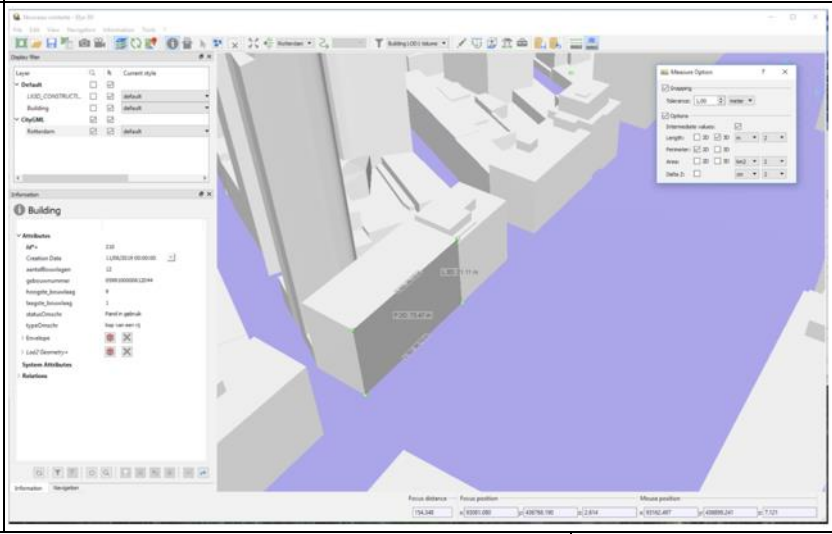
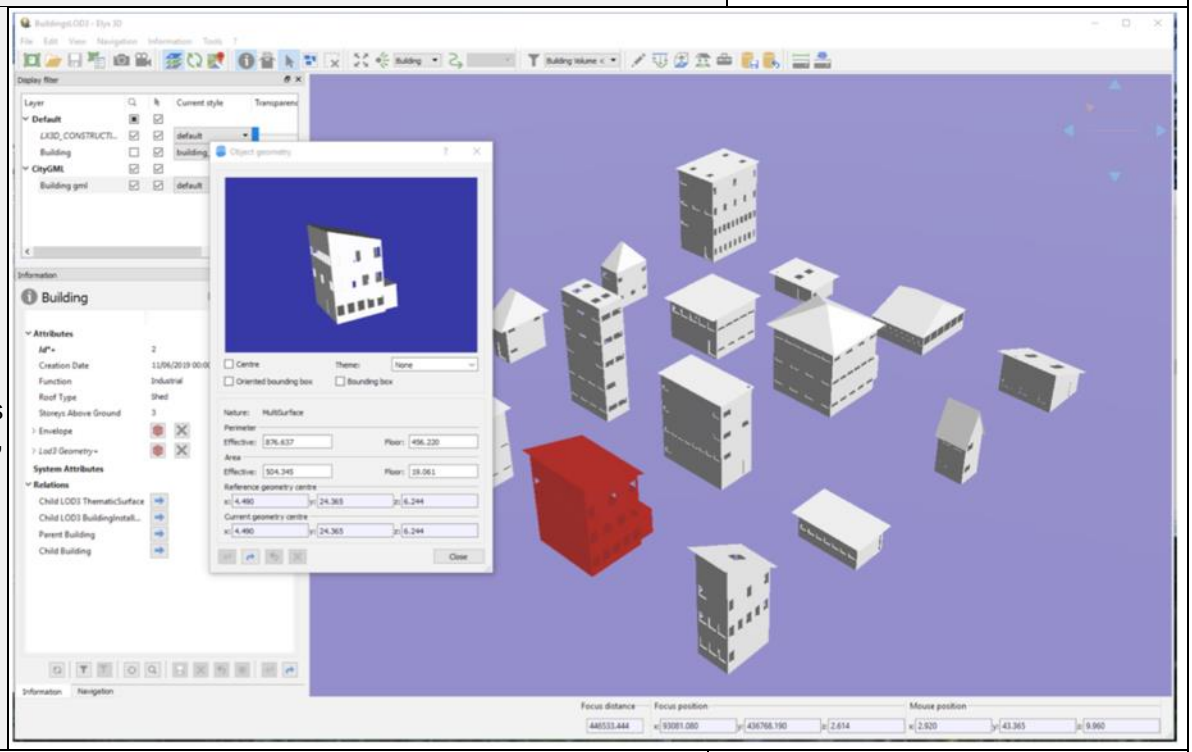
	19.1.2) Attach screenshots	
Analysis	20.1) Is it possible to analyse the objects and the model?	Yes, analysis about the modelled object performaces (energy, noise, shadow...) are possible (type 2)
	20.1.1) What analysis are possible? Do you know if the results are reliable? How much time is needed to perform them?	Intervisibility, surface calculations, volumes calculations, buffers
	20.1.2) Attach screenshots Image 10.1 – Intervisibility analysis	

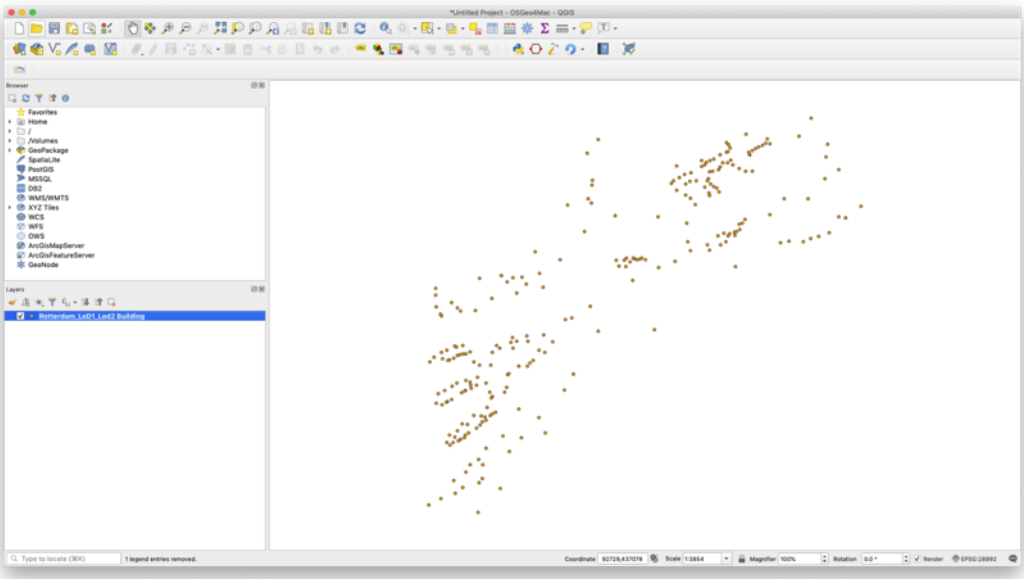
	Image 10.2 – Buffer analysis	
	Image 10.3 – Measurement	
	20.1.4) Time required to perform the analysis about the model itself (type 2)	it's almost immediate
Export	You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:	The software has also export-to-CityGML abilities
	21.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	No
	21.2) short comments to the previous question (optional)	CityGML Export could be done on any data loaded in Elyx 3D so CityGML ,shp, db data, ...
	22) How long does it take for the data to be exported to CityGML?	it's almost immediate
	Short comments regarding the export functionality (optional)	Possibility to choose data (selection, current view), attributes (mapping input to standard or generic attribute) and CityGML version (1.0 ou 2.0)

Test with BuildingsLoD3.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	it's almost immediate

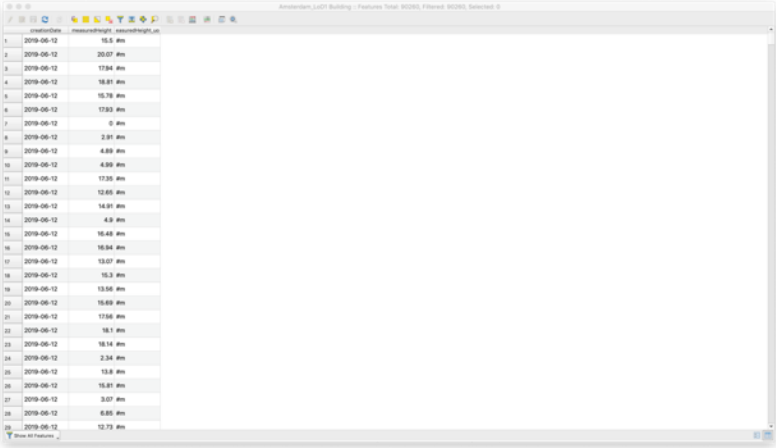
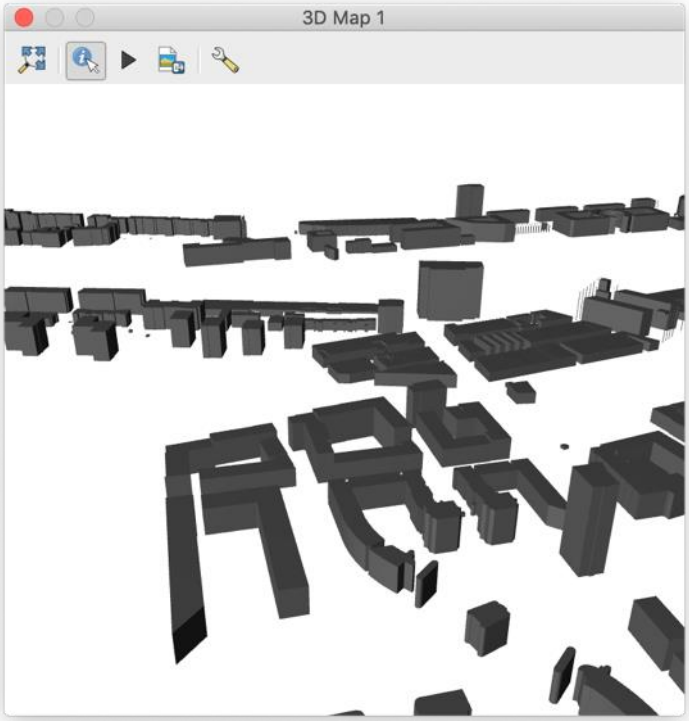
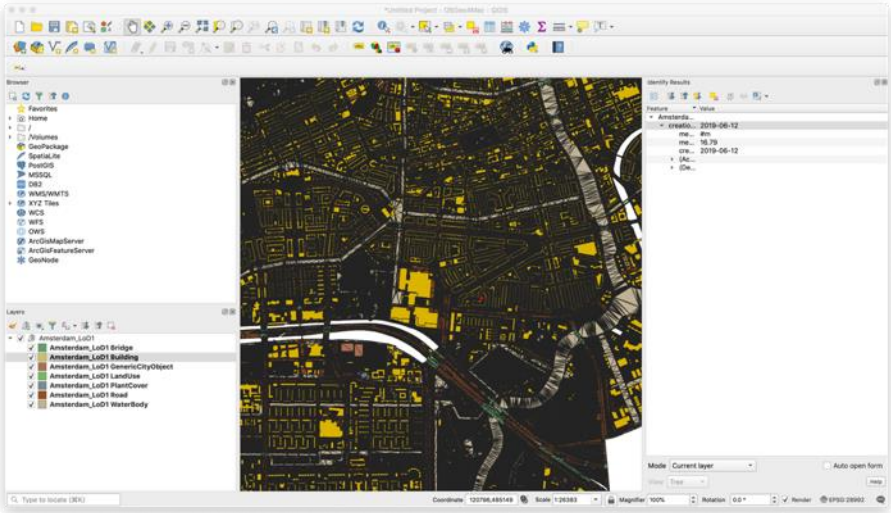
Geo ref	24.1) Does the model maintain its correct dimensions and proportions?	Yes
	Image 10.4 – Visualisation: geometries, attributes, relations	
Export	37) How long does it take for the data to be exported to CityGML?	it's almost immediate
Test with amsterdam.gml		
	How long does it take, approximately, to:Import (and visualise, if the software allows it) the model	it crashes without completing the operation
Final notes		
	Kind of possible CityGML management possible	• Import • Export • View • Query • Analysis • Import in RDBMS

QGIS – Test 1

Software	Software Name	**QGIS [3.6.3]**		Developers	https://www.qgis.org/en/site/		
	Proprietary or open source software?			Kind of software			
	open source			GIS			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	MacBook Pro 15" (Late 2016)	MacOS Mojave	Intel Core i7 2,6 GHz	Radeon Pro 460 4 GB / Intel HD Graphics 530	16 GB LPDDR3	500 GB SSD (of which 400 GB are allocated to MacOS)	17,68GB
ADE	1.1) Does the software support CityGML ADEs?			I don't know			
	1.2) Add short comments to the previous questions			The software is supposed to parse generic GML, therefore ADEs should be supported through their XSD files. Unfortunately, it still doesn't work so I cannot verify.			
Data format	2.1) Does the software support this CityGML data in native format?			Yes			
	2.2) short comments to the previous question (optional)			Originally, QGIS loads GML files by drag-n-drop. The data are loaded in a relational data format (due to QGIS's internal data structure)			

Test with RotterdamLoD12.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	The geometry is not loaded properly (loaded as points)
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	it's almost immediate
Import	Was any error reported when importing the file?	No, but the geometries are shown as points
LoDs	4.1) How are the different LoDs read/managed in the software?	They can only be imported and visualised all together, with overlaps in their view / management / analysis
	4.2) Please, give more details and examples	All points of all LoDs loaded in one layer.
	4.3) Attach screenshots	

Texture	Can the textures be visualised correctly?	No, the software does not support the texture visualisation
Test with BuildiongsLoD3.gml		
	How long does it take, approximately to: Import (and visualise, if the software allows it) the model	the software was not able to import the dataset, even if without crushing
Test with amsterdam.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	5-20 minutes
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	Querying is fast, but does not work properly
	Inspect the objects linked to the queried one through a relationship	the software does not allow this
Georeferencing	39.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	40.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	41.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	42.1) Is the model oriented correctly with respect to the true North?	Yes
	43.1) Does the model maintain its correct dimensions and proportions?	Yes
	44.1) When you import the data, Is it necessary to set the correct CRS manually?	No
Semantics	45.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	45.2) short comments to the previous question (optional)	Different object types are loaded to different layers.
	46.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	The software does not have the necessary tools to determine this information
	47.1) Are the attributes present in the CityGML entities retained and consistent?	Yes
	48.1) Are the relationships between the objects retained?	No
Geometry	49.1) Is geometry read correctly?	The software does not have the necessary tools to determine this information
	50.1) Did the normals change?	The software does not have the necessary tools for checking it
View	51.1) Is it possible to view the model in 3D?	Yes
	52.1) Is it possible to view the model in 2D?	Yes
	Other	
	52.2) short comments to the previous question (optional)	The 2D viewer is significantly slower than the 3D viewer. All answers regarding performance were given for the 3D viewer.

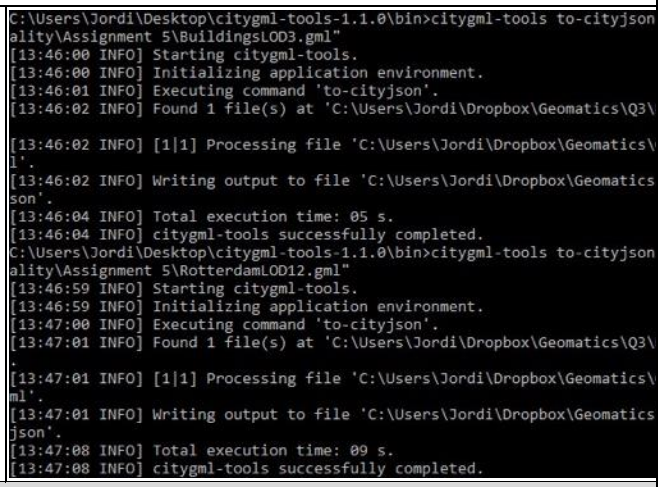
	48.1.2) Attach screenshots Image 12.1 - The attributes of buildings as loaded by QGIS	
	Image 12.2 – The 3D viewer with buildings loaded	
	Image 12.3 - The 2D viewer and all layers as loaded by QGIS. 2D viewer is significantly slower than the 3D viewer.	
Edit	53.1) Is it possible to edit the model?	No

	53.2) short comments to the previous question (optional)	QGIS has grayed out the "Edit mode" option.
Analysis	55.1) Is it possible to analyse the objects and the model?	Yes
	55.1.1) What analysis are possible? Do you know if the results are reliable?	QGIS provides a toolbox for doing analysis. Most of it will probably work only for 2D coordinates, but there are options to use GRASS which has several 3D processing algorithms implemented.
	55.1.3) Needed time to perform the analysis about the model itself (type 1)	1-5 minutes
	55.2) short comments to the previous question (optional)	The analysis conducted was the extraction of points from polygons.
Export	You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:	The software cannot export, therefore skip the phase 2
	Short comments regarding the export functionality (optional)	QGIS can export in other formats, but not in CityGML.
Final notes		
	Kind of CityGML management possible	• Import • View • Query • Analysis
	58) Would you like to share any other comments or observations?	Loading is inconsistent. 2D view is slow, but querying works. 3D view takes a while to initialize, but after that it's fast (but querying doesn't work). Inspecting attributes is a bit slow. Analysis can be conducted but is mostly limited to 2D (although GRASS algorithms might be used but that's not working with QGIS 3.6).

QGIS Test 2

Software	Software Name	**QGIS**	developer	QGIS Organization
	Proprietary or open source software?		Kind of software	
	open source		GIS	

Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	Lenovo Y700, 2015	Windows 10 Home 64-bit	i7- 6700HG	GeForce 960 4GB	16	500	100

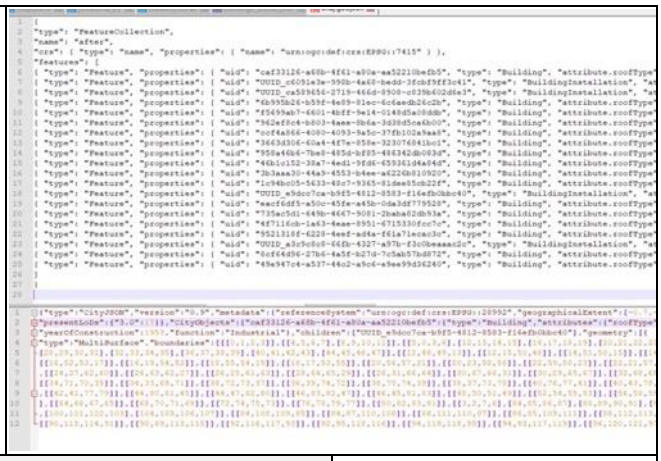
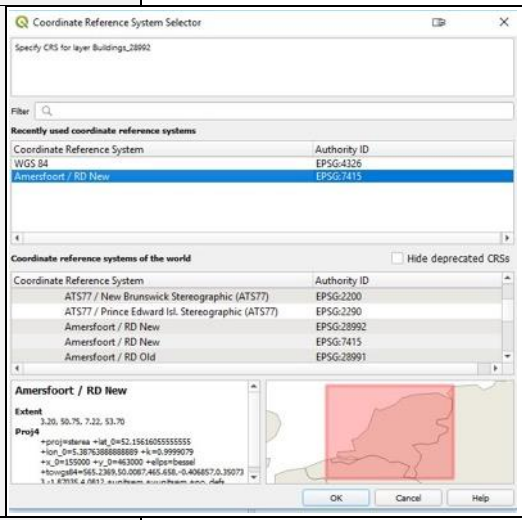
ADE	1.1) Does the software support CityGML ADEs?	No
Data format	2.1) Does the software support this CityGML data in native format?	No
	2.1.1) Which one of the following is true?	Some specific translation through specific tool/plugin is necessary, or other kind of formats are used.
	2.1.1.2) What processing and/or tools/plugins are necessary to import the CityGML file?	Conversion to CityJSON with citygml-tools 1.1.0
	2.1.1.3) Attach screenshots	

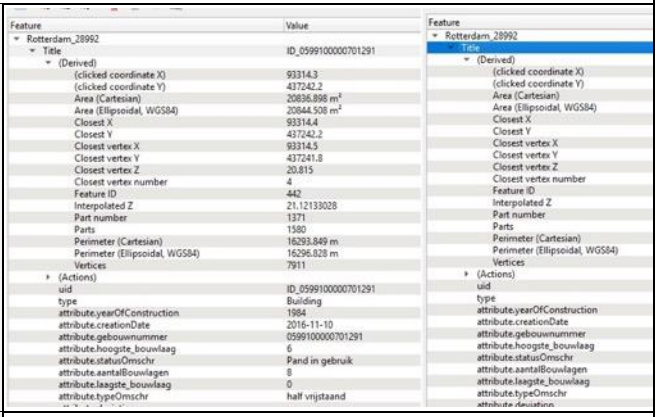
```
C:\Users\Jordi\Desktop\citygml-tools-1.1.0\bin>citygml-tools to-cityjson
ality\Assignment 5\BuildingsLOD3.gml"
[13:46:00 INFO] Starting citygml-tools.
[13:46:00 INFO] Initializing application environment.
[13:46:01 INFO] Executing command 'to-cityjson'.
[13:46:02 INFO] Found 1 file(s) at 'C:\Users\Jordi\Dropbox\Geomatics\Q3\

[13:46:02 INFO] [1|1] Processing file 'C:\Users\Jordi\Dropbox\Geomatics\
l'.
[13:46:02 INFO] Writing output to file 'C:\Users\Jordi\Dropbox\Geomatics
son'.
[13:46:04 INFO] Total execution time: 05 s.
[13:46:04 INFO] citygml-tools successfully completed.
C:\Users\Jordi\Desktop\citygml-tools-1.1.0\bin>citygml-tools to-cityjson
ality\Assignment 5\RotterdamLOD12.gml"
[13:46:59 INFO] Starting citygml-tools.
[13:46:59 INFO] Initializing application environment.
[13:47:00 INFO] Executing command 'to-cityjson'.
[13:47:01 INFO] Found 1 file(s) at 'C:\Users\Jordi\Dropbox\Geomatics\Q3\
.
[13:47:01 INFO] [1|1] Processing file 'C:\Users\Jordi\Dropbox\Geomatics\
ml'.
[13:47:01 INFO] Writing output to file 'C:\Users\Jordi\Dropbox\Geomatics
json'.
[13:47:08 INFO] Total execution time: 09 s.
[13:47:08 INFO] citygml-tools successfully completed.
```

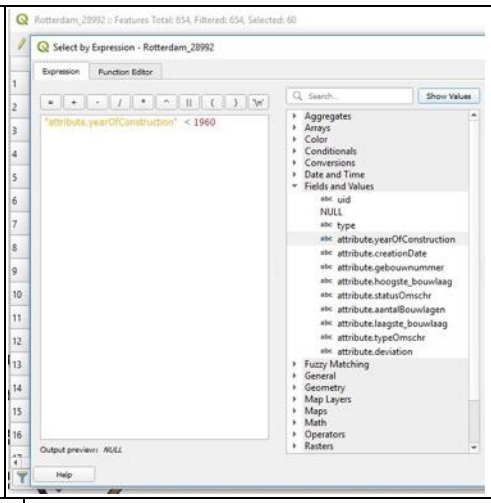
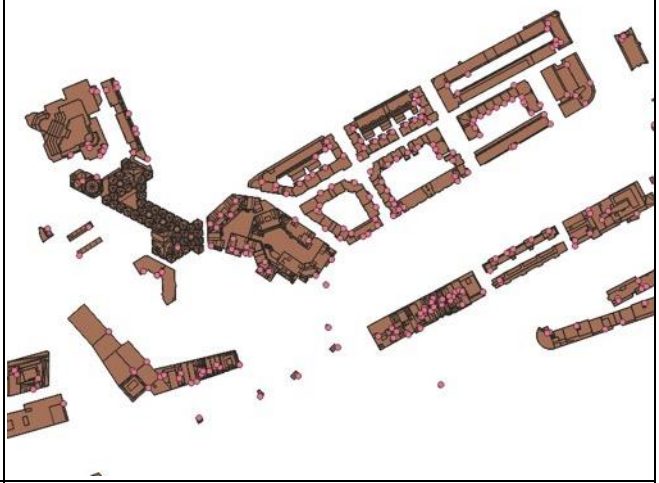
Test with RotterdamLoD12.gml

How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	20 minutes-1 hour
	Inspect the objects linked to the queried one through a relationship	it's almost immediate

LoD	4.1) How are the different LoDs read/managed in the software?	The software cannot recognize different LoD Levels, information is lost. Exporting feature to the same format (json) shows the problem, the information is not included there anymore
	4.2) Please, give more details and examples	The information referring to LoD (for example, parameter desribing to which level the feature is assigned, 'lod' = '3', is not available after exporting the imported file

	4.3) Attach screenshots	
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	5.2) Add short comments to the previous questions (optional)	Information about CRS is stored without any problems
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	6.2) short comments to the previous question (optional)	Information is handled without problem
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	7.2) short comments to the previous question (optional)	The origin value as well as the height is stored correctly
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	8.2) short comments to the previous question (optional)	In 2D yes. 3D viewer in QGIS does not let to check that
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	No
	9.1.1) What are the tools needed to set the correct CRS, or where is it possible to set it in the software?	It is possible to set it in the software
	9.1.2) Attach screenshots	
	9.2) short comments to the previous question (optional)	Coordinate system is not an issue in GIS
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	10.2) short comments to the previous question (optional)	It is possible to distinguish buildings and buildingspart as a type of feature
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	No

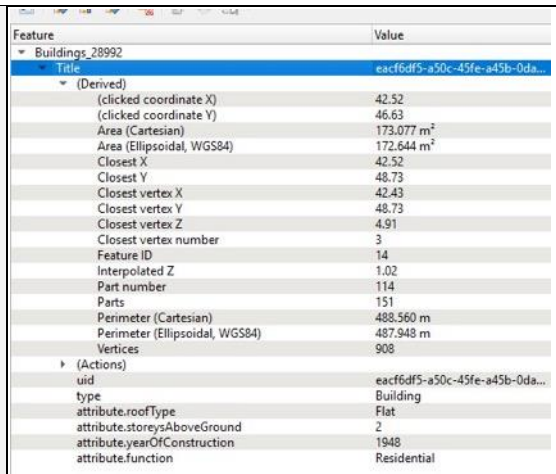
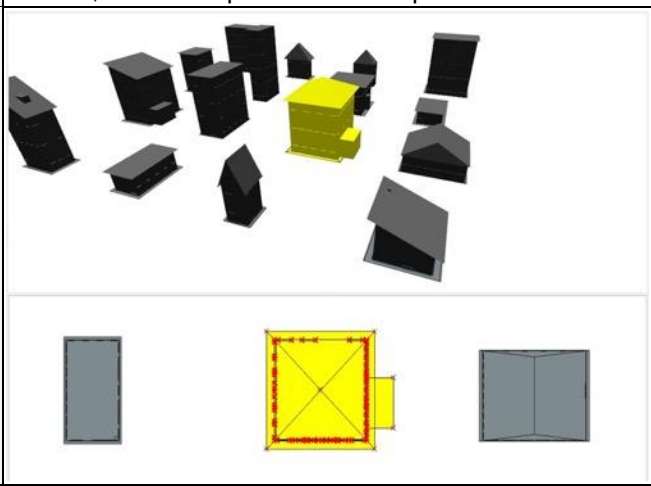
	12.1) Are the attributes present in the CityGML entities retained and consistent?	No
	12.1.1) What changes / inconsistencies / errors / other issues were noted?	It is trying to make it consistent, but the classes vary between different objects - beucase of that, buildingparts information is just a list of NULLs, so it is hard to treat this information as solid. The information about dimensions, cubature and so on is stored correctly
	12.1.2) Attach screenshots	
	12.2) short comments to the previous question	It is possible to distinguish which object should be a parent and which should be a child. It is hard to provide exact solution, but it is possible to distinguish with naked eye that parent id is shorter and less complicated.
Geometry	14.1) Is geometry read correctly?	Yes, partially
	14.2) short comments to the previous question (optional)	It is possible to visualize the model correctly. However, a lot of geometries are invalid
	15.1) Did normals change?	Yes
	15.2) short comments to the previous question (optional)	The model looks to be consistent when it comes to normals, however it is just based on the observation (no weird things noticed)
View	16.1) Is it possible to view the model in 3D?	Yes
	16.2) short comments to the previous question (optional)	It is quite a new feature in QGIS and it is limited to just a view
	17.1) Is it possible to view the model in 2D?	Yes
	17.2) short comments to the previous question	It is possible to visualize it without any problem in 2D
Editing	18.1) Is it possible to edit the model?	No
	18.2) short comments to the previous question (optional)	It is not possible to edit the model - the toggle edit button is gray. The found explanation states that i can be referred to mixed geometries and driver limitations. Same issue as with the Rotterdam - probably problem with GDAL capacities and drivers.
Query	19.1) Is it possible to query the model and the attributes?	It is possible to do it but not in 100%
	19.1.1) What kinds of query are possible?	It is possible to query the elements that appear in all of the object types. As screenshot the query for all the buildings built before 1960.

	19.1.2) Attach screenshots	
Analysis	20.1) Is it possible to analyse the objects and the model?	In some way - a lot of geometries are invalid
	20.1.1) What analysis are possible? Do you know if the results are reliable? How much time is needed to perform them?	The results are not reliable - most of the geometries are invalid and we can simply ignore that and move on. It is not making them valid anyway. I attach the screenshot with invalid features marked with dots. The number of them is referring the problem
	20.1.2) Attach screenshots Image 13.1 – geometries validity (analysis output?)?	
	20.2) short comments to the previous question (optional)	It is performing fast, the results are not reliable and speed is probably caused by avoiding broken geometry
Export	You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:	The software has also export abilities
	21.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	Yes
	21.1.1) Can you add a short description of the steps involved in the pre-processing?	If you import GML directly and export it right after - the information about Buildingparts is lost. With JSON in the middle, this information is stored (not on the proper way, but it exist). That's because it is stored as same level object and it is not lost inside of the parent

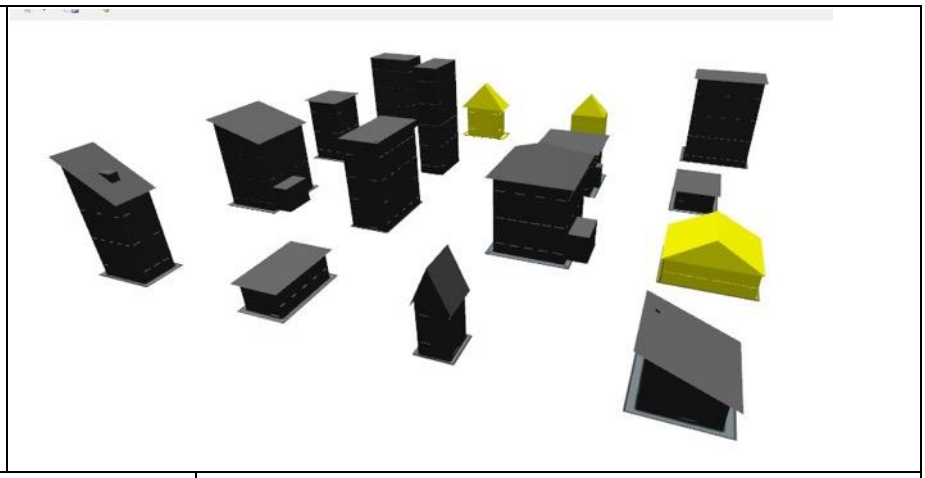
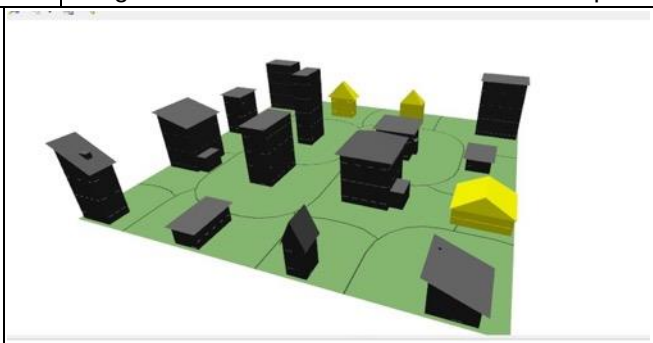
	21.1.2) Attach screenshots and files	
	21.2) short comments to the previous question (optional)	I provided the screenshot with visible BuildingPart as normal object
	22) How long does it take for the data to be exported to CityGML?	it's almost immediate

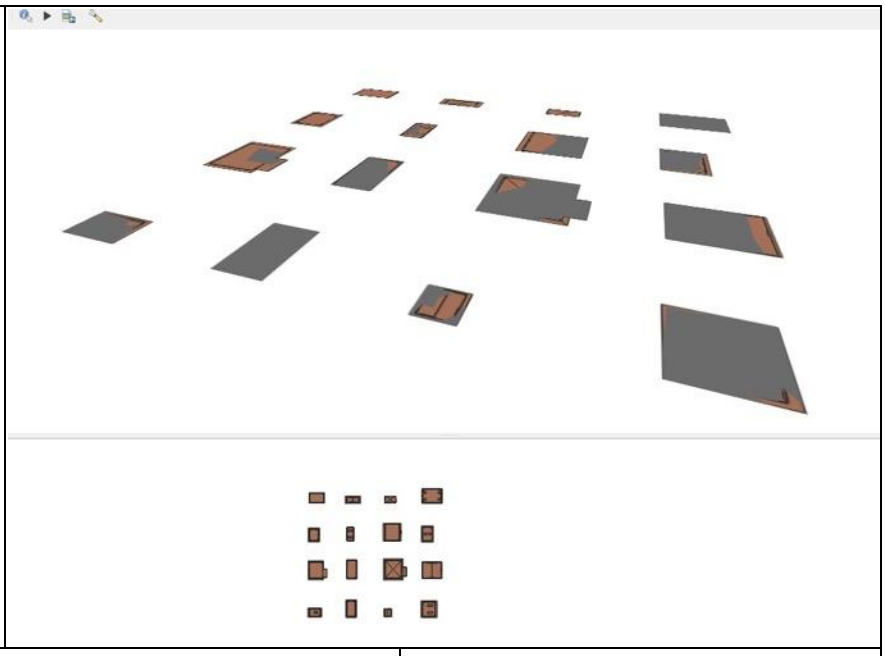
Test with BuildingsLoD3.gml

How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	the software does not allow this
Georef	24.1) Does the model maintain its correct dimensions and proportions?	Yes
	24.2) short comments to the previous question (optional)	The measured distances are the same as on the picture above
Semantics	25.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	25.2) short comments to the previous question (optional)	The buildings are still buildings when it comes to type
	26.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	No

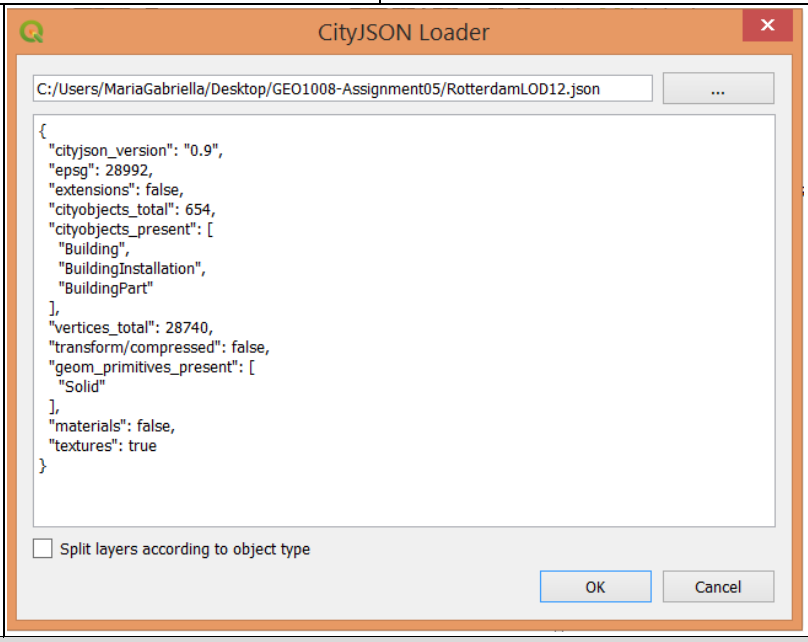
	26.1.2) Attach screenshots	
	27.2) short comments to the previous question (optional)	All of the object have same attributes, so no NULL values this time
	28.1) Are the relationships between the objects retained?	No
	28.1.1) What changes / inconsistencies / errors / other issues were noted?	There are no information about relationship, all of the childs of the buildings are stored into geometry, not as separate objects. Only the whole building can be chosen, without seperation on the parts
	28.1.2) Attach screenshots	
Geometry	29.1) Is geometry read correctly?	Yes
	29.2) short comments to the previous question	The model looks consistent when it comes to the visualization.
	30.1) Did the normals change?	Yes
	30.2) short comments to the previous question	The visualization looks correct
Query	34.1) Is it possible to query the model and the attributes?	Yes
	34.1.1) What kinds of query are possible?	It is possible to query the attributes

Feature	Value
Buildings_28992	
Title	eacf6df5-a50c-45fe-a45b-0da...
(Derived)	
(clicked coordinate X)	42.52
(clicked coordinate Y)	46.63
Area (Cartesian)	173.077 m²
Area (Ellipsoidal, WGS84)	172.644 m²
Closest X	42.52
Closest Y	48.73
Closest vertex X	42.43
Closest vertex Y	48.73
Closest vertex Z	4.91
Closest vertex number	3
Feature ID	14
Interpolated Z	1.02
Part number	114
Parts	151
Perimeter (Cartesian)	488.560 m
Perimeter (Ellipsoidal, WGS84)	487.948 m
Vertices	908
(Actions)	
uid	eacf6df5-a50c-45fe-a45b-0da...
type	Building
attribute.roofType	Flat
attribute.storeysAboveGround	2
attribute.yearOfConstruction	1948
attribute.function	Residential

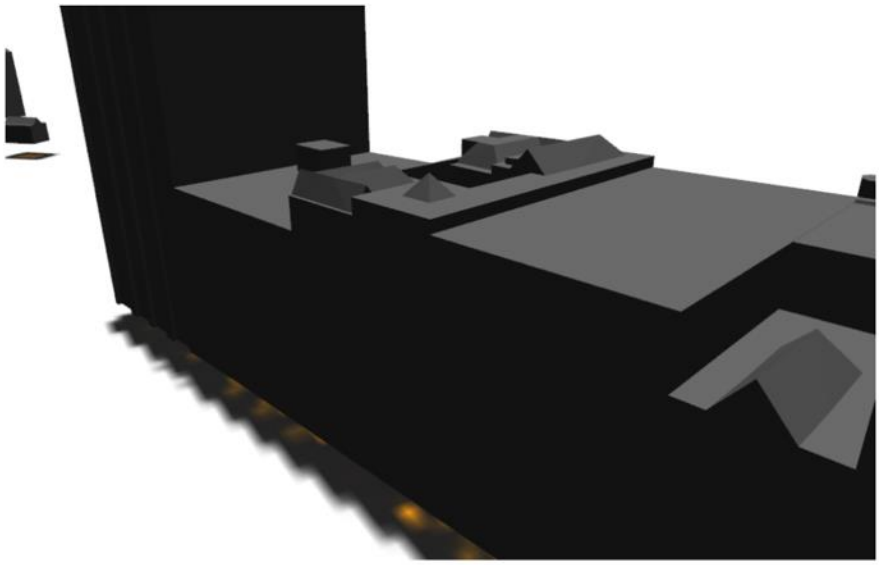
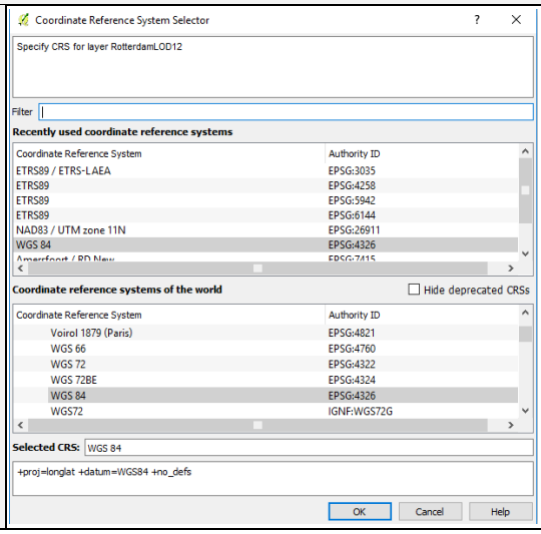
	34.1.2) Attach screenshots	
	34.2) short comments to the previous question	On the screenshot buildings with hipped roof were chosen
Analysis	35.1) Is it possible to analyse the objects and the model?	Yes
	35.1.1) What analysis are possible? Do you know if the results are reliable?	To some extend yes. Anyway, the geometry is also not valid in that case. We managed to buffer the objects, but the results are far away from being considered as reliable. The buffer was performed in 2d.
	35.1.2) Attach screenshots	
	35.1.3) Needed time to perform the analysis	it's almost immediate
Export	You arrived at the end of the phase 1: "Import and manage the file in the software".Now choose:	The software has also export abilities
	36.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	Yes
	36.1.1) Can you add a short description of the steps involved in the pre-processing?	Same as with rotterdam data, the data was transformed to JSON at first, when to QGIS and to GML again. The final final lost the geometries and it was not possible to visualize it in 3d anymore

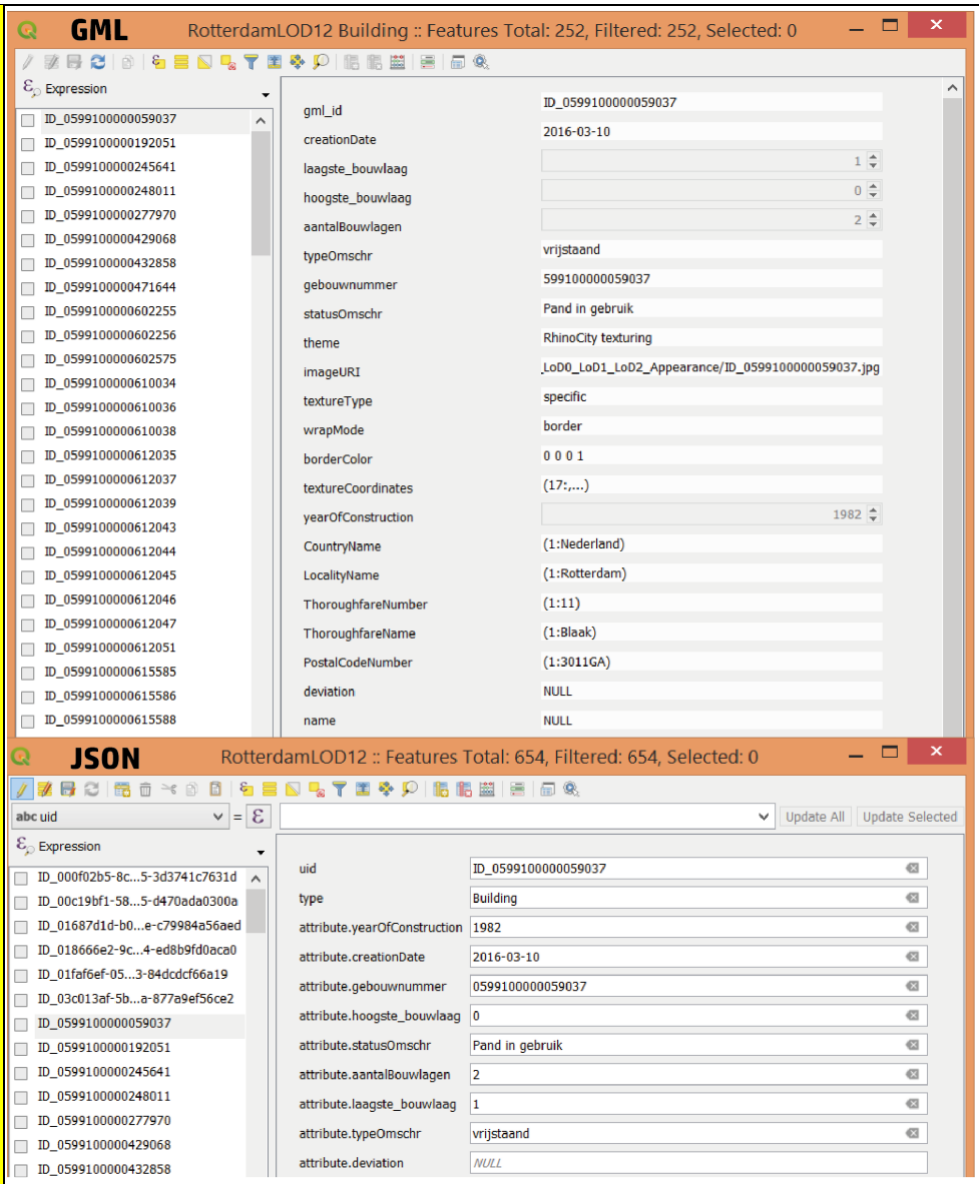
	36.1.2) Attach screenshots and files	
	37) How long does it take for the data to be exported to CityGML?	it's almost immediate
Test with amsterdam.gml		
	How long does it take, approximately, to:Import (and visualise, if the software allows it) the model	the software does not allow this
Final notes		
	Kind of CityGML management possible (through JSON conversion)	Import View Query Analyse

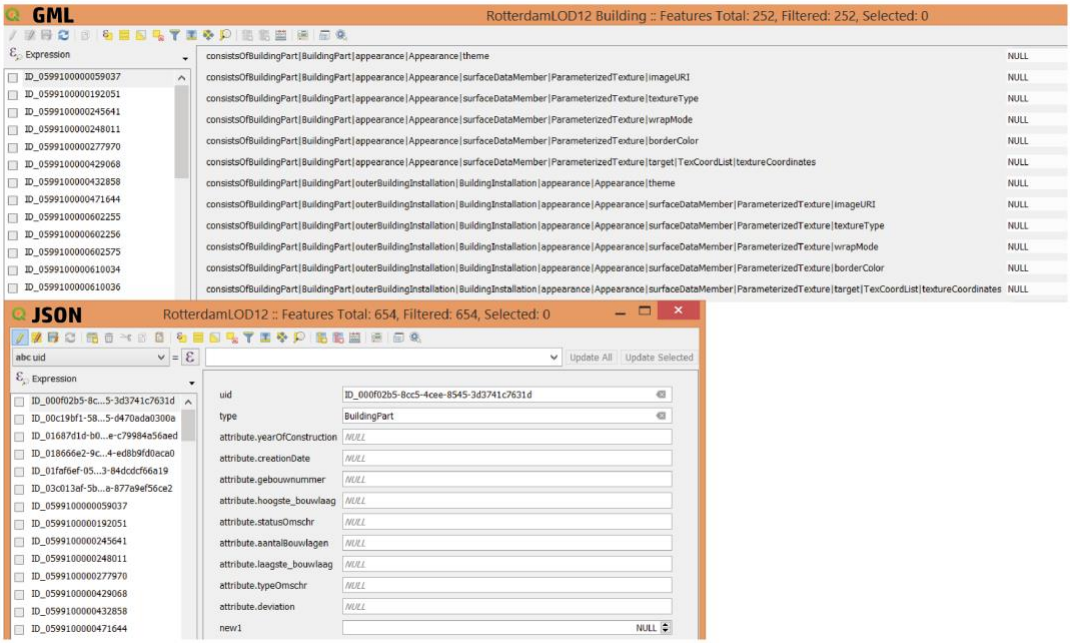
QGIS - Test 3

Software	Software Name	**QGIS [3.4]**		developer		QGIS Development Team	
	Proprietary or open source software?			Kind of software			
	open source			GIS			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	HP ZBook 15 G2	Windows 64-bits	Intel Core i7-4800MQ 34	:NVIDIA Quadro K2100M	8 GB	221 GB	31,6 GB
ADE	1.1) Does the software support CityGML ADEs?	No					
	1.2) Add short comments to the previous questions (optional)	CityJSON does have support for gml ADEs. However, we could not find out through documentation how this is handled by the cityjsontools converter or the cityjsonloader plugin. Nonetheless, QGIS3 does not offer direct support.					
Data form	2.1) Does the software support this CityGML data in native format?	No					
	2.1.1) Which one of the following is true?	Some specific translation through specific tool/plugin is necessary, or other kind of formats are used.					
	2.1.1.2) What processing and/or tools/plugins are necessary to import the CityGML file?Please justify your choices.	We used cityjsontools to convert between GML and JSON. Then, the plugin 'cityjsonloader' was installed on qgis. With this, the converted cityjson could be imported					
	2.1.1.3) Attach screenshots						

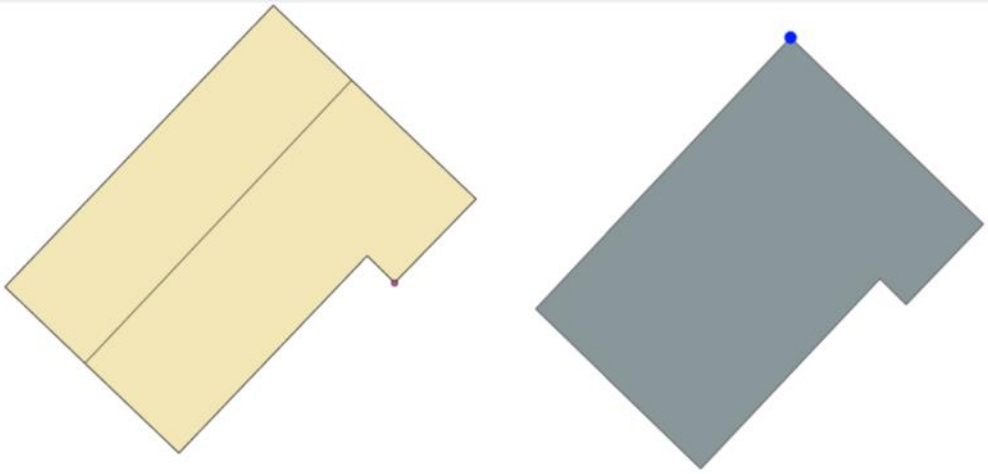
Test with RotterdamLoD12.gml		
How long does it take, approximately,	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	the software does not allow this

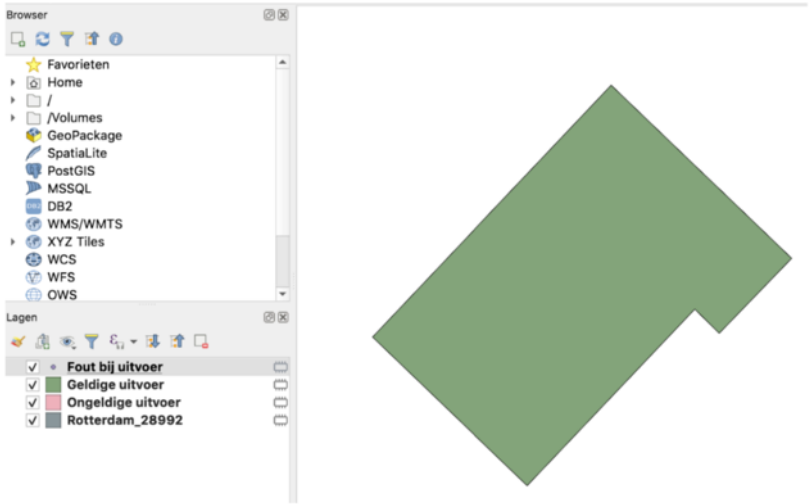
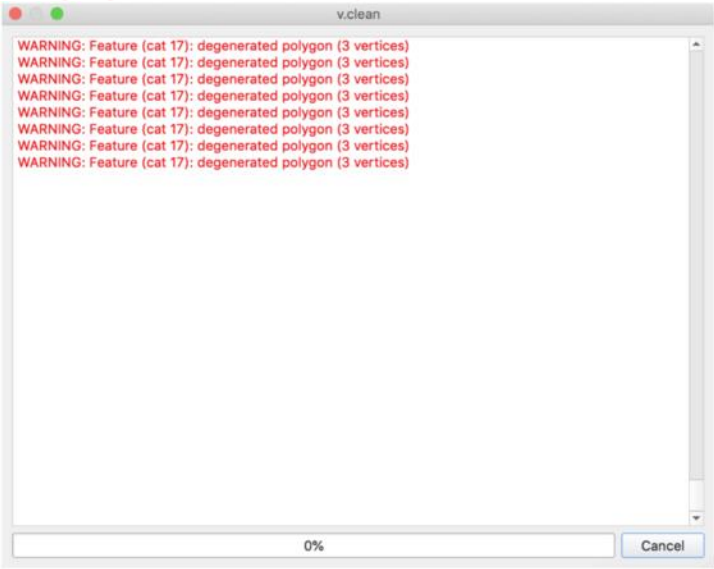
LoDs	4.1) How are the different LoDs read/managed in the software?	They can only be imported and visualised all together, with overlaps in their view / management / analysis
	4.2) Please, give more details and examples	For RotterdamLod12 all the information concerning geometries is stored directly under the attribute. However, as QGIS does not support CityGML, this cannot be viewed when importing it directly. So when importing the converted cityJSON, both lod's can only be seen together. In tthe BuildingsLOD3 dataset, the geometry information is directly found under , with each surface under a attribute. Then, each surface is represented by a . This is different from the Rotterdam dataset, were all surfaces are stored twice under an lod1 or lod2 Solid.
	4.3) Attach screenshots	 Levels of Detail. Figure 1.
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	5.2) Add short comments to the previous questions (optional)	CRS needs to be defined manually
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	The software does not have the necessary tools for checking it
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	Yes
	9.1.1) What are the tools needed to set the correct CRS, or where is it possible to set it in the software?	Just enter it in the prompt that shows up.
	9.1.2) Attach screenshots	

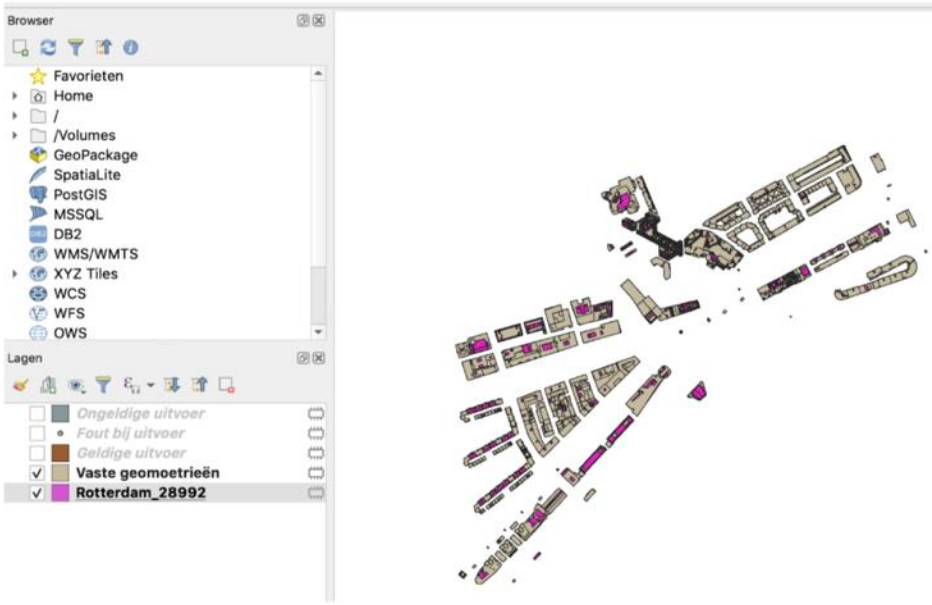
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	No
	10.1.1) What changes / inconsistencies / errors / other issues were noted?	CityGML → Firstly, QGIS does not support cityGML properly. So when importing the gml file directly, all information regarding the geometry of the buildings is lost. This means QGIS reads all attributes listed directly under the cityobjectmember, but not the geometry itself. So: no walls, doors or other building parts can be found. However, attributes seem to be present with the proper nomenclature. And there is one attribute 'name' that could not be found in the xml - and is always NULL in QGIS. CityJSON → Geometry can be visualized, but is not accessible through the attribute table. Attribute names are not the same as for the directly imported CityGML: it becomes attribute.'name'. Besides, 'gml_id' becomes 'uid' and an extra attribute 'type' is present, that distinguishes between Building and BuildingPart objects. Therefore, there are 654 features listed instead of 252.
	10.1.2) Attach screenshots	
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	No

	11.1.1) What changes / inconsistencies / errors / other issues were noted?	CityGML → It is difficult to answer this as many hierarchical relationships take place within the geometry objects (and these are not properly present in QGIS). However, the program has made an attempt at it: by including attributes in the attribute table. However, this has not been done successfully: again, the geometries are not read, and most attributes have NULL value as not every has an. CityJSON → In the original GML file BuildingPart objects are found within each Building object - together with the geometry of the building -, but QGIS reads BuildingPart geometries as separate features. In the attribute table they are assigned the same attributes (yearOfConstruction, function, roofType) as their parent Building objects, which are then left NULL. This assumes that they are equivalent types, which is not the case.
	11.1.2) Attach screenshots	
	12.1) Are the attributes present in the CityGML entities retained and consistent?	No
	12.1.1) What changes / inconsistencies / errors / other issues were noted?	CityGML → The attributes that were maintained can be read and interpreted by users, but it may be more difficult to perform queries in cases where one object has several instances within a subclass (such is the case for attributes within the BuildingPart and Address classes). In these cases, a list is given in the format (X: a, b, c), with X being the number of instances found within the attribute class. Besides, the attribute names for all things within BuildingPart are extensive, and not easy to be written out. CityJSON → As BuildingPart is seen as a separate object from Building with the same attributes, all information related to it is lost except its ID. However, this is not enough to establish a connection with Building objects.
	12.1.2) Attach screenshots	

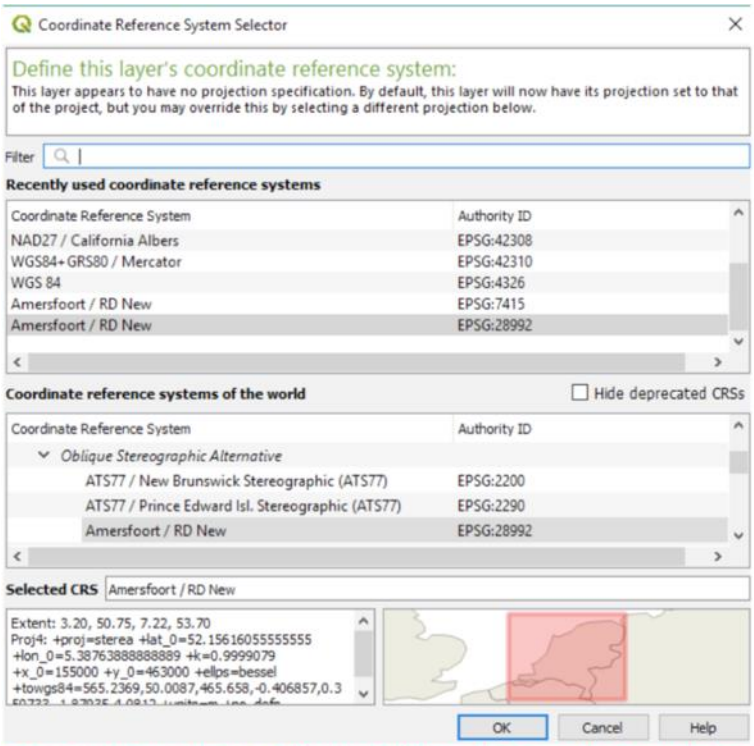
	13.2) short comments to the previous question (optional)	There are links between instances or objects through the use of gml IDs. For example, a surface member appointed under will have a reference ID. This ID is used to identify the polygons under , that together represent a Building/BuildingPart. A polygon, on its turn, will be composed of at least one , which will have the same ID plus '_E_X_Y' at the end. The E signalizes it's an exterior ring (I for interior), X identifies which LinearRing it is and Y stands for the total number of rings in the polygon. However, as no geometries are read when importing the CityGML, this relationship is lost. And as these ring IDs are used to handle the appearance of a building properly, everything under will also be affected.
Geometry	14.1) Is geometry read correctly?	The software does not have the necessary tools to determine this information
	14.2) short comments to the previous question (optional)	Regarding question 14.1: for the CityGML file there are points (representing the addresses), but for the JSON file there are no tools
	15.1) Did normals change?	The software does not have the necessary tools for checking it
	15.2) short comments to the previous question (optional)	Regarding question 15.1: the normals are changed for the CityGML file. And for CityJSON: there was something experimental which made it possible to add normals. However, nothing changed in the attribute table and the normals were not visualized.
View	16.1) Is it possible to view the model in 3D?	Yes
	16.2) short comments to the previous question (optional)	It is possible with the tool: New 3D Map View
	17.1) Is it possible to view the model in 2D?	Yes
	17.2) short comments to the previous question (optional)	It is for CityGML only possible to view the buildings as points, which represent the addresses.
Editing	18.1) Is it possible to edit the model?	Yes
	18.1.1) What editing is possible (attributes, geometry, georeferencing, please add details)?	Geometry: It was possible to manually edit the geometries. The result can be seen in figure 1. The building on the left is the original CityJSON (invalid geometry) and the building on the right is the CityJSON after editing. It became a valid geometry, which can be seen in figure 2. There are also a few tools tried to validate the geometry automatically. v.clean → generated warnings (figure 3) and it has a very long computation time/or maybe it will be impossible to run. It is therefore considered not useful. removing duplicate points → generating output worked, but the geometries of the output were still invalid repair geometries → validates a lot of the geometries, but some geometries wil be missing. This can be seen in figure 4. This may be due to the absence of spatial index files or it can be a bug in QGIS 3, source: https://issues.qgis.org/issues/14711. Georeferencing: The spatial reference system can be edited as well by right-clicking the data layer and then choosing "Set CRS". In 2D, the orientation can not be changed, but in 3D this is possible by dragging the mouse. Attributes: Attributes can be edited, and new attributes added by right-clicking the data layer and choosing 'Attribute Table'. it is also possible to perform selections based on certain values within the attributes. However, the JSON file does differentiate between features of type 'Building' and 'BuildingPart' - this last has all attributes set to NULL, so this should be remembered when making selections.

	18.1.2) Attach screenshots	 Editing possibilities. Figure 1. Screenshot which shows the invalid original geometry (on the left) and the manually added geometry on the right.

	Attach screenshots	 Editing possibilities. Figure 2. Screenshot which shows that the feature became valid. geldige uitvoer means valid output.  Editing possibilities. Figure 3. Screenshot which shows the warnings when cleaning the geometry



Editing possibilities. Figure 4. Screenshot which shows the repaired geometries in green and the missing geometries in pink.



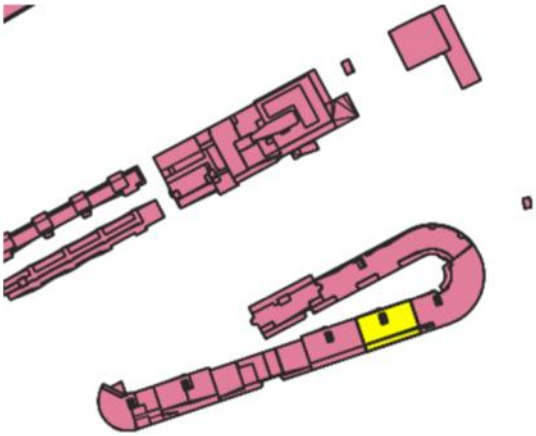
Editing possibilities. Figure 5. Screenshot of how to change the spatial reference system of a layer.

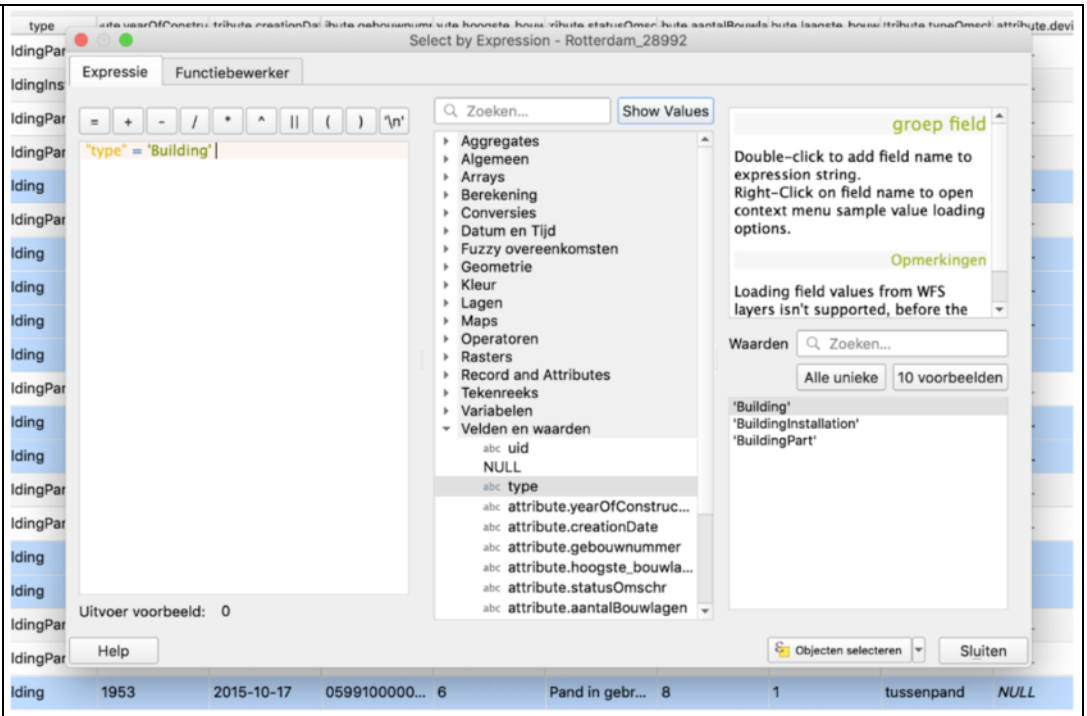
Ou	19.1) Is it possible to query the model and the attributes?	Yes

	19.1.1) What kinds of query are possible ?	Example 1. (selecting one building) In figure 1, one building is selected in the attribute table. In figure 2, it becomes visible that indeed only one building is selected and when saving this feature as a shapefile, only this building is saved, which can be seen in figure 3. Example 2. (selecting all buildings) In Figure 1 of example 2, it can be seen that all building were selected in the attribute table, but in figure 2, it can be seen that not all buildings were selected. A strange thing is that by selecting certain geometries with query language more or less buildings will be selected. The output is therefore different from the expected output, which makes it not logical and very difficult to use. Example 3. (selecting all features) It may be that this happens, because the other buildings only exists of building parts. Therefore, all features were selected in example 3. In figure 1 & 2, it can be seen that all features well selected. However, in figure 3 a new layer was created, but not all geometries were kept. This makes the output again not logical and very difficult to use.
	Attach screenshots	

	uid	type	ute.yearOfConstru	tribute.creationDa	ibute.gebouwnumm	ute.hoogste_bouw	ribute.statusOmsc	bute.aantalBouwla	bute.laagste_bouw	ttribute.typeOmscl	attribute.deviation
1	ID_6ea4a8ad...	BuildingPart	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
2	UUID_28010...	BuildingInstal...	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
3	ID_d9eea064...	BuildingPart	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
4	ID_19a05c96...	BuildingPart	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
5	ID_05991000...	Building	1988	2016-07-28	0599100000...	2	Pand in gebr...	3	0	tussenpand	NULL
6	ID_c5364851...	BuildingPart	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
7	ID_05991000...	Building	1987	2016-02-08	0599100000...	5	Pand in gebr...	6	0	vrijstaand	NULL
8	ID_05991000...	Building	1988	2015-10-16	0599100000...	2	Pand in gebr...	3	0	tussenpand	NULL
9	ID_05991000...	Building	1988	2017-01-06	0599100000...	3	Pand in gebr...	4	0	tussenpand	NULL

Query possibilities. Example 1. Figure 1. Screenshot of one selected building in the attribute table.

	19.1.2) Attach screenshots	 Query possibilities. Example 1. Figure 2. Screenshot which shows that indeed one building is selected. Yellow means a selected feature. Query possibilities. Example 1. Figure 3. Screenshot which shows the new layer containing one building



Query possibilities. Example 2. Figure 1. Screenshot of selected buildings in the attribute table with query language

Query possibilities. Example 2. Figure 2. Screenshot which shows which buildings are selected. Yellow means a selected feature.

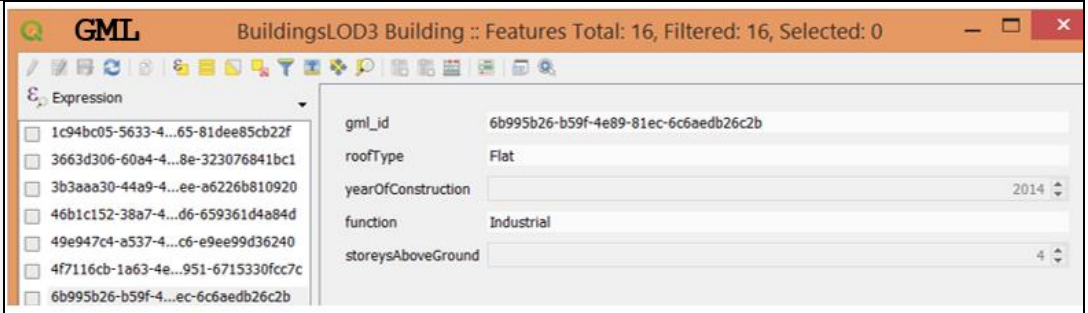
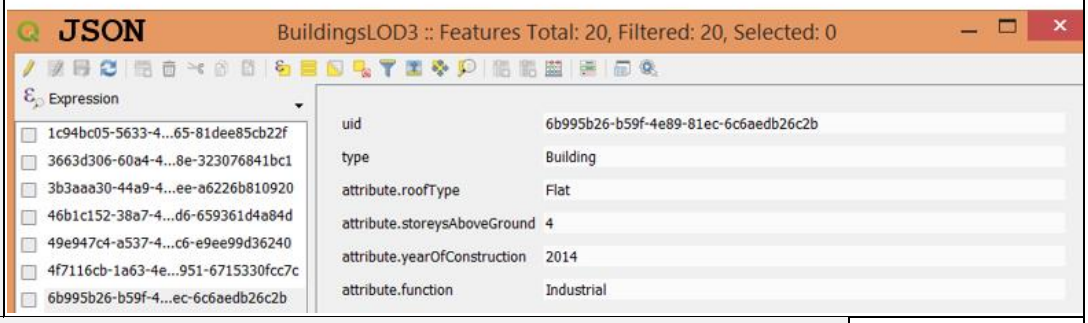
	uid	type	ute.yearOfConstru	tribute.creationDa	ibute.gebouwnum	ute.hoogste_boua	ribute.statusOmsc	bute.aantalBouwla	bute.laagste_bouw	tribute.typeOmsch	attribute.deviation
1	ID_6ea4a8ad...	BuildingPart	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
2	UUID_28010...	BuildingInstal...	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
3	ID_d9eea064...	BuildingPart	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
4	ID_19a05c96...	BuildingPart	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
5	ID_05991000...	Building	1988	2016-07-28	0599100000...	2	Pand in gebr...	3	0	tussenpand	NULL
6	ID_c5364851...	BuildingPart	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
7	ID_05991000...	Building	1987	2016-02-08	0599100000...	5	Pand in gebr...	6	0	vrijstaand	NULL
8	ID_05991000...	Building	1988	2015-10-16	0599100000...	2	Pand in gebr...	3	0	tussenpand	NULL
9	ID_05991000...	Building	1988	2017-01-06	0599100000...	3	Pand in gebr...	4	0	tussenpand	NULL
10	ID_05991000...	Building	1983	2016-02-08	0599100000...	5	Pand in gebr...	6	0	kop van een rij	yes
11	ID_4c6be014...	BuildingPart	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL
12	ID_05991000...	Building	1949	2015-10-17	0599100000...	7	Pand in gebr...	9	1	tussenpand	NULL
13	ID_05991000...	Building	1956	2015-10-12	0599100000...	6	Pand in gebr...	7	0	half vrijstaand	NULL
14	ID_505c71bc...	BuildingPart	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

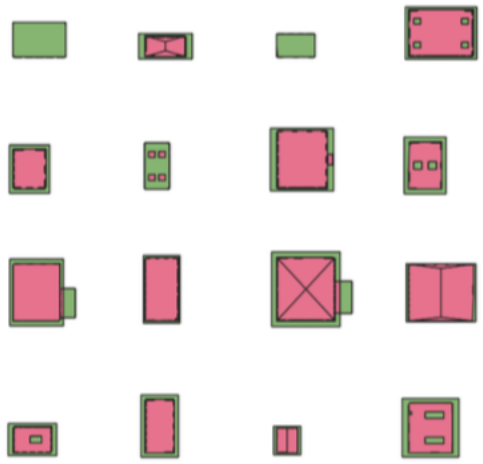
Query possibilities. Example 3. Figure 1. Screenshot which shows that every feature was selected in the attribute table.

Query possibilities. Example 3. Figure 2. Screenshot which shows that all features are selected. Yellow means a selected feature.

		 Query possibilities. Example 3. Figure 3. Screenshot which shows the new layer in yellow and the missing geometries in blue.
Analysis	20.1) Is it possible to analyse the objects and the model?	Yes
	20.1.1) What analysis are possible? Do you know if the results are reliable? How much time is needed to perform them?	Original CityGML → its was possible to create buffers and select certain points CityJSON → 3D geometries can only be viewed in the 3D viewer 2D geometries: It is normally only possible to analyse valid geometries, but it may also be possible to turn this off. However, the output can or will be unexpected, which is earlier described under the following sections: editing possibilities and query possibilities
Export	You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:	The software cannot export, therefore skip the phase 2

Test with BuildingsLoD3.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	the software does not allow this
Georef	24.1) Does the model maintain its correct dimensions and proportions?	Yes
Se	25.1) Is the eventual translation consistent with the CityGML definitions?	No

	25.1.1) What changes / inconsistencies / errors / other issues were noted?	CityGML → As with the Rotterdam dataset, when loading it directly in QGIS, the attributes having a single value in between (as yearOfConstruction, storeysAboveGround and roofType) are shown properly in the attribute table. Everything else is absent, including the geometry information. And as there are no addresses available, QGIS represents the dataset as a table. CityJSON → Geometry can be visualized, but is not accessible through the attribute table. Attribute names are not the same as for the directly imported CityGML: it becomes attribute.'name'. Besides, 'gml_id' becomes 'uid' and an extra attribute 'type' is present, that distinguishes between Building and BuildingInstallation objects. Therefore, there are 20 features listed instead of 16.
	25.1.2) Attach screenshots	 
	26.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	No
	26.1.1) What changes / inconsistencies / errors / other issues were noted?	CityGML → It is not possible to assess hierarchical relationships, as the attributes for geometries are not present. All other attributes listed in QGIS fall under the same hierarchical level. CityJSON → Although in the original GML file BuildingInstallation objects are found within each Building object - together with the geometry of the building -, QGIS reads BuildingInstallation geometries as separate features. In the attribute table they are assigned the same attributes (yearOfConstruction, function, roofType) as their parent Building objects, which are then left NULL. This assumes that they are equivalent types, which is not the case.
	26.1.2) Attach screenshots	
	27.1) Are the attributes present in the CityGML entities retained and consistent?	Yes

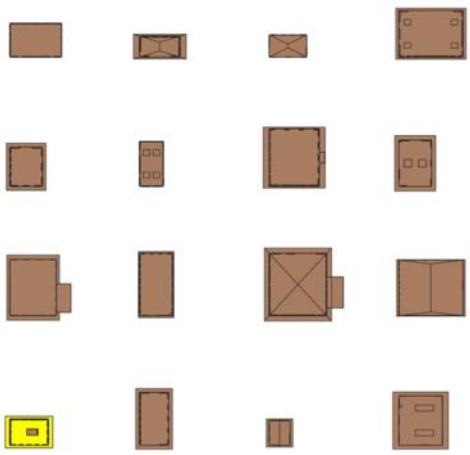
	27.2) short comments to the previous question (optional)	CityGML → The attributes that are present have the correct name as specified in the CItyGML file, and the values are appropriate for querying. CityJSON → the attribute names are preceded by the word 'attribute' - maybe as to define the hierarchical relationship? However, this seems to be more impractical.
Geometry	29.1) Is geometry read correctly?	No
	29.1.1) What changes / inconsistencies / errors / other issues were noted?	CityGML → not possible CityJSON → only possible to view 3D 2D geometries are invalid
Editing	33.1) Is it possible to edit the model?	Yes
	33.1.1) What editing is possible (attributes, geometry, georeferencing, please add details)?	It is only possible for CityJSON 2D Geometry: manual editing → the same as for Rotterdam. It is possible! v.clean → generated warnings and it has a very long computation time/or maybe it will be impossible to run. It is therefore considered not useful. removing duplicate points → generating output worked, but the geometries of the output were still invalid repair geometries → validates a lot of the geometries, but some geometries will be missing, which can be seen in figure 1. This may be due to the absence of spatial index files or it can be a bug in QGIS 3, source: https://issues.qgis.org/issues/14711. Georeferencing: The spatial reference system can be edited as well by right-clicking the data layer and then choosing "Set CRS". In 2D, the orientation can not be changed, but in 3D this is possible by dragging the mouse. Attributes: Attributes can be edited, and new attributes added by right-clicking the data layer and choosing 'Attribute Table'. it is also possible to perform selections based on certain values within the attributes. However, the JSON file does differentiate between features of type 'Building' and 'BuildingInstallation' - this last has all attributes set to NULL, so this should be remembered when making selections.
	33.1.2) Attach screenshots	 Editing possibilities. Figure 1. Screenshot which shows the repaired geometries in green and the missing geometries in pink.
Query	34.1) Is it possible to query the model and the attributes?	Yes

	34.1.1) What kinds of query are possible?	Example 1. (selecting one building) Not the whole geometry of the building is selected. This can be seen in figure 2 & 3. Example 2. (selecting all buildings) When selecting all buildings, most parts of the geometry will be selected, which can be seen in figure 2. However, when creating a new layer, large parts of the buildings will be missing. This can be seen in figure 3. Example 3. (selecting all features) Even when selecting all features, still some parts of the geometry will be missing when creating a new layer. This can be seen in figure 3.

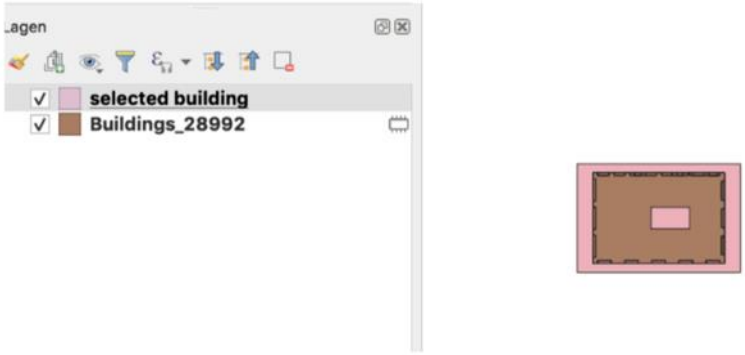
34.1.2) Attach screenshots

	uid	type	attribute.roofType	ute.storeysAboveG	ute.yearOfConstru	attribute.function
1	46b1c152-38...	Building	Flat	1	1979	Residential
2	f5699ab7-66...	Building	Hipped	1	1992	Residential
3	6b995b26-b...	Building	Flat	4	2014	Industrial
4	ccf4a866-40...	Building	Pyramidal	3	2006	Residential
5	962ef8c4-b...	Building	Hipped	2	2006	Industrial
6	caf33126-a6...	Building	Shed	3	1953	Industrial
7	UUID_ca589...	BuildingInstal...	NULL	NULL	NULL	NULL
8	UUID_c6091...	BuildingInstal...	NULL	NULL	NULL	NULL
9	49e947c4-a...	Building	Flat	5	1951	Industrial
10	9521318f-62...	Building	Shed	1	1952	Residential
11	4f7116cb-1a...	Building	Flat	1	1946	Industrial
12	8cf64d96-2...	Building	Flat	4	1975	Industrial
13	UUID_a3c9c...	BuildingInstal...	NULL	NULL	NULL	NULL
14	UUID_e9dcc7...	BuildingInstal...	NULL	NULL	NULL	NULL
15	1c94bc05-5...	Building	Flat	4	1964	Residential
16	735ac5d1-6...	Building	Flat	3	1987	Residential
17	eacf6df5-a5...	Building	Flat	2	1948	Residential
18	958a46b6-7...	Building	Gabled	2	1976	Residential
19	3663d306-6...	Building	Shed	3	1951	Industrial
20	3b3aaa30-4...	Building	Hipped	2	1989	Residential

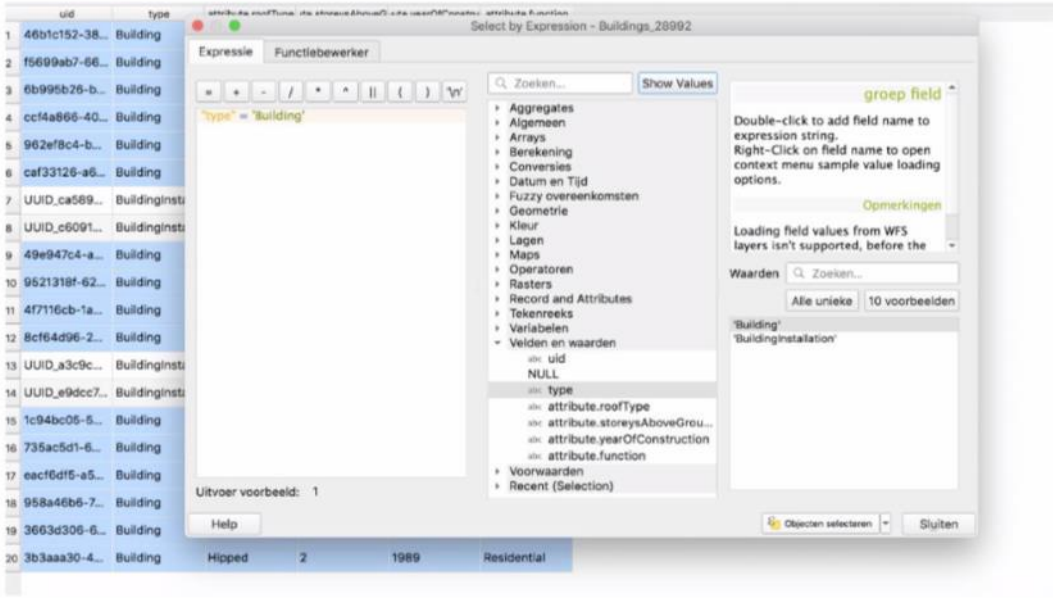
Query possibilities. Example 1. Figure 1. Screenshot of one selected building in the attribute table.



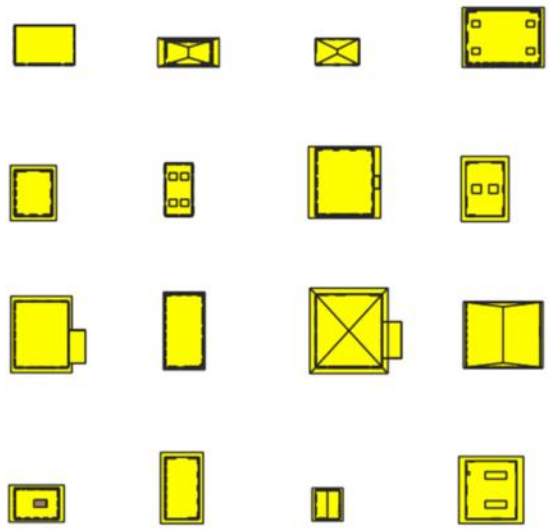
Query possibilities. Example 1. Figure 2. Screenshot which shows that indeed one building is selected. Yellow means a selected feature.



Query possibilities. Example 1. Figure 3. Screenshot which shows the new layer containing one building (pink is the new layer and brown is the missing geometry)

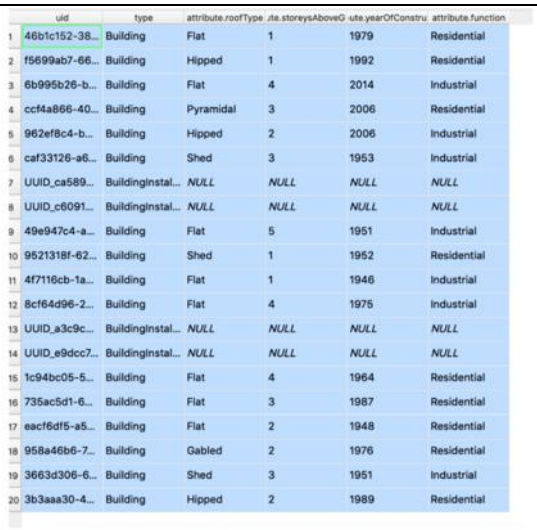


Query possibilities. Example 2. Figure 1. Screenshot of selected buildings in the attribute table with query language



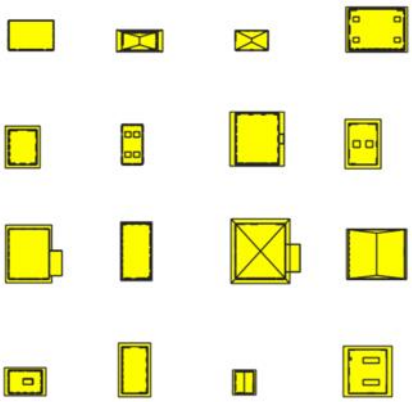
Query possibilities. Example 2. Figure 2. Screenshot which shows which buildings are selected. Yellow means a selected feature.

Query possibilities. Example 2. Figure 3. Screenshot which shows that the new layer does not contain the whole geometry of the buildings. The new layer is shown in orange and the missing geometry in brown.

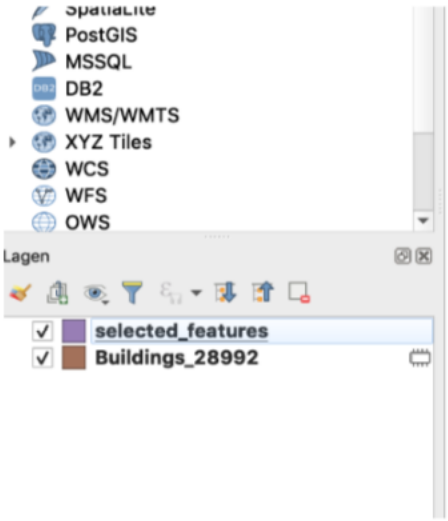
<table>
<tr><td></td><td></td><td>


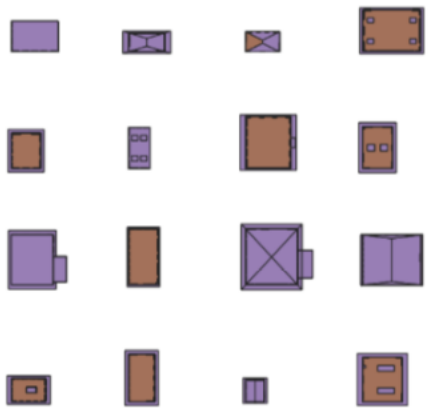
	uid	type	attribute.roofType	ute.storeysAboveG	ute.yearOfConstru	attribute.function
1	46b1c152-38...	Building	Flat	1	1979	Residential
2	f5699ab7-66...	Building	Hipped	1	1992	Residential
3	6b995b26-b...	Building	Flat	4	2014	Industrial
4	ccf4a866-40...	Building	Pyramidal	3	2006	Residential
5	962ef8c4-b...	Building	Hipped	2	2006	Industrial
6	caf33126-a6...	Building	Shed	3	1953	Industrial
7	UUID_ca589...	BuildingInstal...	NULL	NULL	NULL	NULL
8	UUID_c6091...	BuildingInstal...	NULL	NULL	NULL	NULL
9	49e947c4-a...	Building	Flat	5	1951	Industrial
10	9521318f-62...	Building	Shed	1	1952	Residential
11	4f7116cb-1a...	Building	Flat	1	1946	Industrial
12	8cf64d96-2...	Building	Flat	4	1975	Industrial
13	UUID_a3c9c...	BuildingInstal...	NULL	NULL	NULL	NULL
14	UUID_e9dcc7...	BuildingInstal...	NULL	NULL	NULL	NULL
15	1c94bc05-5...	Building	Flat	4	1964	Residential
16	735ac5d1-6...	Building	Flat	3	1987	Residential
17	eacf6df5-a5...	Building	Flat	2	1948	Residential
18	958a46b6-7...	Building	Gabled	2	1976	Residential
19	3663d306-6...	Building	Shed	3	1951	Industrial
20	3b3aaa30-4...	Building	Hipped	2	1989	Residential

Query possibilities. Example 3. Figure 1. Screenshot which shows that every feature was selected in the attribute table.



Query possibilities. Example 3. Figure 2. Screenshot which shows that all features are selected. Yellow means a selected feature.



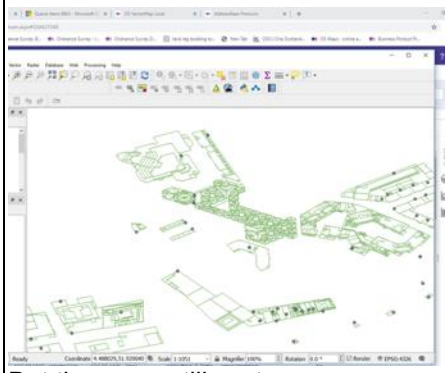


Query possibilities. Example 3. Figure 3. Screenshot which shows the new layer in purple and the missing geometries in brown.</td></tr>
<tr><td rowspan="3">Analyse</td><td colspan="2">35.1) Is it possible to analyse the objects and the model?</td><td>Yes</td></tr>
<tr><td>35.1.1) What analysis are possible? Do you know if the results are reliable?</td><td colspan="2">Original CityGML → its was possible to create buffers and select certain points; but no other geometry is available

CityJSON → 3D geometries can only be viewed in the 3D viewer
2D geometries: It is normally only possible to analyse valid geometries, but it may also be possible to turn this off. However, the output can or will be unexpected, which is earlier described under the following sections: editing possibilities and query possibilities.</td></tr>
<tr><td colspan="2">35.1.3) Needed time to perform the analysis about the model itself (type 1)</td><td>1-5 minutes</td></tr>
<tr><td>Export</td><td colspan="2">You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:</td><td>The software cannot export, therefore skip the phase 2</td></tr>
<tr><td colspan="4">Test with amsterdam.gml</td></tr>
<tr><td></td><td colspan="2">Not possible to try out the dataset for Amsterdam</td><td></td></tr>
<tr><td colspan="4">Final notes</td></tr>
</table>

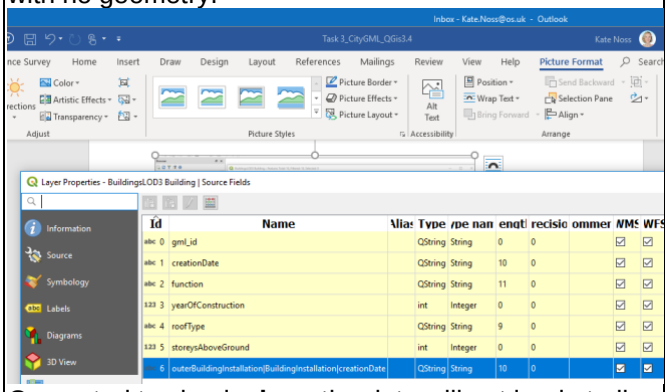
	Kind of CityGML management possible	• Import (through JSON) • View • Query • Edit • Analysis(2D)

QGIS 3.4 – Some more comments from one additional test

Software	Software Name [version]	**QGIS 3.4**	Software house	
	Proprietary or open source software?		Kind of software	
	Open source		GIS	
Needed Data Format and conversion	2.1) Does it support this CityGML dataset in native format?		Not for all the datasets	
	2.1.1) Which one of the following is true?		Some specific translation through specific tool/plugin is necessary, or other kind of formats are used.	
	2.1.1.2) What processing and/or tools/plugins are necessary to import the CityGML file?	Looking online it appears that a variety of other tools are available to convert the data into a format QGIS will read directly; these include **citygml4j-master** and **cityjson-qgis-plugin-master**. **citygml4j** requires Java version 8 or above. The project uses Gradle as build system to build the program model from source by running commands (https://github.com/citygml4j/ade-xjc/blob/master/README.md). Finding the relevant plug-ins and how to use them could be a blocker for many customers, particularly those with strict software security policies. Running the data through **FME** to create a json file is time consuming for some of the datasets. The resultant data still throws an error in QGIS and will not load.		
Test with Rotterdam.gml				
LoDs	4.1) How are the different LoDs read /managed?		Multi-LoD data are just loaded like points	
	Running the data through **FME** to create a Geojson file: Does allow a simple drag and drop with some 3D modelling: 	 But there are still system messages advising “Error unsupported geometry type”. The data loads quickly and can be panned around quickly too. Applying the **Qgis2threejs** plugin has no effect with the converted data.		
Test with BuilsdingsLOD3.gml[6]				

[6] The information already reported for the Rotterdam dataset is not repeated, unless there is any noticeable difference.

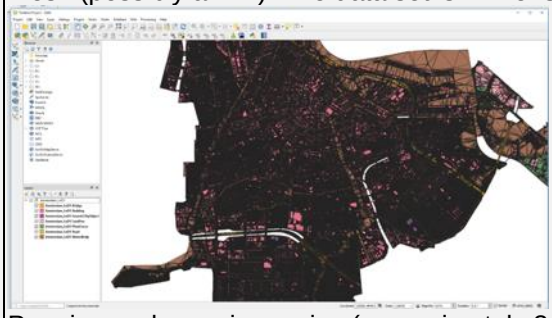
QGIS 3.4 – Some more comments from one additional test
Open source software
GIS
Level of tester expertise: 2

<table>
<tr>
<td></td>
<td>The native building LoD3 file loads only as a table file with no geometry.
 

Converted to simple .json the data will not load at all.</td>
<td>Converted to Geojson, the file can be loaded using simple drag and drop with geometries, none of which are 3D.

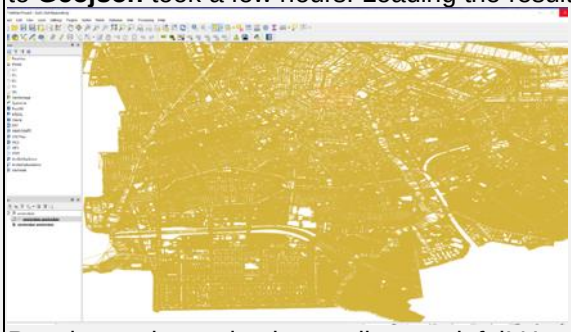
The same qgis plugin, Qgis2threejs has no effect with this layer</td>
</tr>
<tr>
<td colspan="3">Test with amsterdam.gml</td>
</tr>
</table>

Looking at the Amsterdam data, which is used later in the task, the .**gml** loaded with geometries, almost as a mesh (possibly a TIN). The data set is immense and took some length to load (9 minutes) and render.



Panning and zooming varies (approximately 3-5 mins for pan and zoom load).

Without further processing the data cannot be visualised as a model, though the same qgis plugin, **Qgis2threejs**, can be applied to create the simple 3D element as with the Rotterdam data above. I would not recommend trying this with the whole data file, which would almost certainly crash! Converting the file via FME to **Geojson** took a few hours. Loading the resultant file took approximately 1hr 15 minutes!



Panning and zooming is equally as painful! However, this does indicate some 3D element.

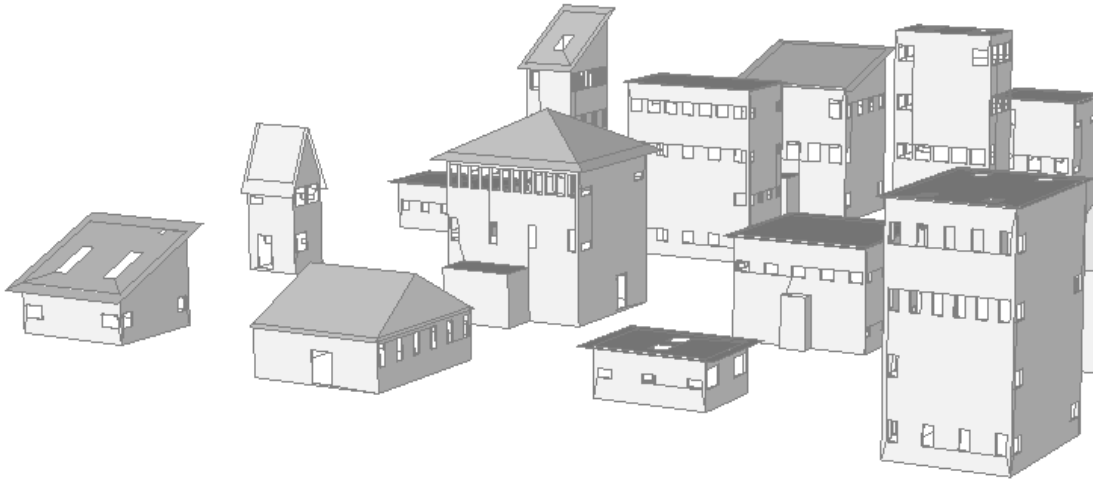
Trying to select a smaller area to export and view is also problematic and crashes. Thus, it has not been possible to test the **Qgis2threejs** plugin with the Amsterdam data after conversion to **Geojson**.

Final notes

For someone with limited experience of GIS, this data is not user friendly. The advertised tools cannot be downloaded easily, as security regulations prevent this;
citygml4j-master: https://www.3dcitydb.org/3dcitydb/citygml4j/
Citygml_tools: https://www.cityjson.org/help/users/conversion/
cityjson-qgis-plugin-master: https://www.cityjson.org/about/
The tools work with java and executable files. Someone with developer skills might find these easy to use, though OS experience of our customer base would suggest a number of our customers would encounter issues.

Tridicon CityDiscoverer Light

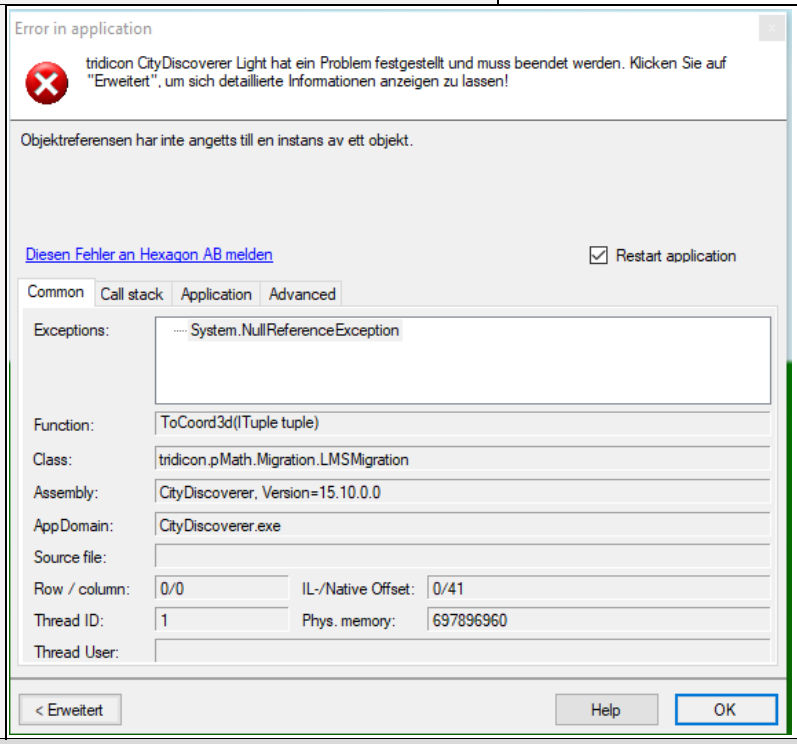
Software	Software Name		**tridicon CityDiscoverer Light [15.10]**		Software house		Hexagon AB, C:\Downloads\tridicon_cityDiscovererlight-15.10.exe
	Proprietary or open source software?				Kind of software		
	open source				3D viewer		
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	HP ZBook 15 G3, 2018	Windows 10 Enterprise, 64-bit	Intel ® Core™ i7-6820HQ CPU	NVIDIA Quatro M1000M	32	474	217
ADE	1.1) Does the software support CityGML ADEs?			No			
Test with RotterdamLoD12.gml							
	Was any error reported when importing the file?	Yes, the program crasheswhen trying to import it and no further tests are possible to perform for RotterdamLOD12.gml					
Test with BuildingsLoD3.gml							
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	it's almost immediate					
	Zoom into the model to see more detail	it's almost immediate					
	Pan the model	it's almost immediate					
	Rotate the model	it's almost immediate					
	Query an object	the software does not allow this					
	Inspect the objects linked to the queried one through a relationship	the software does not allow this					
Data form	Does the software support this CityGML data in native format?	Yes					
Georefere	24.1) Does the model maintain its correct dimensions and proportions?	Yes					
Semantics	25.1) Is the eventual translation consistent with the CityGML definitions?	The software does not have the necessary tools for checking it					
	26.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	The software does not have the necessary tools to determine this information					
	27.1) Are the attributes present in the CityGML entities retained and consistent?	The software does not have the necessary tools to determine this information					
	28.1) Are the relationships between the objects retained?	The software does not have the necessary tools to determine this information					
Geometry	29.1) Is geometry read correctly?	Yes					
	29.2) short comments to the previous question (optional)	At least it looks correct.					
	30.1) Did the normals change?	Yes					
View	31.1) Is it possible to view the model in 3D?	Yes					



	32.1) Is it possible to view the model in 2D?	No
Editing	33.1) Is it possible to edit the model?	No
Query	34.1) Is it possible to query the model and the attributes?	No
Export	37) How long does it take for the data to be exported to CityGML?	It does not have export abilities

Test with amsterdam.gml

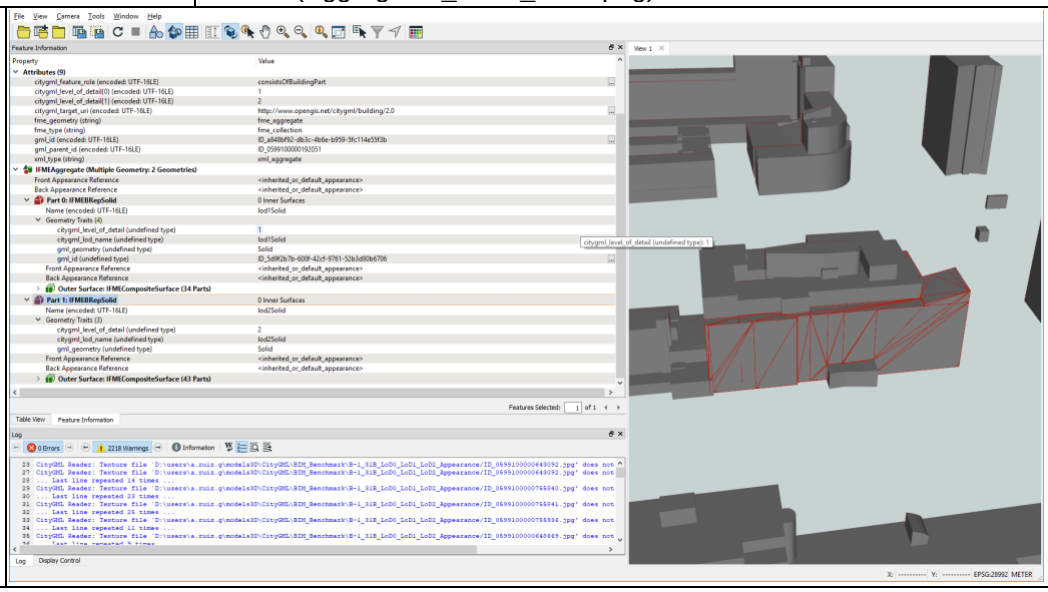
	How long does it take, approximately, to:Import (and visualise, if the software allows it) the model	it crashes without completing the operation

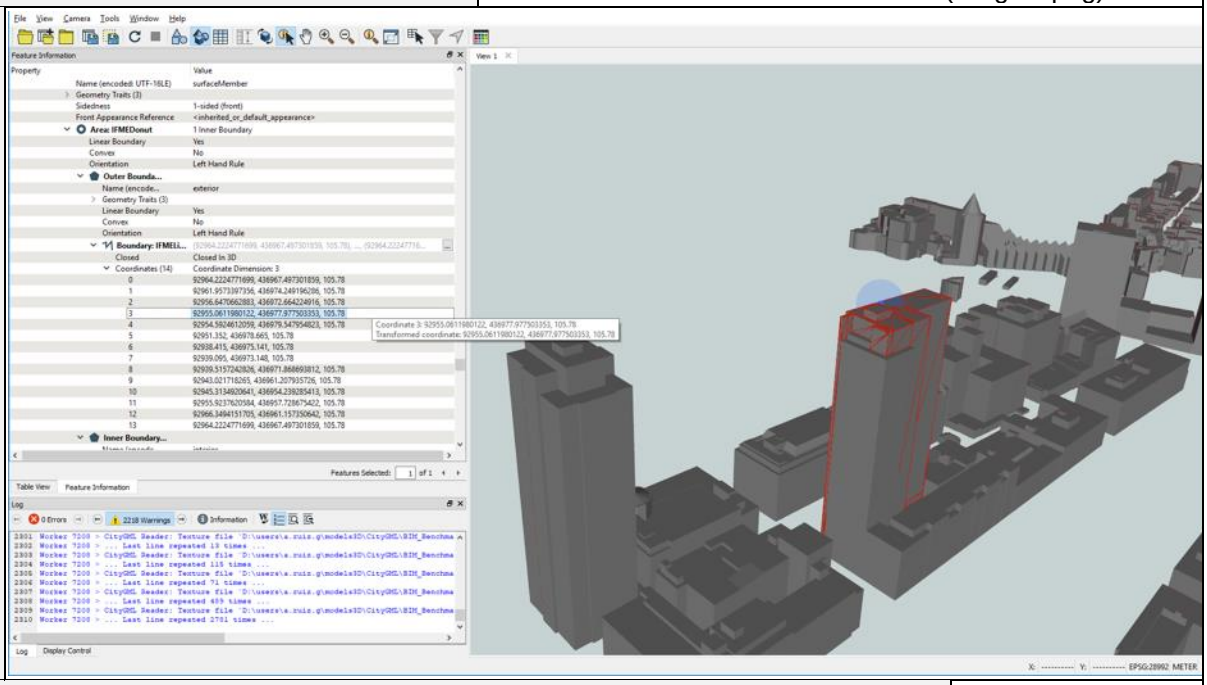
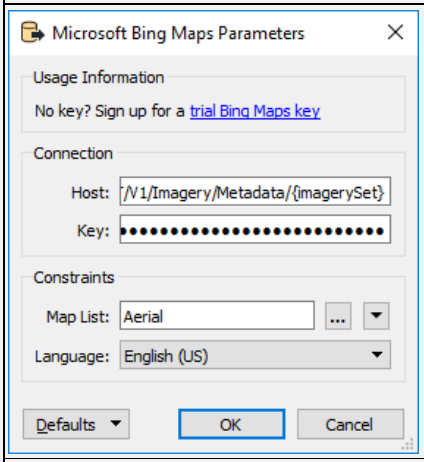
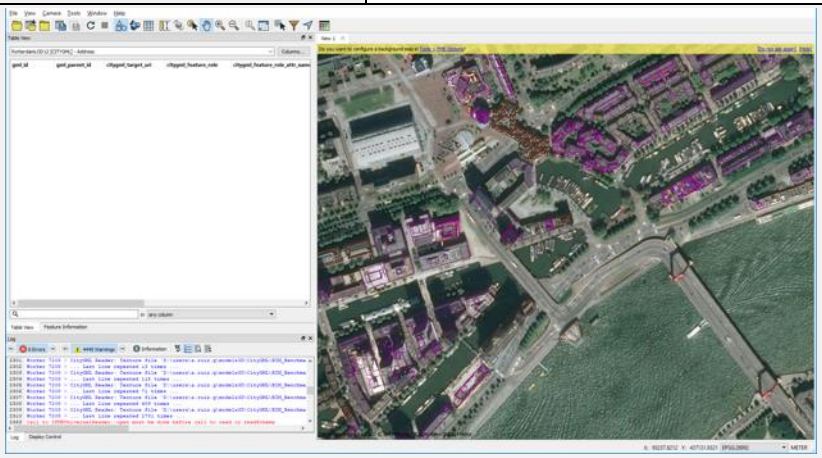


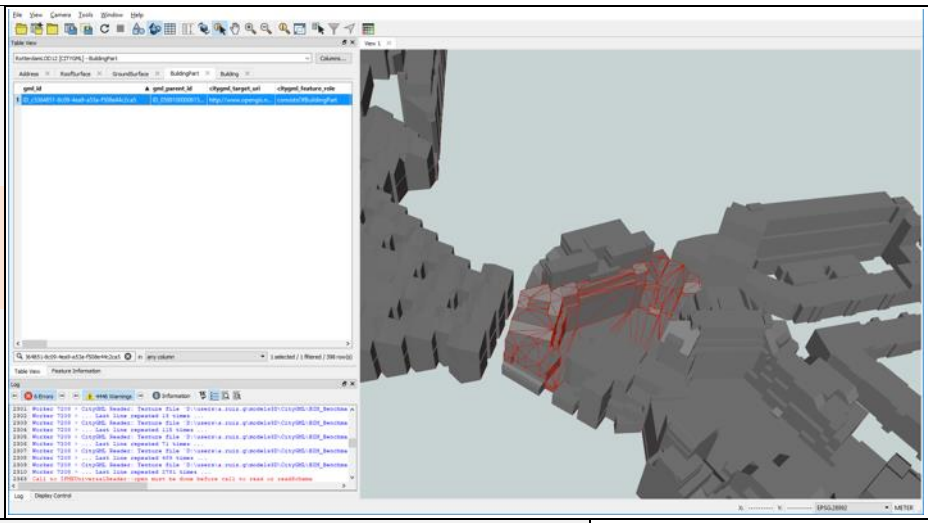
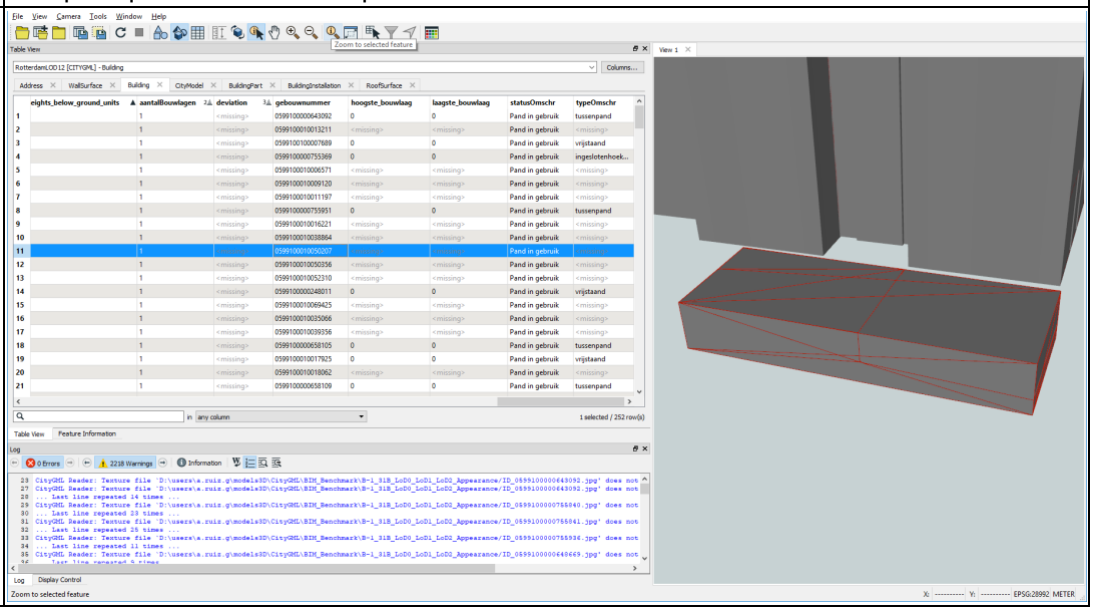
Final notes

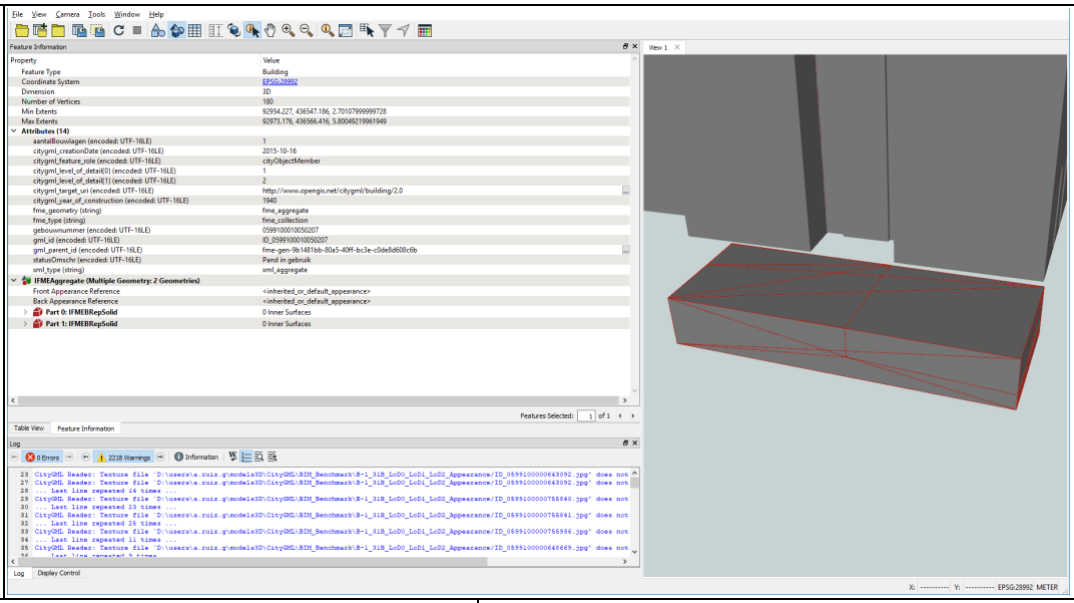
	Kind of CityGML management possible	• Import • View

FME Data Inspector – FME Desktop 2018.1

Software	Software Name	**FMEDataInspector-FME Desktop [2018.1]**		Software house		Safe Software	
	Proprietary or open source software?			Kind of software			
	Version proprietary			3D viewer – ETL tool			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	HP Z4 - 2018	Windows 10 Enterprise, version 1803	Intel® Xeon® W-2104 CPU @3.20GHz 3.19 GHz	Nvidia Quadro P400	16 GB	235 GB + 931 GB	75,7GB + 462 GB
ADE	1.1) Does the software support CityGML ADEs?				Yes		
	1.1.1) Are they directly managed without any change in the settings / specific tools / plugins?				Yes		
	it can be viewed and inspected				it can be viewed and inspected		
Data format	2.1) Does the software support this CityGML data in native format?	Yes					
Test with RotterdamLoD12.gml							
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model			1-5 minutes			
	Zoom into the model to see more detail			it's almost immediate			
	Pan the model			it's almost immediate			
	Rotate the model			it's almost immediate			
	Query an object						
	Inspect the objects linked to the queried one through a relationship			less then a minute			
LoDs	4.1) How are the different LoDs read/managed in the software?	They can only be imported and visualised all together, with overlaps in their view / management / analysis					
	4.2) Please, give more details and examples	Multiple geometries (lod1Solid and lod2Solid) are considered as a unique FME aggregate geometry. This can be seen in the FME FeatureView window (Aggregated_LoD1_Lod2.png).					
	4.3) Attach screenshots						

Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	7.2) short comments to the previous question (optional)	Heights cannot be queried in the scene view but they can be seen in the feature information window (Heights.png).
		
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	8.2) short comments to the previous question (optional)	It has been check with Bing imagery.
	 	
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	No
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	Yes
	11.2) short comments to the previous question (optional)	The hierarchy is kept but it is difficult to navigate through the gml hierarchy. The gml_id and gml_parent_id are available and in Table View it is possible to search for a features with certain gml_id.or gml_parent_id

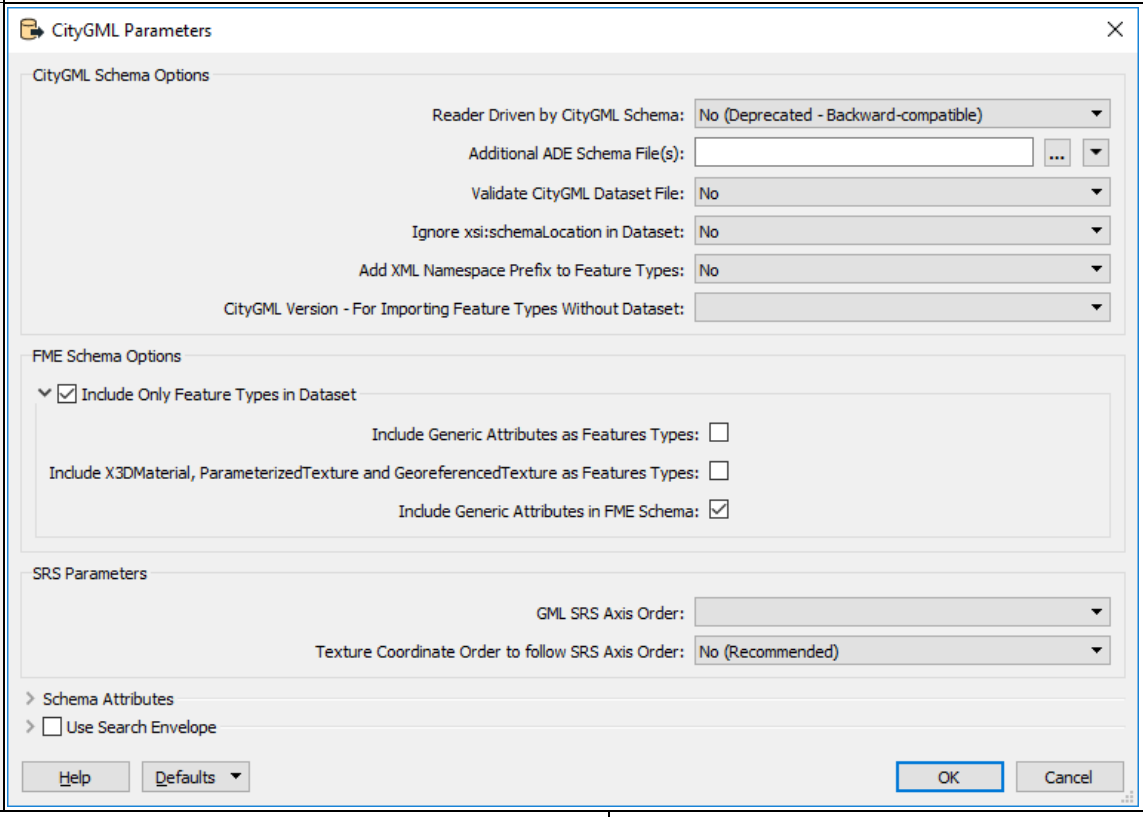
	The following image correspond to the identification of the BuildingPart in element 6 from Semantics details	
	12.1) Are the attributes present in the CityGML entities retained and consistent?	Yes
	12.2) short comments to the previous question (optional)	Different CityGML feature types are shown as different tables in FME Table View: Address, WallSurface, Building, CityModel, BuildingPart, BuildingInstallation, RoofSurface.
	13.1) Are the relationships between the objects retained?	Yes
Geometry	14.1) Is geometry read correctly?	Yes
	15.2) short comments to the previous question (optional)	In this example we have not been able to navigate inside a building to view surfaces from the other side.
View	16.1) Is it possible to view the model in 3D?	Yes
	17.1) Is it possible to view the model in 2D?	Yes
Edit	18.1) Is it possible to edit the model?	No
Query	19.1) Is it possible to query the model and the attributes?	Yes
	19.1.1) What kinds of query are possible?	It is possible to search for a string or substring values in a table column or all of them (attributes of the CityGML feature). It is possible to zoom to it and see its attributes. Complex queries are not accepted.
	19.1.2) Attach screenshots Image - Table View of a building (Query_Table_View.png)	

	19.1.2) Attach screenshots Image - Feature Information of the same building (Query_Feature_Information.png).	
Analysis	20.1) Is it possible to analyse the objects and the model?	No
	20.2) short comments to the previous question (optional)	It is possible to select all features without geometry and some analysis is possible following pointers by hand but it is too painful. There is no tool to help following the pointers. It can be done manually: you have to find the value of the gml_id in one table and search for objects with this value in gml_id or gml_parent_id in another table.
Export	You arrived at the end of the phase 1: "Import and manage the file in the software".Now choose:	The software has also export abilities
	21.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	No
	22) How long does it take for the data to be exported to CityGML?	it's almost immediate

Test with BuildingsLoD3.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	less than a minute
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	less than a minute
	...	Inspecting the objects linked to another one is not easy. You have to find the gml_id of the object and search on the Table View for the objects with this gml_id or gml_parent_id
Georef	24.1) Does the model maintain its correct dimensions and proportions?	Yes
Geometry	29.1) Is geometry read correctly?	Yes
	30.1) Did the normals change?	Yes
Export	37) How long does it take for the data to be exported to CityGML?	less then a minute

Test with amsterdam.gml		
How long does it take,	Import (and visualise, if the software allows it) the model	more than one hour
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	less than a minute

Import	Is any error reported when importing the model	There was a crash with the default options because the software couldn't find .\CityGML_2.0\CityGML.xsd I had to place the CityGML schema v2.0 in a subdirectory named CityGML_2.0 in the same directory holding Amsterdam.gml file. Another possibility to avoid the crash is changing the default CityGML Parameters setting "Reader Driven by CityGML Schema" to No.



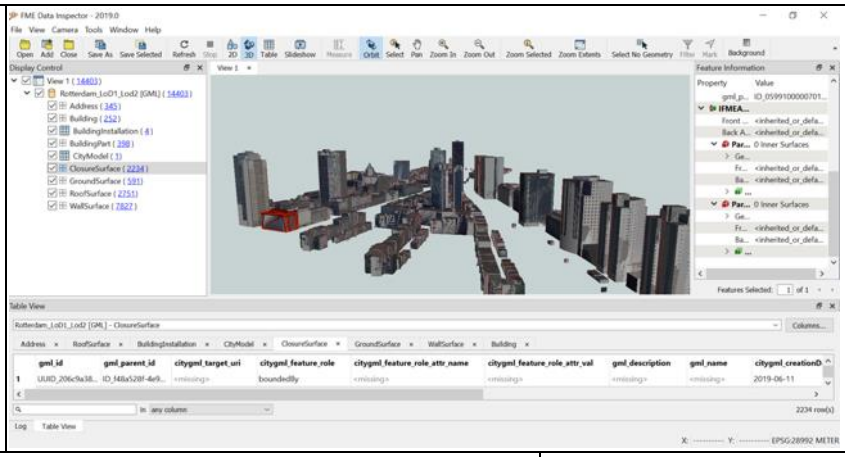
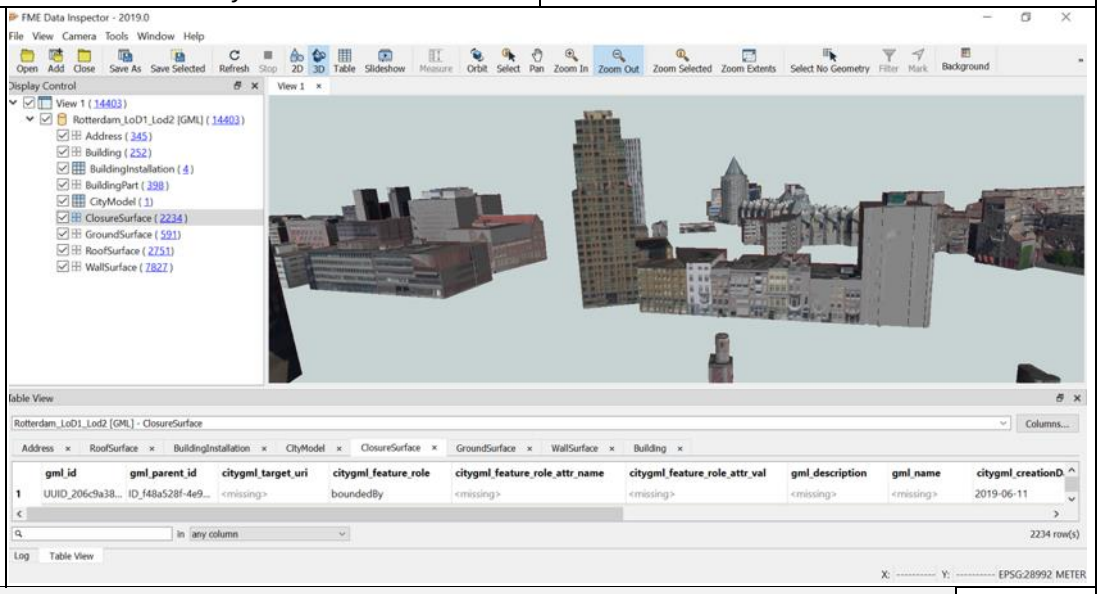
Query	54.1) Is it possible to query the model and the attributes?	Yes
	54.1.1) What kinds of query are possible?	It is only possible to query for buildings having It is possible to search for a string or substring values in a table column or all of them (attributes of the CityGML feature). It is possible to zoom to it and see its attributes. Complex queries are not accepted.
	54.2) short comments to the previous question (optional)	It is not operative. The program is all the time optimizing the memory usage.
Export	You arrived at the end of the phase 1: "Import and manage the file in the software".Now choose:	The software has also export abilities
	56.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	No
	57) How long does it take for the data to be exported to CityGML?	5-20 minutes

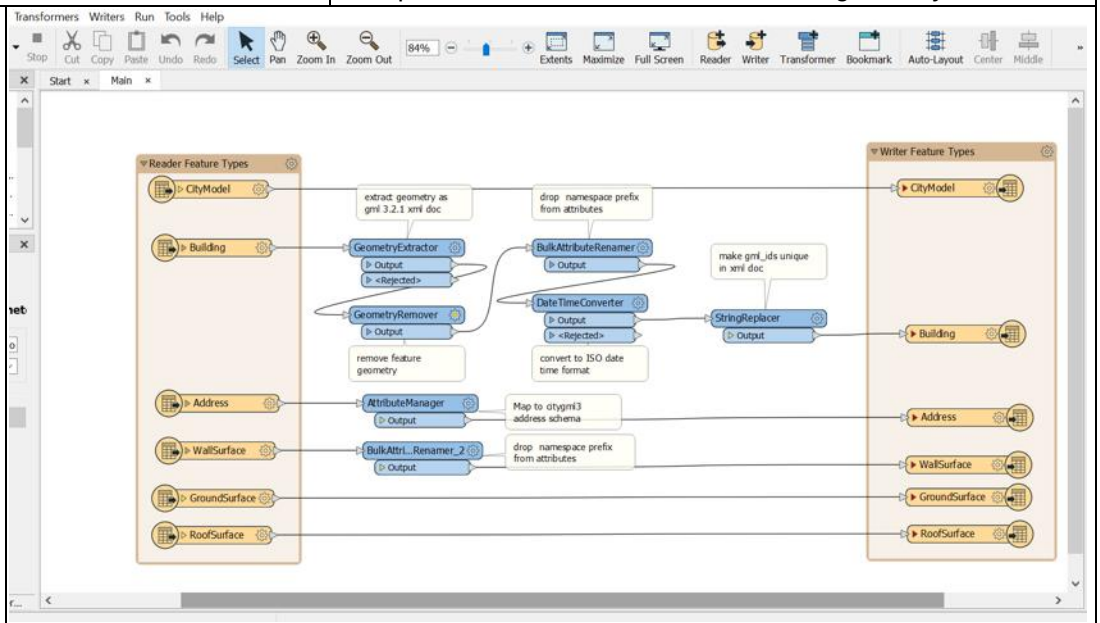
Final notes

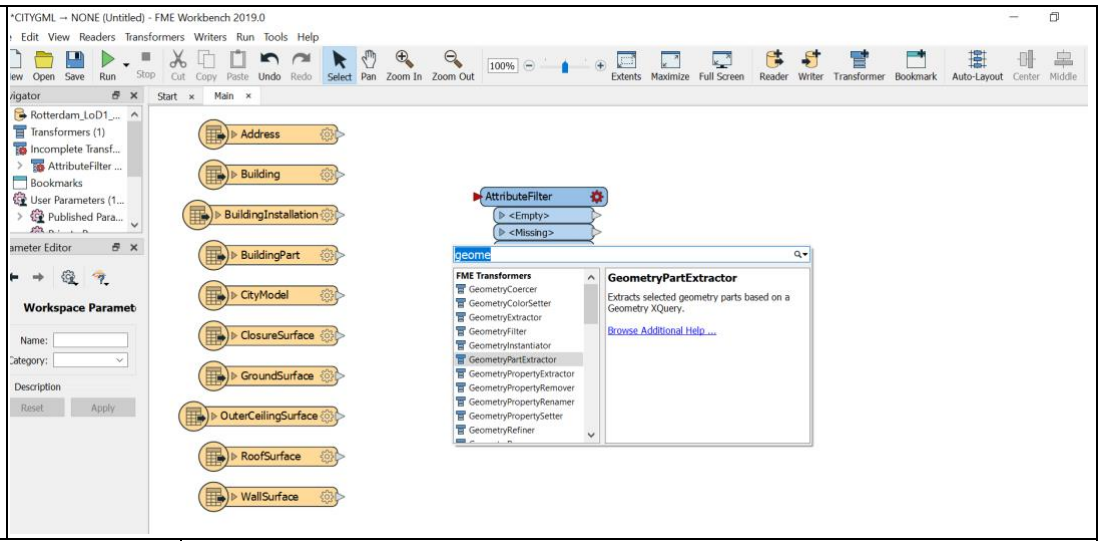
	Kind of CityGML management possible	• Import • Export • View • query
	58) Would you like to share any other comments or observations?	lod0FootPrint, lod0RoofEdge for Building and lod1MultiSurface for Bridge have not been accepted and these geometries were lost.

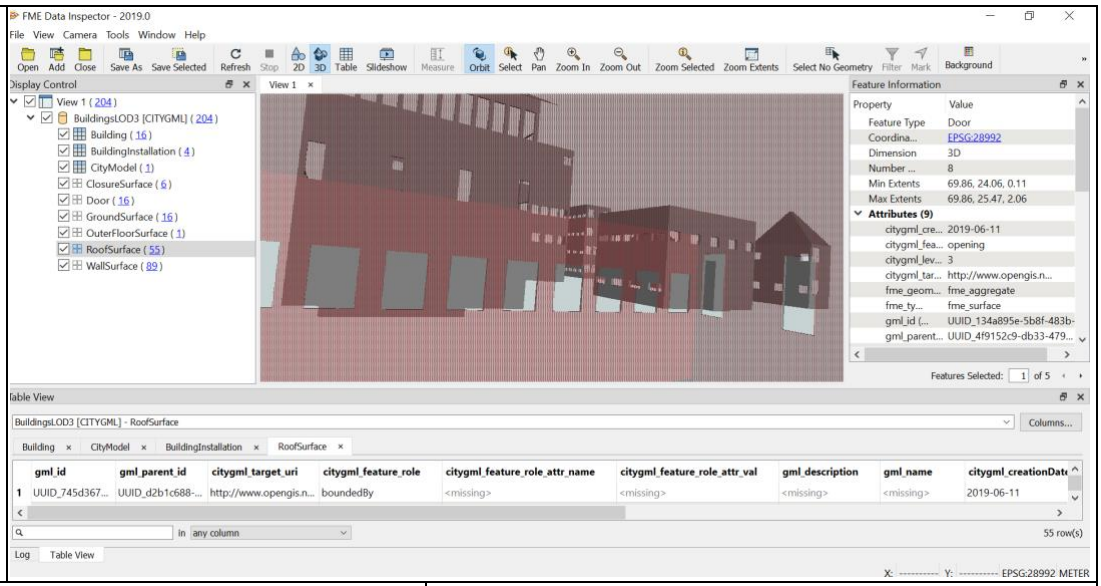
FME – Test 2

Software	Software Name	**1.Safe Software FME [2019.0.1 (32 bit)]**		Software house		SAFE SOFTWARE	
	Proprietary or open source software?			Kind of software			
	proprietary			ETL			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	Lenovo ThinkPad T480 - 2019	Windows 10 Enterprise v10.0.17134	Intel® Core(TM) i7 - 8550U CPU @ 1.80 GHz 1.90 GHz	NVIDIA GeForce MX150	32 GB	952 GB	654 GB
ADE	1.1) Does the software support CityGML ADEs?			Yes			
	1.1.1) Are they directly managed without any change in the settings / specific tools / plugins?			Yes			
	Kind of ADE information management possible:	• it can be viewed and inspected • it can be queried • it is possible to use the ADE information for analysis in the software					
	1.2) Add short comments to the previous questions (optional)	For inspection and viewing you can use FME Data Inspector; whereas for Querying and Analysing the data you can use FME Workbench(this can be done by having a CityGML ADE schema defined which you can use and import into FME Workbench and corresponding transformers you plan to use).					
Data form	2.1) Does the software support this CityGML data in native format?			Yes			
Test with RotterdamLoD12.gml							
How long does it take, approximately,	Import (and visualise, if the software allows it) the model			less then a minute			
	Zoom into the model to see more detail			it's almost immediate			
	Pan the model			it's almost immediate			
	Rotate the model			it's almost immediate			
	Query an object			it's almost immediate			
	Inspect the objects linked to the queried one through a relationship			less then a minute			
LoDs	4.1) How are the different LoDs read/managed in the software?	They can only be imported and visualised all together, with overlaps in their view / management / analysis					
	4.2) Please, give more details and examples	FME seems to aggregate the LOD geometry together, however this could possibly be mitigated by having different files for each LOD level.					

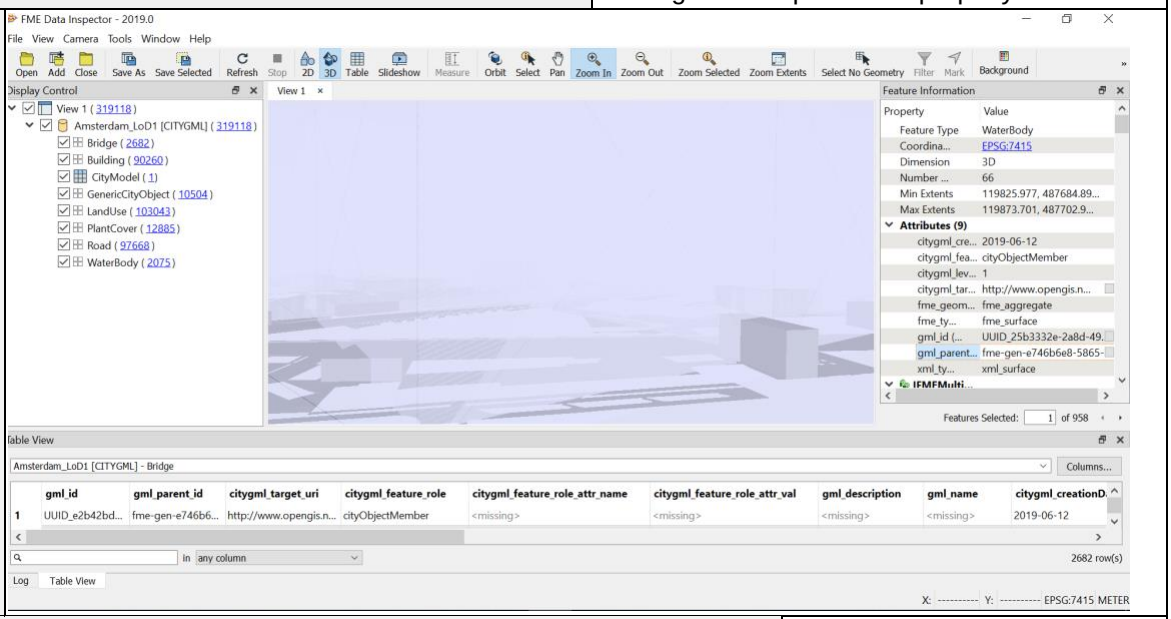
	4.3) Attach screenshots	
Texture	Can the textures be visualised correctly?	Yes
	Attach screenshots	
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	No
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	10.2) short comments to the previous question (optional)	All feature types are imported consistently, however Appearence seems to be automatically imported without having it as a separate layer to inspect.
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	Yes
	11.2) short comments to the previous question (optional)	Yes they are maintained, however they are not visualised as straightforward and you would rather identify parent and child relationships via Table View window and Feature Information window or by querying the data.
	12.1) Are the attributes present in the CityGML entities retained and consistent?	Yes
	13.1) Are the relationships between the objects retained?	Yes
	13.2) short comments to the previous question (optional)	CityGML feature types are shown as different Table View windows(one for each feature): Address, WallSurface, Building, CityModel, BuildingPart, BuildingInstallation, RoofSurface.
Geo metry	14.1) Is geometry read correctly?	Yes
	15.1) Did normals change?	Yes

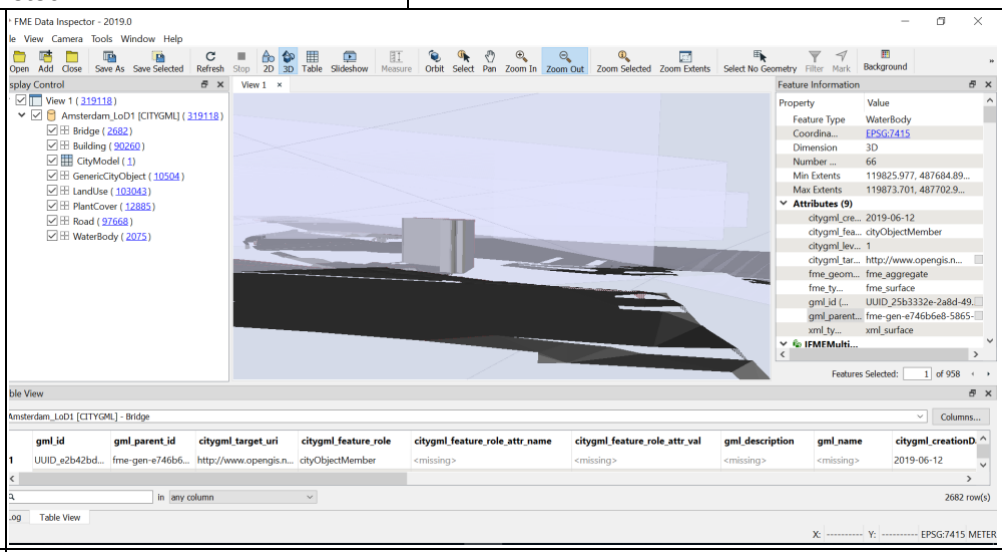
	15.2) short comments to the previous question (optional)	When you look for example at a specific building from different angles, the textures and their colour can change -e.g from one direction looks as it should(as the facade in real life), whereas from a different angle the same facade has grey patches on its texture.
View	16.1) Is it possible to view the model in 3D?	Yes
	17.1) Is it possible to view the model in 2D?	Yes
	17.2) short comments to the previous question (optional)	The visualisation tools are easy to use and you can switch between 2D and 3D very quickly.
Editing	18.1) Is it possible to edit the model?	Yes
	18.1.1) What editing is possible (attributes, geometry, georeferencing, please add details)?	All of these options are possible via using transformers within FME Workbench(rather than FME Inspector which is only used to inspect/visualise data and its attribution/geometry etc.
	18.1.2) Attach screenshots	
	18.2) short comments to the previous question (optional)	FME Worbench is quite a powerful tool for editing CityGML, whether it's for editing attributes or geometry, relating or importing information from other datasets etc. I believe time and perfomance are very good, however they do depend on the size and complexity of the CityGML input data.
Query	19.1) Is it possible to query the model and the attributes?	Yes
	19.1.1) What kinds of query are possible?	It is possible to query the data in both FME Inspector and FME Workbench. However, please note FME Inspector only offers limited and simple ways of querying the data such as looking into tables and searching for specific values. On the other hand, FME Workbench allows for more options such as querying the data in relation to other datasets, or querying to identify a selection of records using location information/data or by using complex SQL queries etc.(this is done by specific transformers in FME Workbench).

	19.1.2) Attach screenshots	
Analysis	20.1) Is it possible to analyse the objects and the model?	Yes, both analysis about the model and the model performaces are possible (type 1 and 2)
	20.1.1) What analysis are possible? Do you know if the results are reliable? How much time is needed to perform them?	Depending on the transformers you use , you can analyse both the model and its related attributes if you use corresponding data and information for your analysis use case(e.g. for energy, you need to use related data and information within the model, for example relating to physical characteristics of the buildings etc.)
	20.1.4) Time required to perform the analysis about the model itself (type 2)	depends on the complexity of the analysis, however given the area is small I would guess it takes around 20min up to max 1h.
Export	You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:	The software has also export-to-CityGML abilities
	21.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	No
	22) How long does it take for the data to be exported to CityGML?	it's almost immediate
	Short comments regarding the export functionality (optional)	FME is one of the great flexible software that can even allow you to export using a schema saved locally.
Test with BuildingsLoD3.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	it's almost immediate
Geor ef	24.1) Does the model maintain its correct dimensions and proportions?	Yes
Geometry	29.1) Is geometry read correctly?	Yes
	30.1) Did the normals change?	No
	30.1.1) What changes / inconsistencies / errors / other issues were noted?	from the inside out, the colours are different, which I assume is expected.

	30.1.2) Attach screenshots	
Export	37) How long does it take for the data to be exported to CityGML?	it's almost immediate

Test with amsterdam.gml		
How long does it take, approximately,	Import (and visualise, if the software allows it) the model	more than one hour
	Zoom into the model to see more detail	less then a minute
	Pan the model	1-5 minutes
	Rotate the model	less then a minute
	Query an object	
	Inspect the objects linked to the queried one through a relationship	
Import	Is any error reported when importing the model	Not all objects seem to be loading properly and neither textures with their corresponding colours.

Semantics	45.1) Is the eventual translation consistent with the CityGML definitions?	No
	45.1.1) What changes / inconsistencies / errors / other issues were noted?	However I believe some objects might be missing or not represented properly.
	45.1.2) Attach screenshots Image amsterdam FME	
	46.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	No

	46.1.1) What changes / inconsistencies / errors / other issues were noted?	Some objects are not possibly missing and not shown. However, for buildings for example, some of the attribution (e.g. parent id, citygml_id) and relationships seem to be kept. Not sure if this is also due to computer performance.
Geometry	49.1) Is geometry read correctly?	No
	49.1.1) What changes / inconsistencies / errors / other issues were noted?	When you zoom in the model does not load completely.
	49.1.2) Attach screenshots	
	49.2) short comments to the previous question	I am not sure if the data is not loading properly due to hardware limitations or whether I should wait longer for it to load when I zoom in. I did give it a few minutes(around15min) and it still remains the same as in the screenshot above.
	50.1) Did the normals change?	No
	50.1.1) What changes / inconsistencies / errors / other issues were noted?	The software has issues with loading the data properly.
View	51.1) Is it possible to view the model in 3D?	Yes
	51.2) short comments to the previous question (optional)	However there are inconsitencies and issues with the loaded data(possibly missing objects or not loading properly, issues with loading textures)
	52.1) Is it possible to view the model in 2D?	Yes
	52.2) short comments to the previous question (optional)	It takes a couple of minutes to switch between 3D and 2D.
Analysis	55.1) Is it possible to analyse the objects and the model?	The answer is the same I gave while testing the Rotterdam.gml or Buildings.gml files
	55.1.3) Needed time to perform the analysis about the model itself (type 1)	more than one hour
	55.1.4) Needed time to perform the analysis about the model performance (type 2)	more than one hour
Export	You arrived at the end of the phase 1: "Import and manage the file in the software".Now choose:	The software has also export-to-CityGML abilities
	56.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	No
	57) How long does it take for the data to be exported to CityGML?	20 minutes-1 hour
Final notes		
	Kind of CityGMl management possible	• Import • Export • View • Query (complex query in FME workbench) • Edit (in workbench) • Analysis (in workbench)

	58) Would you like to share any other comments or observations?	Size of the data is critical for the performance of the software. For example, Amsterdam dataset, being a larger dataset was harder and slower to inspect, edit or analyse. Chunking the data into smaller size might be a solution to tackle this issue in FME.

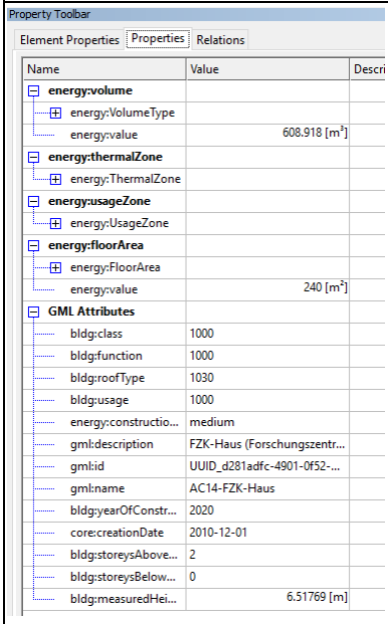
FZK Viewer – test 1

Helen Eriksson
1 - Very beginner user (it is nearly the first time you use the software)

Software	Software Name	**FZKViewer [5.1]**	developer	Karlsruhe Institute for Technology, C:\Downloads\FZKViewer-5.1_Build-978.zip
	Proprietary or open source software?		Kind of software	
	open source		3D viewer	

columns	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	HP ZBook 15 G3, 2018	Windows 10 Enterprise, 64-bit	Intel ® Core™ i7-6820HQ CPU	NVIDIA Quatro M1000M	32	474	217

ADE	1.1) Does the software support CityGML ADEs?	Yes
	1.1.1) Are they directly managed without any change in the settings / specific tools / plugins?	No, some specific settings / tools / plugins are necessary
	1.1.1.1) Please give a description about how is it necessary to install the needed tool or plugin, or change the software settings, or any other intervention which is necessary to enable the functionality.	For the Energy ADE I used it works without any changes, otherwise I think the schema file for the ADE need to be added
	Kind of ADE information management	• it can be viewed and inspected • it can be queried



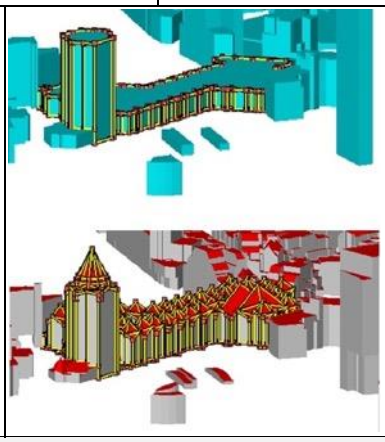
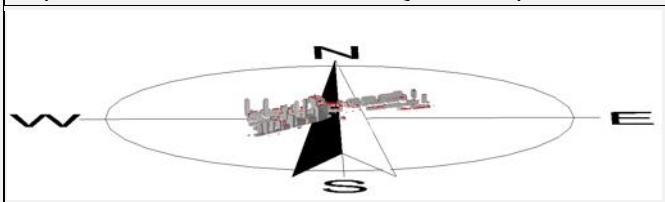

```
<energy:constructionWeight>medium</energy:constructionWeight>
<energy:volume>
  <energy:VolumeType>
    <energy:type>grossVolume</energy:type>
    <energy:value uom="m3">608.917893677988</energy:value>
  </energy:VolumeType>
</energy:volume>
<energy:referencePoint>
  <gml:Point srsName="urn:adv:crs:ETRS89_UTM32*DE_DHHN92_NH" gml:id="GML_d2b5cd60-45a3-41f2-b0d8-db58abdef97e">
    <gml:pos>458883 5438358 115.05884</gml:pos>
  </gml:Point>
</energy:referencePoint>
<energy:thermalZone>
  <energy:ThermalZone gml:id="GML_0d710724-1143-47e2-b824-0dadf29c1a84">
    <gml:boundedBy>
      <gml:Envelope srsName="urn:adv:crs:ETRS89_UTM32*DE_DHHN92_NH">
        <gml:lowerCorner>458877 5438353 111.8</gml:lowerCorner>
        <gml:upperCorner>458889 5438363 118.31769</gml:upperCorner>
      </gml:Envelope>
    </gml:boundedBy>
    <energy:contains xlink:href="#GML_f7f94cac-3601-4c1d-a9ed-868ecdd42ea4" />
    <energy:floorArea>
      <energy:FloorArea>
        <energy:type>grossFloorArea</energy:type>
        <energy:value uom="m2">240</energy:value>
      </energy:FloorArea>
    </energy:floorArea>
    <energy:volume>
      <energy:VolumeType>
        <energy:type>grossVolume</energy:type>
        <energy:value uom="m3">608.917893677988</energy:value>
      </energy:VolumeType>
    </energy:volume>
    <energy:isCooled>false</energy:isCooled>
    <energy:isHeated>true</energy:isHeated>
    <energy:volumeGeometry>
```

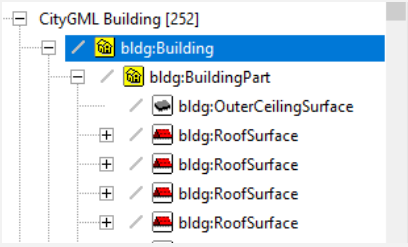

In GML file

Data form	2.1) Does the software support this CityGML data in native format?	Yes

Test with RotterdamLoD12.gml

How long does it take,	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate

	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	it's almost immediate
Import	Was any error reported when importing the file?	Yes, Error 1724, "Non-planar face" for more than 100 geometries
LoDs	4.1) How are the different LoDs read/managed in the software?	They are all read and managed in the software and a consistent multi-LoD view and management is possible by visualising / managing / analysing the objects in the different connected LoDs.
	4.2) Please, give more details and examples	All different LoDs available in the GML file are imported and you can choose which LoD to visualise
	4.3) Attach screenshots	
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	5.2) Add short comments to the previous questions (optional)	The software describes the bounding box in the original EPSG:28992 format but also as Long/Lat and UTM.
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	8.1) Is the model oriented correctly with respect to the true North?	Yes
		
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	No
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	10.2) short comments to the previous question (optional)	When for example comparing a gml:id for a WallSurface in the GML file, it has still the same gml:id in FKZViewer
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	Yes
	11.2) short comments to the previous question (optional)	When comparing the hierarchy in FKZViewer with the one in the GML file, it looks correct.
	12.1) Are the attributes present in the CityGML entities retained and consistent?	Yes
	13.1) Are the relationships between the objects retained?	Yes

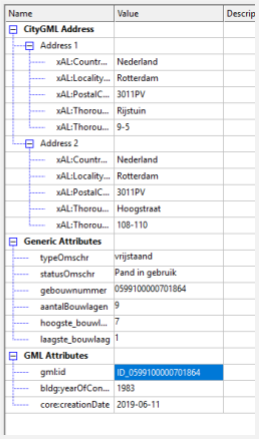


In GML file:

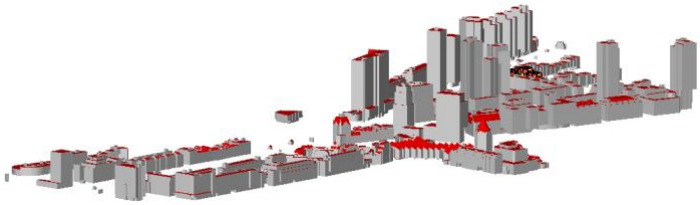
```
<bldg:Building gml:id="ID_0599100000615588">
```

```
<bldg:consistsOfBuildingPart>
  <bldg:BuildingPart gml:id="ID_c5364851-8c09-4ea9-a53a-f508e44c2ca5">
    <creationDate>2019-06-11</creationDate>
```

```
  <bldg:boundedBy>
    <bldg:OuterCeilingSurface gml:id="UUID_4ee86523-81ce-4574-a762-a2f193788d97">
      <creationDate>2019-06-11</creationDate>
```



Name	Value
CityGML Address	
Address 1	
xAL:Countr...	Nederland
xAL:Locality...	Rotterdam
xAL:PostalC...	3011PV
xAL:Thorou...	Rijstuin
xAL:Thorou...	9-5
Address 2	
xAL:Countr...	Nederland
xAL:Locality...	Rotterdam
xAL:PostalC...	3011PV
xAL:Thorou...	Hoogstraat
xAL:Thorou...	108-110
Generic Attributes	
typeOmschr	vrijstaand
statusOmschr	Pand in gebruik
gebouwnummer	0599100000701864
aantalBouwlagen	9
hoogste_bouwl...	7
laagste_bouwlaag	1
GML Attributes	
gml:id	ID_0599100000701864
bldg:yearOfCon...	1983
core:creationDate	2019-06-11

Geometry	14.1) Is geometry read correctly?	Yes
		
	15.1) Did normals change?	Yes
View	16.1) Is it possible to view the model in 3D?	Yes
	17.1) Is it possible to view the model in 2D?	No
Edit	18.1) Is it possible to edit the model?	No
Query	19.1) Is it possible to query the model and the attributes?	Yes
	19.1.1) What kinds of query are possible?	Yes, viewing elements of an object and by a number of pre-defined queries, e.g. File statistics, Geometry statistics, Entity information and CityGML Building information

File statistics:

Query Entities and Relations

Entity	Amount
Entities	**16056**
bldg:Building	252
bldg:BuildingInstallation	4
bldg:BuildingPart	398
bldg:ClosureSurface	2234
bldg:GroundSurface	591
bldg:OuterCeilingSurface	125
bldg:RoofSurface	2751
bldg:WallSurface	7827
core:CityModel	1
core:xalAddress	345
genobj:intAttribute	724
genobj:stringAttribute	804
Relations	**16055**
GmlRelFeature	16055

OK

Geometry statistics:

Query Geometry Information

Name	Value
Number of points:	242880
Number of polygons:	27075 (Convex polygons)
Number of triangles:	42544
Number of faces:	34900
Scene Bounding Box:	

OK

Entity information:

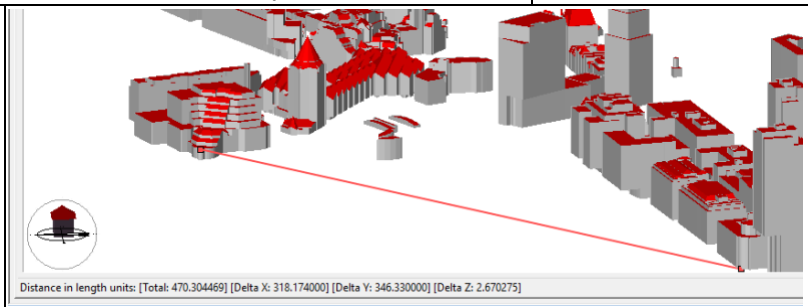
Query Entities

Type	Name	Description	Geometry Types
CityGML Modell	core:CityModel		
CityGML Building	bldg:Building		GmlSolid
GML Data Type	genobj:stringAttribute		
GML Data Type	genobj:stringAttribute		
GML Data Type	genobj:stringAttribute		
GML Data Type	genobj:intAttribute		
GML Data Type	genobj:intAttribute		
GML Data Type	genobj:intAttribute		
CityGML WallSurface	bldg:WallSurface		MultiSurface | Face
CityGML WallSurface	bldg:WallSurface		MultiSurface | Face
CityGML WallSurface	bldg:WallSurface		MultiSurface | Face
CityGML WallSurface	bldg:WallSurface		MultiSurface | Face
CityGML WallSurface	bldg:WallSurface		MultiSurface | Face
CityGML WallSurface	bldg:WallSurface		MultiSurface | Face
CityGML RoofSurface	bldg:RoofSurface		MultiSurface | Face
CityGML RoofSurface	bldg:RoofSurface		MultiSurface | Face
CityGML GroundSurface	bldg:GroundSurface		MultiSurface | Face
CityGML Address	core:xalAddress		MultiPoint | Vertex
CityGML Building	bldg:Building		GmlSolid

CityGML Building information:

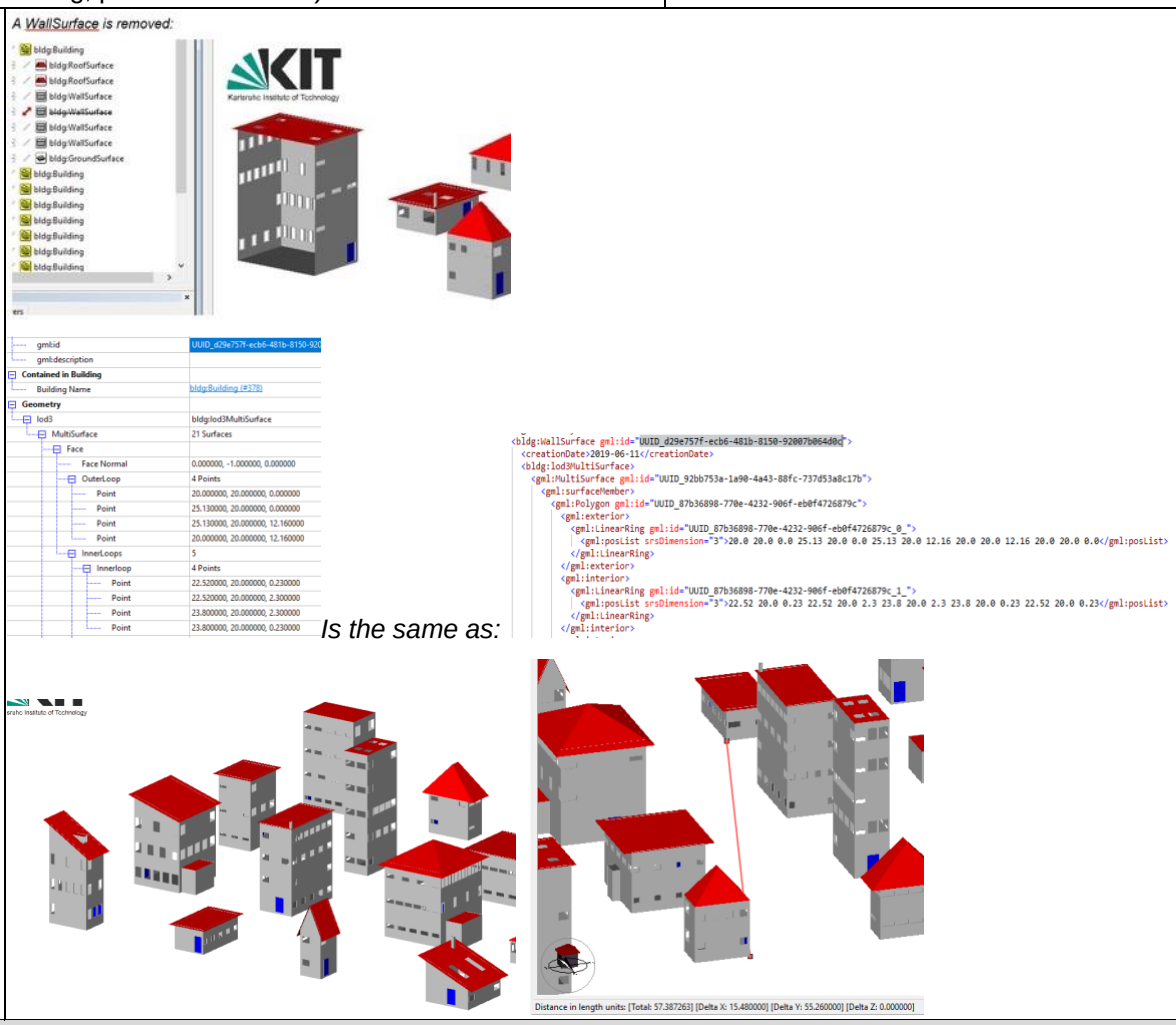
Query cityGML Building

Type	Name	Description	class	function	usage	yearOfConstruction	yearOfDemolition	roofType	measuredHeight	Calculated Height	y Heights Above Gr
CityGML Building	bldg:Building					1983				6.68131	
CityGML Building	bldg:Building					1956				12.8185	
CityGML Building	bldg:Building					2013				2.01162	
CityGML Building	bldg:Building					1608				16.2726	
CityGML Building	bldg:Building					1968				11.0914	
CityGML Building	bldg:Building					1615				15.3922	
CityGML Building	bldg:Building					1953				12.9627	
CityGML Building	bldg:Building					1900				6.0947	
CityGML Building	bldg:Building					1981				14.4208	
CityGML Building	bldg:Building					1980				17.1485	
CityGML Building	bldg:Building					1981				14.3911	
CityGML Building	bldg:Building					1955				8.27989	
CityGML Building	bldg:Building					1957				12.8658	

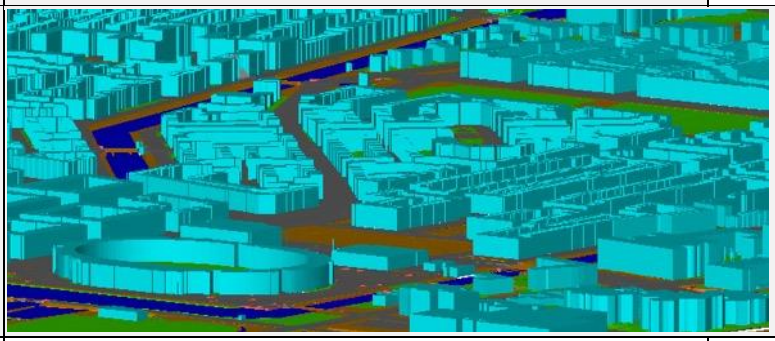
Analyse	20.1) Is it possible to analyse the objects and the model?	Yes, both analysis about the model and the model performances are possible (type 1 and 2)
	20.1.1) What analysis are possible? Do you know if the results are reliable? How much time is needed to perform them?	XML Schema validation and distance can be measured. Do not know if it is reliable.
	20.1.2) Attach screenshots	
	20.1.3) Time required to perform the analysis about the model itself (type 1)	1-5 minutes
	20.1.4) Time required to perform the analysis about the model itself (type 2)	it's almost immediate
Export	You arrived at the end of the phase 1: "Import and manage the file in the software".Now choose:	The software cannot export, therefore skip the phase 2
	Short comments regarding the export functionality (optional)	There is no possibility to export to CityGML. The export options are IFC, Google Earth, Collada, STL and gbXML

Test with BuildingsLoD3.gml

How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	it's almost immediate
Edit	33.1) Is it possible to edit the model?	Yes

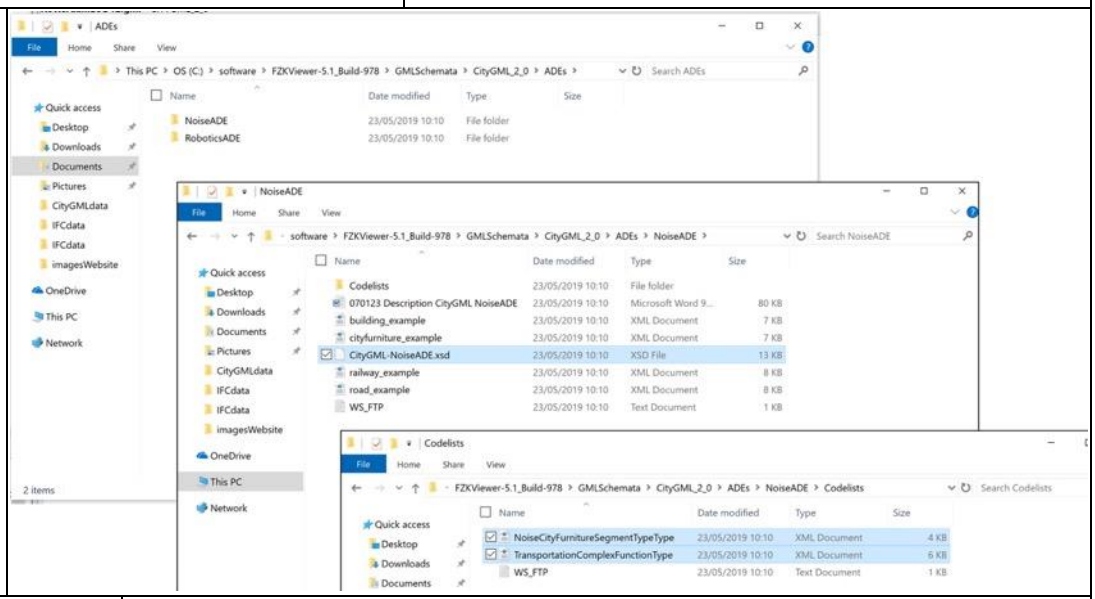
	33.1.1) What editing is possible (attributes, geometry, georeferencing, please add details)?	It is possible to remove elements
	33.1.2) Attach screen shots	

Test with amsterdam.gml

How long does it take, approximately,	Import (and visualise, if the software allows it) the model	5-20 minutes
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	5-20 minutes
	Inspect the objects linked to the queried one through a relationship	5-20 minutes
		
Analysis	55.1) Is it possible to analyse the objects and the model?	The answer is the same I gave while testing the Rotterdam.gml or Buildings.gml files
	55.1.3) Needed time to perform the analysis about the model itself (type 1)	more than one hour

	55.1.4) Needed time to perform the analysis about the model performance (type 2)	less than a minute
Final notes		
	Short comments regarding the export functionality (optional)	There is no possibility to export to CityGML. The export options are IFC, Google Earth, Collada, STL and gbXML
	Kind of CityGMl management possible	• Import • Export • View • Query • Edit (only removing objects) • analysis

FZK Viewer – Test 2

Software	Software Name	**FZK Viewer [5.1 Build 978]**		developer	Karlsruhe Institute of Technology (KIT) - Institute for Automation and Applied Informatics (IAI) (https://www.iai.kit.edu/english/1302.php)		
	Proprietary or open source software?			Kind of software			
	Freeware			3D viewer			
	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	DELL XPS 15 9570 - 2019	Windows 10 Pro (version 1809) 64-bit operating system, x64-based processor	Intel(R) Core(TM) i7-8750H CPU @ 2.20 GHz 2.21 GHz	\-	32,0 GB (31,7 GB usable)	937 GB	848 GB
ADE	1.1) Does the software support CityGML ADEs?			Yes			
	1.1.1) Are they directly managed without any change in the settings / specific tools / plugins?			No, some specific settings / tools / plugins are necessary			
	1.1.1.1) Please give a description about how is it necessary to install the needed tool or plugin, or change the software settings, or any other intervention which is necessary to enable the functionality.			It is necessary to add the schemas extending the CityGML model in the software directories (see attached image). Some 'official' ADEs are already present (Noise ADE and Robotics ADE), while other new ones can be added.			
	1.1.1.2) Attach screenshots						
	Kind of ADE information management	• it can be viewed and inspected • it can be queried					
Data form	2.1) Does the software support this CityGML data in native format?			Yes			
Test with RotterdamLoD12.gml							
How long does it take,	Import (and visualise, if the software allows it) the model			it's almost immediate			
	Zoom into the model to see more detail			less then a minute			
	Pan the model			it's almost immediate			
	Rotate the model			it's almost immediate			
	Query an object			less then a minute			

	Inspect the objects linked to the queried one through a relationship	it's almost immediate
LoD	4.1) How are the different LoDs read/managed in the software?	They are all read and managed in the software and a consistent multi-LoD view and management is possible by visualising / managing / analysing the objects in the different connected LoDs.
	4.2) Please, give more details and examples	Through the menu 'Representation' you can chose if visualising LoD1, LoD2 (in this case those are present, but it will likely allow to choose among all the LoDs which are included in the model) or all together. One of them is considered as the 'Standard' representation, in this case it is the lod 2.
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	5.2) Add short comments to the previous questions (optional)	Through the menu 'Query' --> 'Statistic' --> 'SRS Statistik'
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	No
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	10.2) short comments to the previous question (optional)	The same CityGML entities are retained, no translation is applied.
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	Yes hierarchical relationships and grouping are represented in the same way in the entity tree
	12.1) Are the attributes present in the CityGML entities retained and consistent?	Yes
	13.1) Are the relationships between the objects retained?	Yes
Geo metry	14.1) Is geometry read correctly?	Yes
	15.1) Did normals change?	No
View	16.1) Is it possible to view the model in 3D?	Yes
	17.1) Is it possible to view the model in 2D?	No
Edit	18.1) Is it possible to edit the model?	Yes
	33.1.1) What editing is possible (attributes, geometry, georeferencing, please add details)?	It is possible to remove one entity; to move an entity position and scale it (through right click on the entity in the hierarchy --> transform element). It is possible to choose if applying the same transformation also to its children
Q ue	19.1) Is it possible to query the model and the attributes?	Yes

	19.1.1) What kinds of query are possible?	\- Direct query of an element (from the 3D view, from the properties and relations tables, from the hierarchical view); Through the menu 'Query': - Browse of Entity information tables of: Type (e.g. 'CityGML WallSurface'), Name (e.g. 'bldg:WallSurface'), Description (empty for this file), Geometry type (e.g. 'MultiSurface | Face'); - Browse of CityGML Buildings information, which opens a table collecting the objects 'Buildings' with their properties (as defined in CityGML data model) ; - Statistics: file statistics (with included entities, and relations), geometry statistics, (with n. of points, polygons, triangles, faces and bounding box), SRS, geometry types (n. of faces, GmlSolid, Multipoint, Multisurfaces, Vertex). Through the right button of the mouse, you can compare two elements (their properties are shown in parallel windows and coloured in red if different; Moreover, you can select the element; view the element; zoom to the element, isolate the element and read the element properties. Some properties of the objects can also be visualised when moving the mouse cursor on them.
Analysis	20.1) Is it possible to analyse the objects and the model?	Yes, both analysis about the model and the model performaces are possible (type 1 and 2)
	20.1.1) What analysis are possible? Do you know if the results are reliable? How much time is needed to perform them?	Type 1 XML Schema validation Type 2 You can apply a symbology based on Entity, Types, Face Normals, Property Values, specific CityGML attributes (like yearOfConstruction, function, measuredHeight, roofType, localityName of Address, localityName and ThoroughfareName of Address, relativeToTerrain/Water), energy demand (based on Heating or Heating/m2).

Analysis possibilities

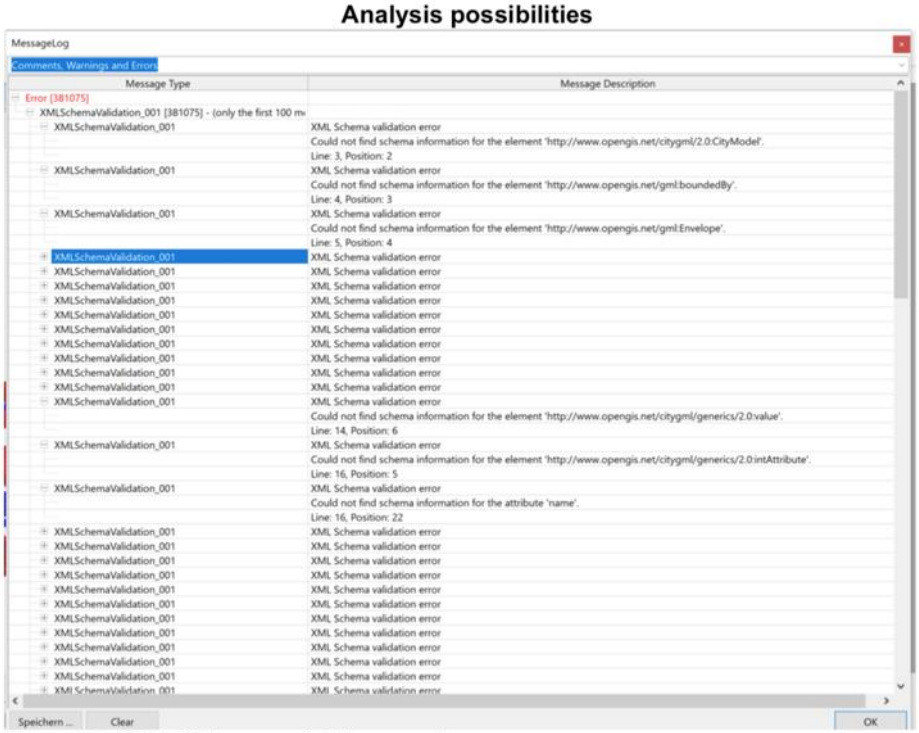


Figure 1 – XML Schema validation result

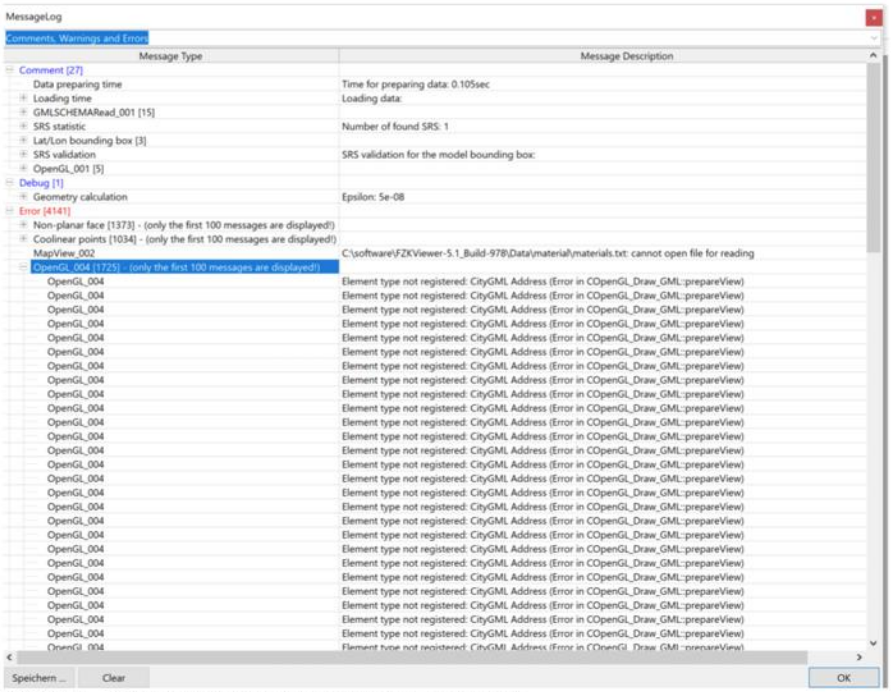
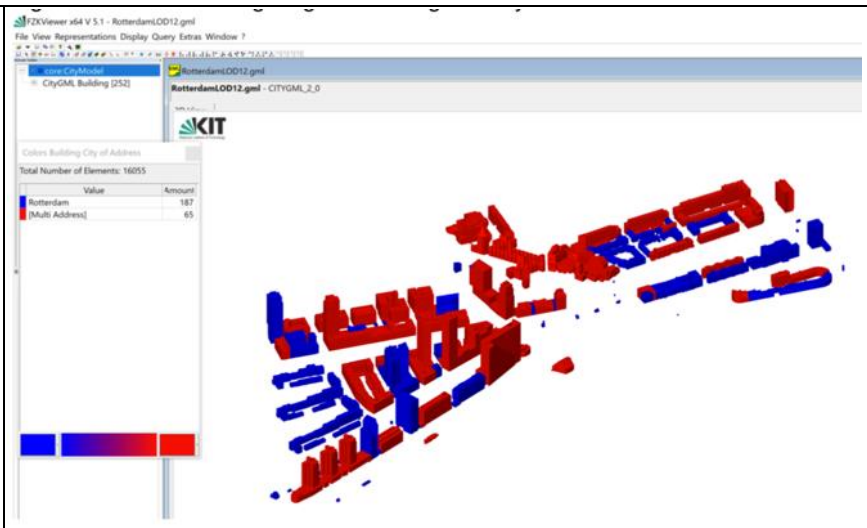
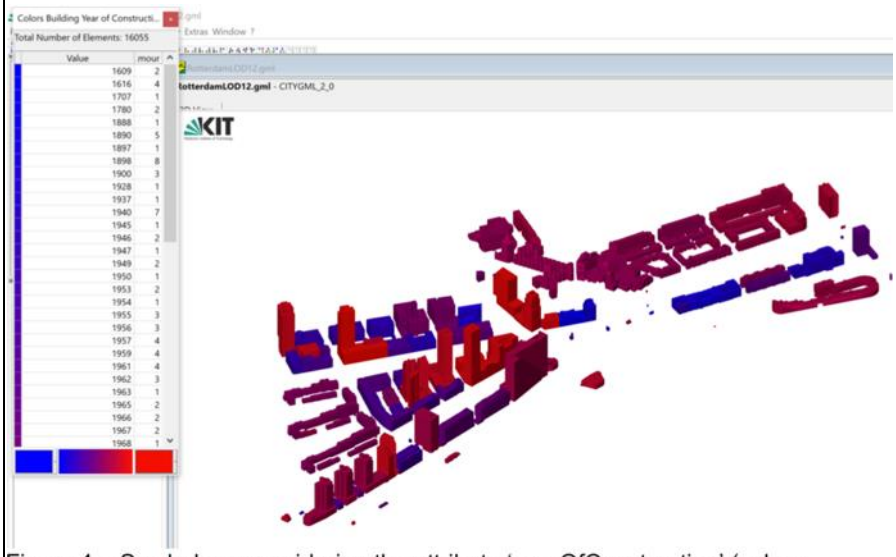


Figure 2 – Error message log about the geometry

	20.1.2) Attach screenshots	 Figure 3 – Symbology considering the City in the Building Adresses.  Figure 4 – Symbology considering the attribute 'yearOfConstruction' (colour transition from blue for the oldest ones to red for the newest ones)

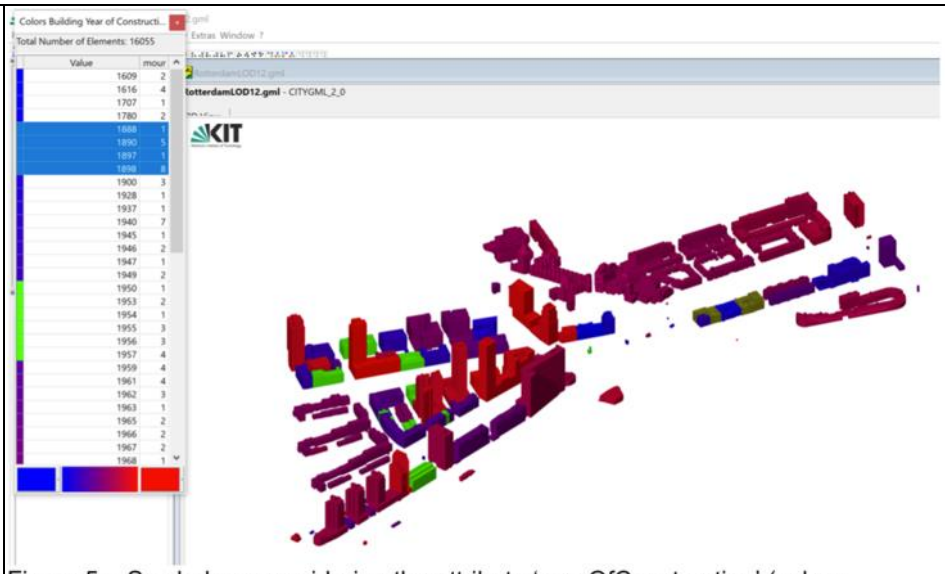


Figure 5 – Symbology considering the attribute 'yearOfConstruction' (colour transition from blue for the oldest ones to red for the newest ones, with the ones built in the '50s in green and the ones built in the XIX Century selected in transparent yellow).

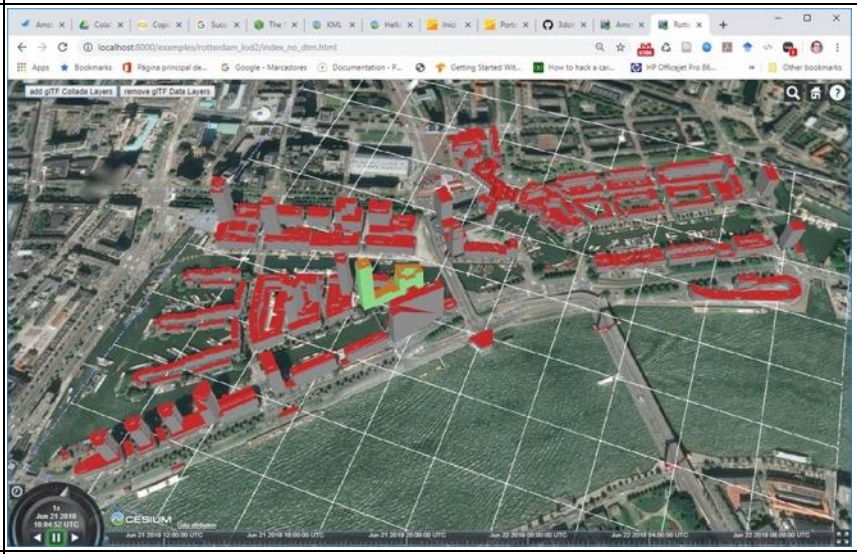
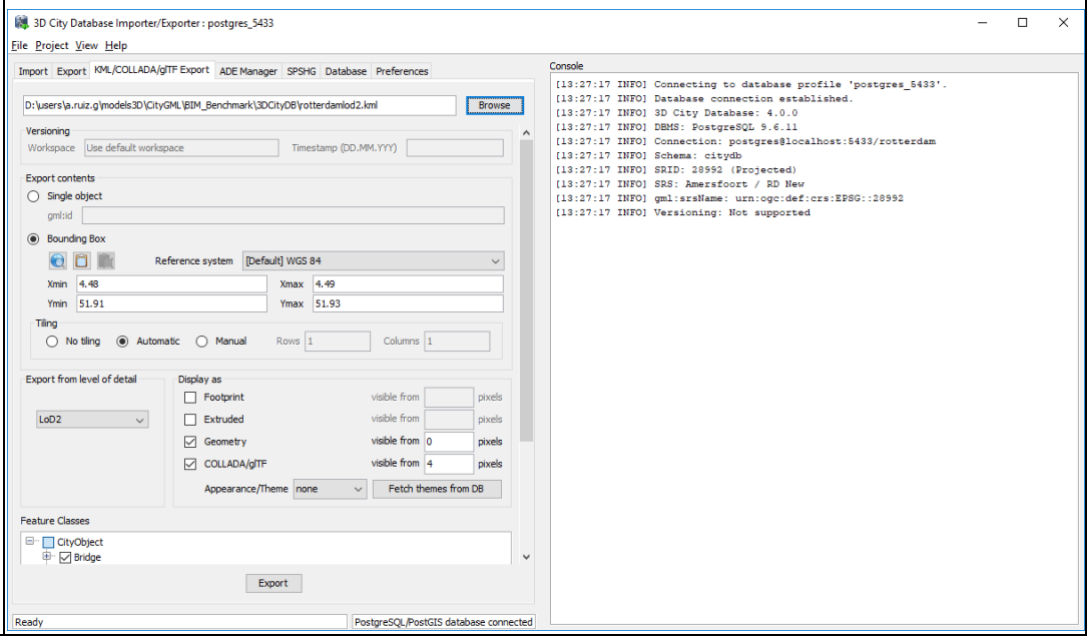
Export	You arrived at the end of the phase 1: "Import and manage the file in the software".Now choose:	The software cannot export, therefore skip the phase 2
	21.2) short comments to the previous question (optional)	the software can export but not back to GML (it can export to IFC, Google Earth, Collada, STL, gbXML)
Test with BuildingsLoD3.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	it's almost immediate
Georef	24.1) Does the model maintain its correct dimensions and proportions?	Yes
Test with amsterdam.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	5-20 minutes
	Zoom into the model to see more detail	more than one hour
	Pan the model	more than one hour
	Rotate the model	less then a minute
	Query an object	more than one hour
	Inspect the objects linked to the queried one through a relationship	more than one hour
Georef	39.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	39.2) Add short comments to the previous questions (optional)	All the operations were allowed (inspecting georeferencing and navigation), but it requires a lot of resources and the software blocks and stop answering very often, preventing its use for anything, even if it does not crushes immediately.
	43.1) Does the model maintain its correct dimensions and proportions?	Visually it does, but it is not possible to check it, due to the huge computation requirements

Semantic	45.1) Is the eventual translation consistent with the CityGML definitions?	It should, but the high computational requirements makes it very difficult to check many elements
Final notes		
	Kind of CityGML management possible	• Import • View • Query • Edit • analyse

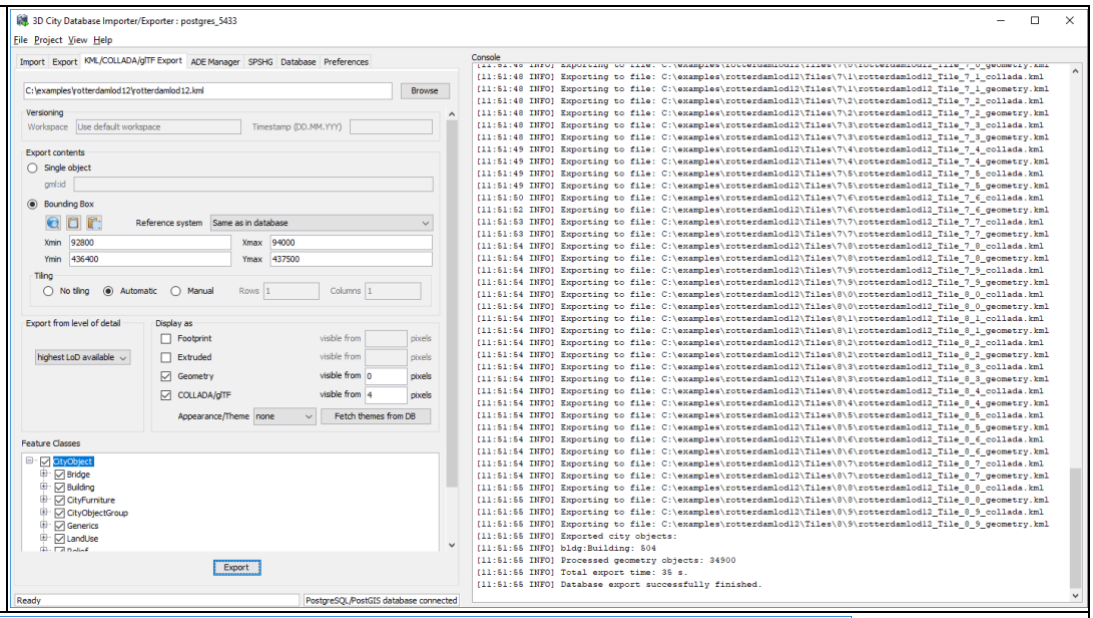
3DCityDB Importer-Exporter[7] & 3DCityDB Web Map CLient

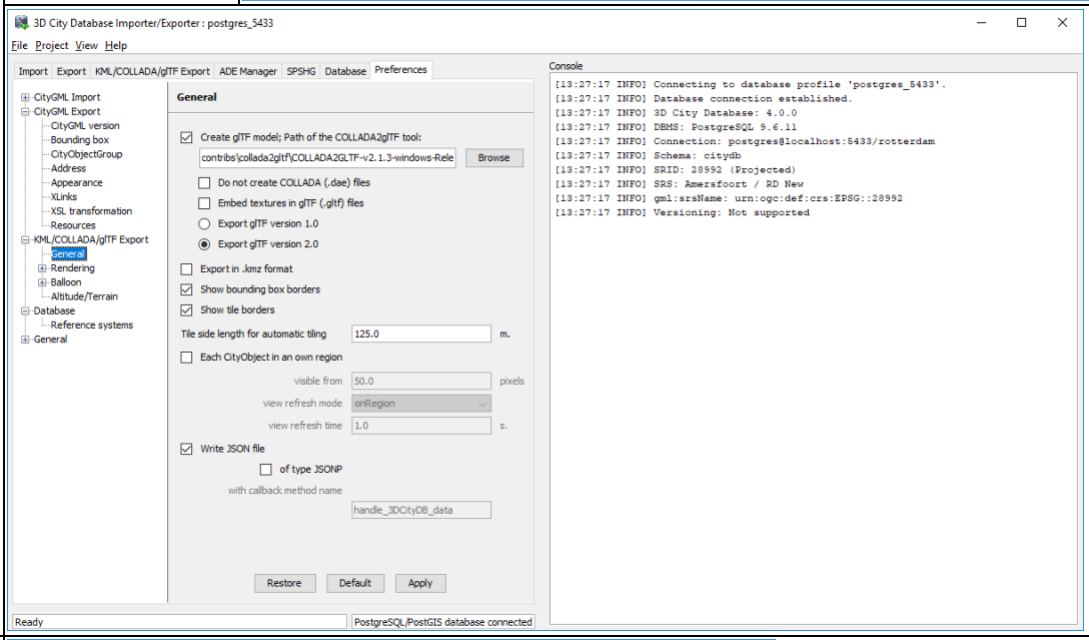
Software	Software Name		**3DCityDB-Importer-Exporter & 3DCityDB-Web-Map-Client [4.0]**		developer	TU München, virtualcitySYSTEMS, M.O.S.S. Computer Grafik System	
	Proprietary or open source software?				Kind of software		
	open source				Extract/Transform/Load		
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	HP Z4 - 2018	Windows 10 Enterprise, version 1803	Intel® Xeon® W-2104 CPU @3.20GHz 3.19 GHz	Nvidia Quadro P400	16	235 GB + 931 GB	75,7GB + 462 GB
ADE	1.1) Does the software support CityGML ADEs?				Yes		
	1.1.1) Are they directly managed without any change in the settings / specific tools / plugins?				No, some specific settings / tools / plugins are necessary		
	1.1.1.1) Please give a description about how is it necessary to install the needed tool or plugin, or change the software settings, or any other intervention which is necessary to enable the functionality.				A specific Java library is required for each ADE to manage the reading and writing of ADE XML elements		
	*Addition from a test of the software by another Geobim benchmark participant:	The **3DCityDB 3.x** does NOT support ADEs natively. The newer 3DCityDB 4.x support automatic generation of the database schema for ADEs, provided that the xsd file of the ADE is given. However, there is still no automatic plugin for importing and exporting ADE data into/from the database, once the tables are generated. This can be achieved using other software, e.g. FME						
Data format	2.1) Does the software support this CityGML data in native format?				Yes		
	2.1.1) Which one of the following is true?	The CityGML file is read through one of its different implementation possibilities described by OGC (e.g. 3DcityDB)					
	2.1.1.1) Which implementation is used? If a database management system is employed, which one is it?Please justify your choices.				PostGIS		
	2.2) short comments to the previous question (optional)	After import, Maintenance (vacuum full freeze verbose analyze) took 34 s.					
Test with RotterdamLoD12.gml							
How long does it take, approximately,	Import (and visualise, if the software allows it) the model				less then a minute		
	Zoom into the model to see more detail				it's almost immediate		
	Pan the model				it's almost immediate		
	Rotate the model				it's almost immediate		
	Query an object				the software does not allow this		
	Inspect the objects linked to the queried one through a relationship				the software does not allow this		
LoD	4.1) How are the different LoDs read/managed in the software?	One LoD can be selected and only the objects having the chosen LoD can be imported in the software to be visualised / managed / analysed					

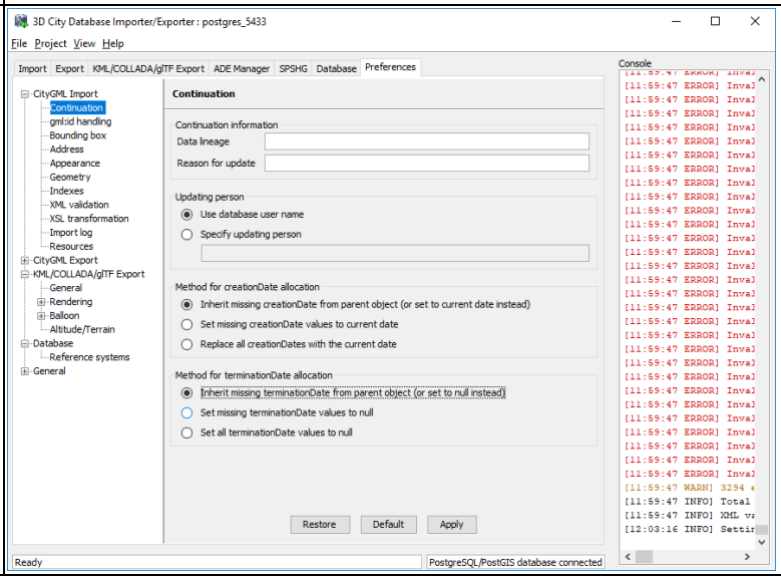
[7] *Addition from a test of the software by another GeoBIM benchmark participant: 3DCityDB only imports/exports data into/from the database. No queries of objects or visualisation are actually possible directly, but this is not the purpose of the software

	4.2) Please, give more details and examples	The models from the database must be exported to glTF. It is in the glTF Export when LoD can be selected (Export_glTF.png). Some coding in javascript is required to render the models with Cesium. We are rendering models without terrain. Exporting requires a bounding box in the same reference system as in database (Export_BB_projected.png) or in WGS84 (Export_BB_geo.png). A view in Cesium is attached (Cesium_View.png).
	4.3) Attach screenshots	
	4.4) short comments to the previous question (optional)	

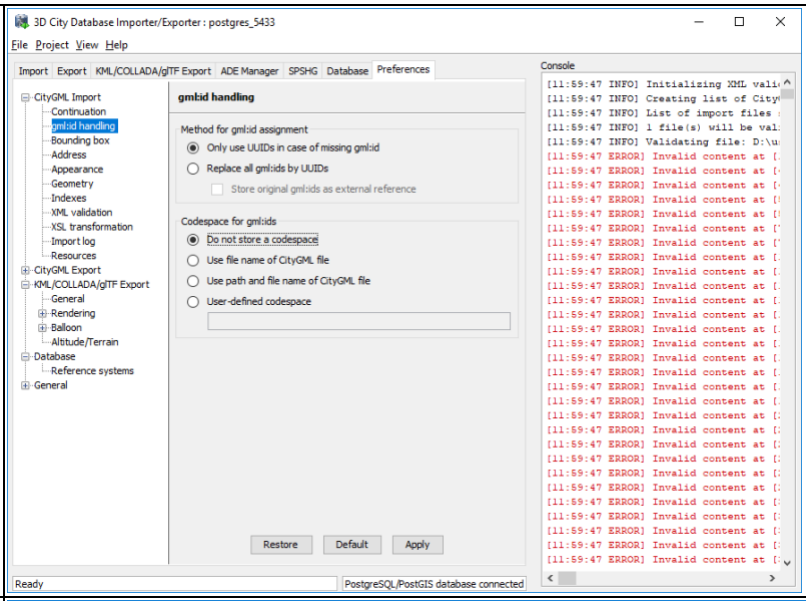
3DcityDB Importer-Exporter & 3DcityDB web map client
Open source
3D viewer
Level of tester expertise: 3

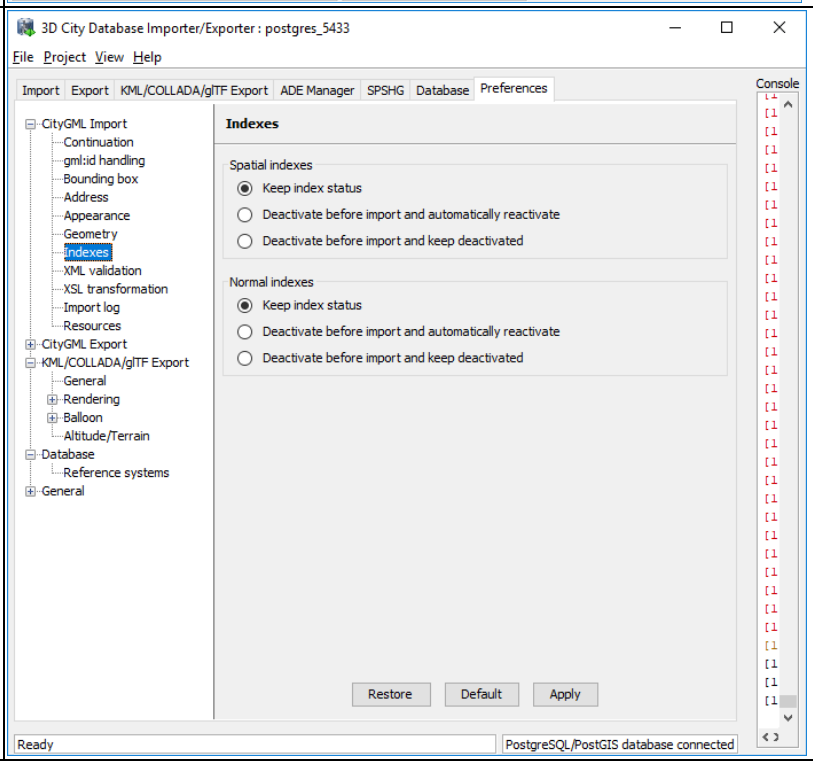


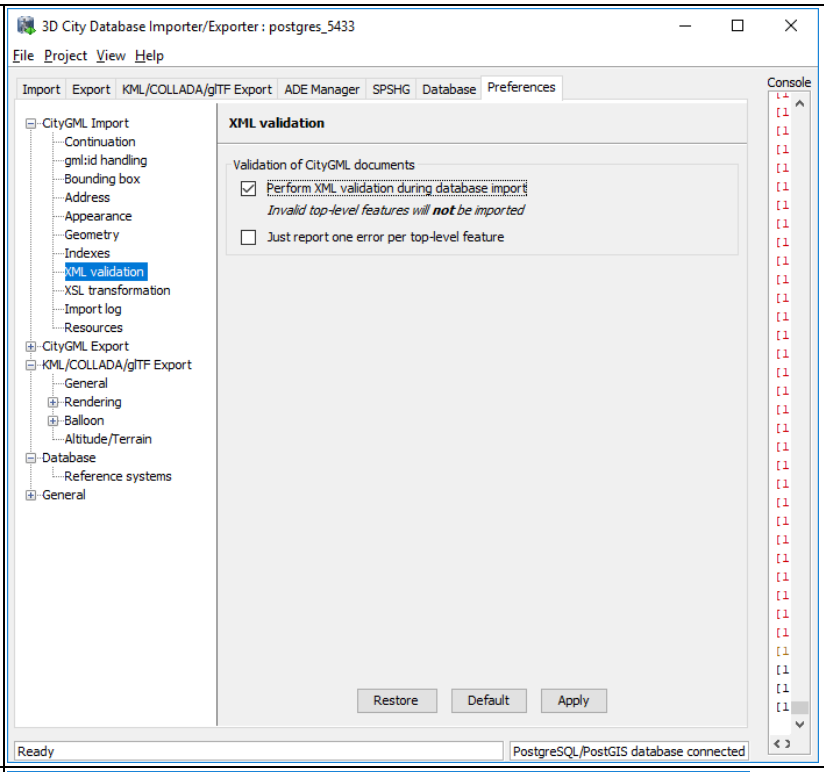


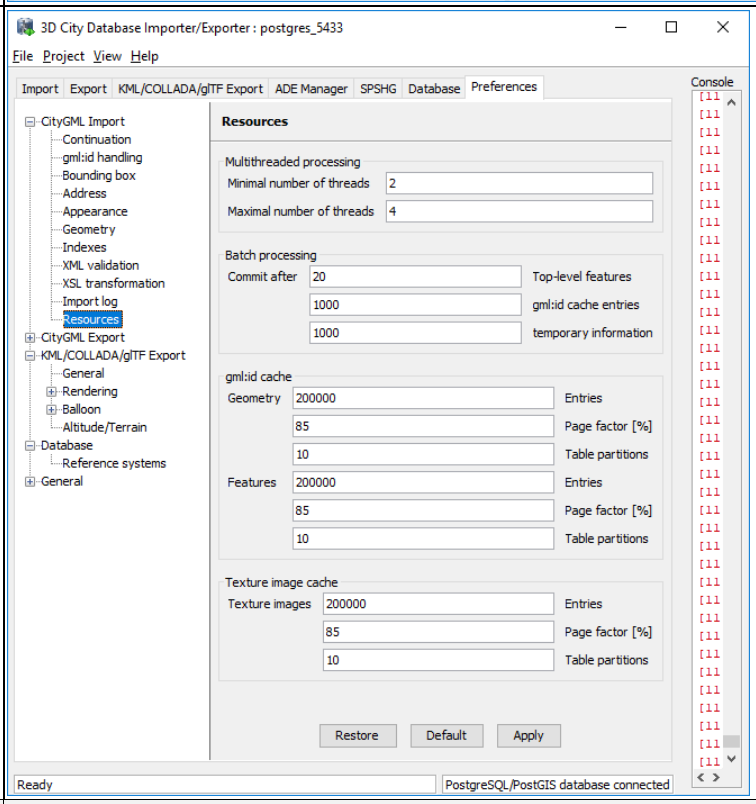


3DcityDB Importer-Exporter & 3DcityDB web map client
Open source
3D viewer
Level of tester expertise: 3









Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	The data is stored in its own coordinate system and the software knows how to convert to wgs84 which is standard for visualization on www.	
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes

		When the model is exported for visualization the elevation can be changed. If absolute elevation is used, a DTM must be provided coherent with these elevations. It is also possible to ignore the elevations of the buildings and use elevations relative to the terrain.
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	Yes
	9.1.1) What are the tools needed to set the correct CRS, or where is it possible to set it in the software?	When creating the database, you have to set the correct CRS. The PostGIS database has to be created beforehand with the correct coordinates system. There is a bat file to do this and it asks for the coordinates system.
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	Yes
	11.2) short comments to the previous question (optional)	The CityGML structure is converted into a schema with many relational tables. There is no distinction between Buildings and BuildingParts.
	12.1) Are the attributes present in the CityGML entities retained and consistent?	Yes
	13.1) Are the relationships between the objects retained?	Yes
	13.2) short comments to the previous question (optional)	There is no distinction between Building and BuildingParts. Both are stored in the same table and it seems this is not a bad thing.
Geometry	14.1) Is geometry read correctly?	Yes
	15.1) Did normals change?	No
View	16.1) Is it possible to view the model in 3D?	Yes, through external platforms
	16.2) short comments to the previous question (optional)	The model has to be exported to glTF of kml format.
	17.1) Is it possible to view the model in 2D?	Yes
Editing	18.1) Is it possible to edit the model?	No
Query	19.1) Is it possible to query the model and the attributes?	No
Analyse	20.1) Is it possible to analyse the objects and the model?	No
Export	37) How long does it take for the data to be exported to CityGML?	it's almost immediate
Test with BuildingLoD3.gml		
How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	less than a minute
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Import (and visualise, if the software allows it) the model	the software does not allow this
	Inspect the objects linked to the queried one through a relationship	the software does not allow this
Import		The import is done with 3DCityDB-Importer-Exporter and the visualization, zoom, pan and rotate are done with 3DCityDB-Web-Map-Client (T3_BuildingsLoD3_3DCityDB_4.0_CityGMLv1_ICGC_import_view.jpg). The validation previous to the import reports the contents is invalid: T3_BuildingsLOD3_3DCityDB_4.0_CityGMLv1_ICGC_import_validation.log.
Test with amsterdam.gml		

How long does it take, approximately, to:	Import (and visualise, if the software allows it) the model	more than one hour
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	the software does not allow this
	Inspect the objects linked to the queried one through a relationship	the software does not allow this
Import	Is any error reported when importing the model	Indexes should be deactivated before importing the model. Import takes 41m 14s. The export for visualization crashes if it includes vegetation. All the other layers can be exported. Export takes 1h 9m 23s.
Semantic	49.1.1) What changes / inconsistencies / errors / other issues were noted?	Vegetation cannot be loaded because it has multisolid geometry.
view	51.1) Is it possible to view the model in 3D?	Yes
	51.2) short comments to the previous question (optional)	The model has to be exported to glTF of kml format but vegetation layer has to be avoided because it contains multi_solid and this not supported by 3DCityDB.
	The model has to be exported to glTF of kml format but vegetation layer has to be avoided because it contains multi_solid and this not supported by 3DCityDB. [11:26:11 ERROR] SQL error while querying the highest available LOD: ERROR: column pc.lod2multi_solid_id does not exist Hint: Perhaps you meant to reference the column "pc.lod2_multi_solid_id". Position: 223 Exception in thread "db_exporter_pool 1" java.lang.NullPointerException at org.citydb.modules.kml.database.PlantCover.read(PlantCover.java:124) at org.citydb.modules.kml.concurrent.KmlExportWorker.doWork(KmlExportWorker.java:482) at org.citydb.modules.kml.concurrent.KmlExportWorker.run(KmlExportWorker.java:266) at java.lang.Thread.run(Unknown Source) [11:26:11 ERROR] SQL error while querying the highest available LOD: ERROR: column pc.lod2multi_solid_id does not exist Hint: Perhaps you meant to reference the column "pc.lod2_multi_solid_id". Position: 223 Exception in thread "db_exporter_pool 0" java.lang.NullPointerException at org.citydb.modules.kml.database.PlantCover.read(PlantCover.java:124) at org.citydb.modules.kml.concurrent.KmlExportWorker.doWork(KmlExportWorker.java:482) at org.citydb.modules.kml.concurrent.KmlExportWorker.run(KmlExportWorker.java:266)	
	52.1) Is it possible to view the model in 2D?	Yes
Export	You arrived at the end of the phase 1: "Import and manage the file in the software".Now choose:	The software has also export abilities
	56.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	Yes
	56.2) short comments to the previous question (optional)	I have to unselect vegetation for exportation. Otherwise, the program crashes.
	57) How long does it take for the data to be exported to CityGML?	1-5 minutes
Final notes		

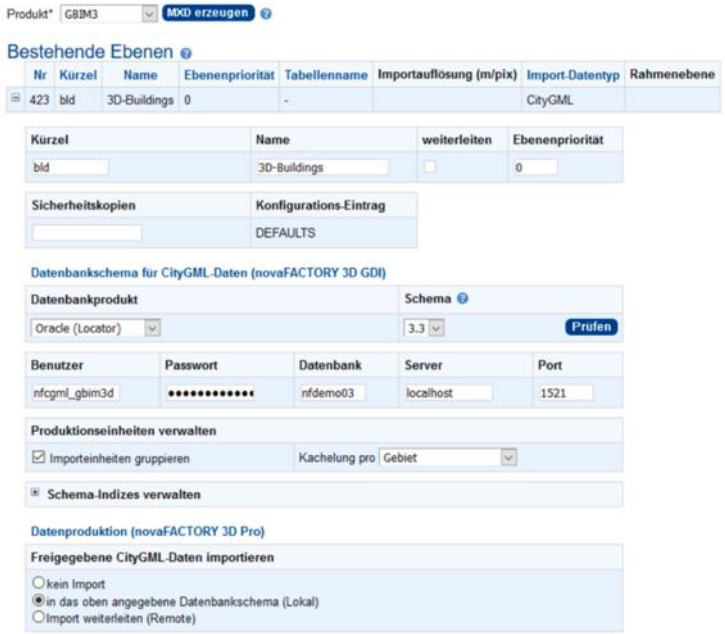
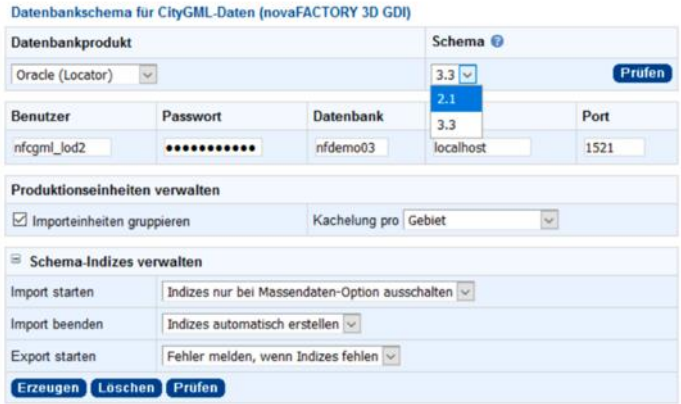
	Kind of CityGMl management possible	• Import • Export • view

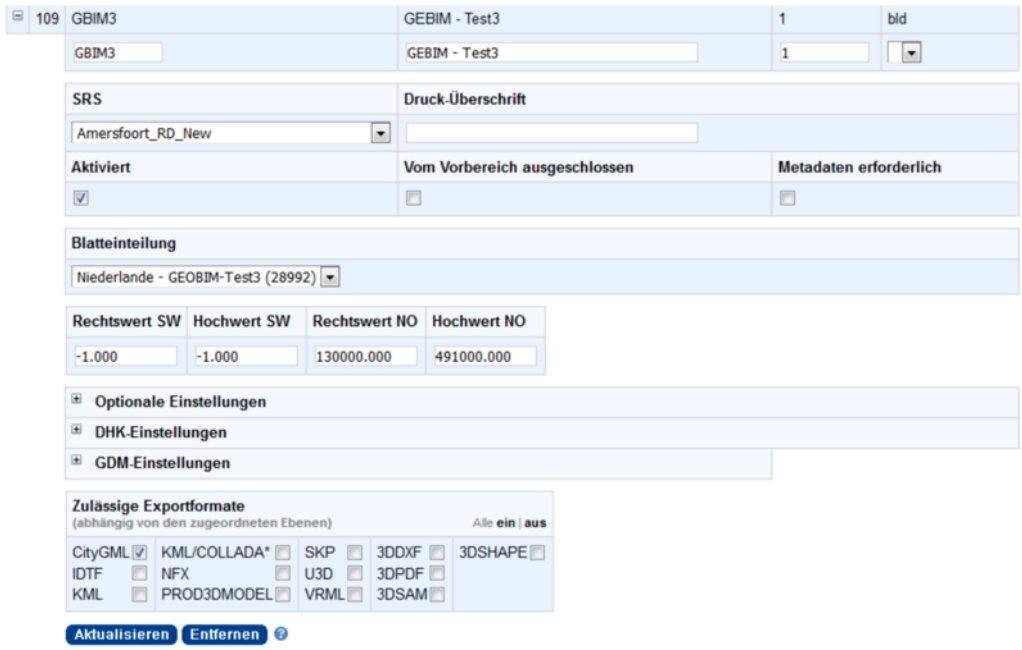
novaFACTORY[8] + WEGA-3D[9]

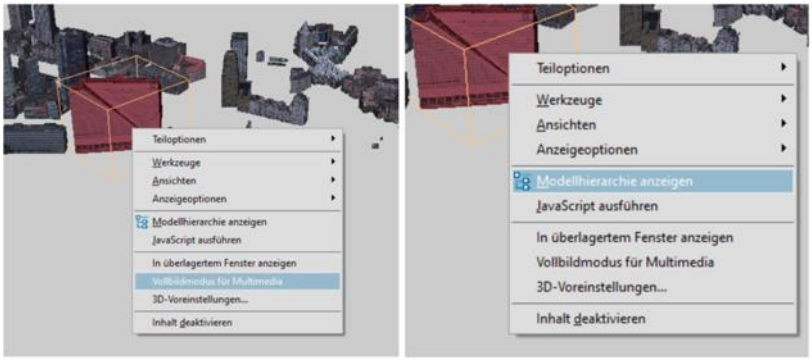
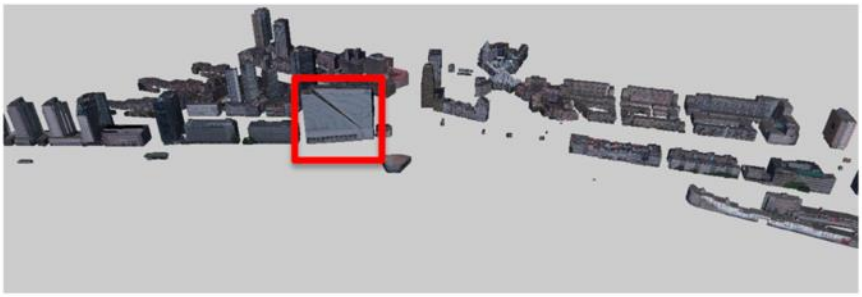
Software	Software Name	**novaFACTORY [8.1.1.1]**		Software house		M.O.S.S. Computer Grafik Systeme GmbH	
	Proprietary or open source software?			Kind of software			
	proprietary			GIS – 3D viewer / ETL / 3D Data management			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	FUJITSU- 2011	Windows 7 Professional (6.1)	Intel® Core(TM) i7-2600 CPU @ 3.40GHz	NVIDIA Quadro 600	16 GB	666 GB	85,6 GB
ADE	1.1) Does the software support CityGML ADEs?			Yes			
	1.1.1) Are they directly managed without any change in the settings / specific tools / plugins?			Yes			
	Kind of ADE information management			• it can be viewed and inspected • it can be queried			
Data form	2.1) Does the software support this CityGML data in native format?			Yes			
Test with RotterdamLoD12.gml							
How long does it take, approximately,	Import (and visualise, if the software allows it) the model			1-5 minutes			
	Zoom into the model to see more detail			it's almost immediate			
	Pan the model			it's almost immediate			
	Rotate the model			it's almost immediate			
	Query an object			it's almost immediate			
	Inspect the objects linked to the queried one through a relationship			the software does not allow this			
LoDs	4.1) How are the different LoDs read/managed in the software?	They are all read and managed in the software and a consistent multi-LoD view and management is possible by visualising / managing / analysing the objects in the different connected LoDs.					

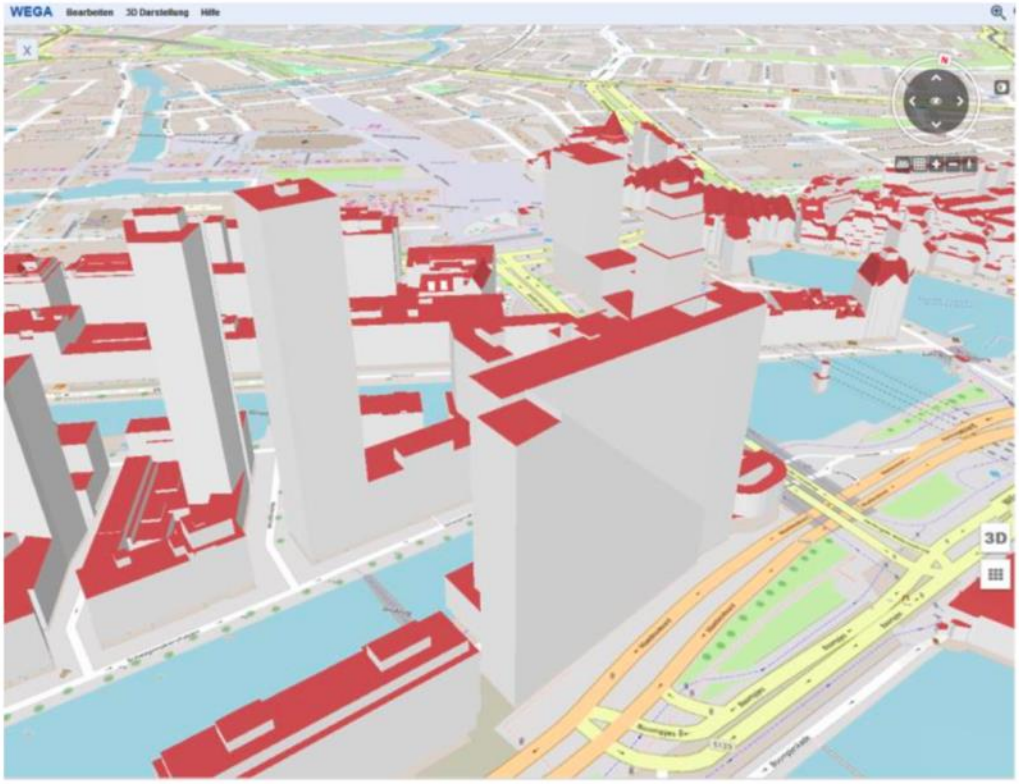
[8] novaFACTORY is an advanced Spatial Data Management solution for efficient Geo-data cataloguing, exploitation and dissemination. With novaFACTORY we are leading the way in the full integration of enterprise-wide geospatial data sources which the whole organization can have access to and work from, covering all aspects of:
· Data Import
· Integration
· Data Storage
· Management
· Data Dissemination.

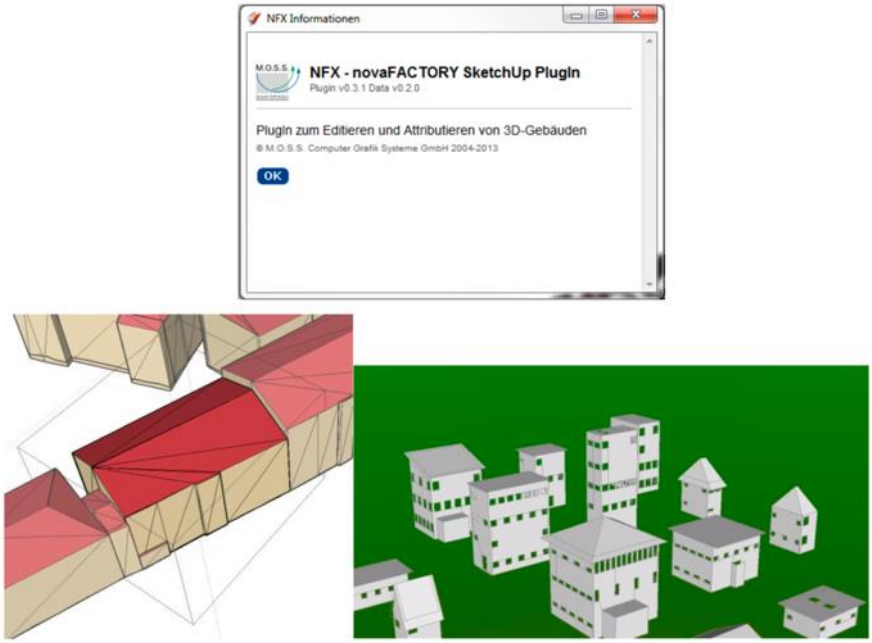
[9] WEGA-3D, is the extended Web-GIS platform WEGA with the integrated use of 3D Geo-data and free plugin in the browser and mobile workstation. This allows locating and visualizing city and landscape models, including the associated factual data, to be available quickly and everywhere for user groups with any size in the Intranet or Internet.

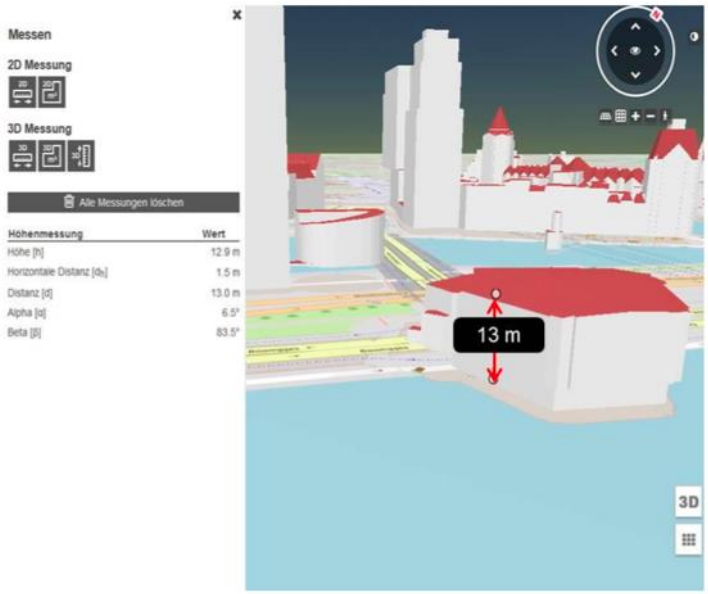
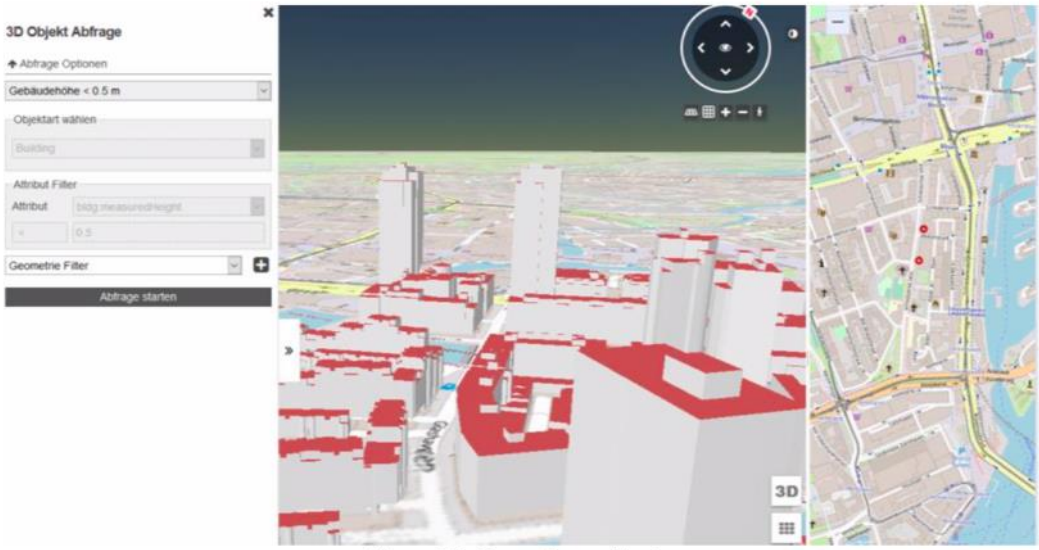
	4.3) Attach screenshots	 *Figure 1, The schema setting to import CityGML with different LoDs.*  *Figure 2. The databank setting to import CityGML with different LoDs.*
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	Essentially the software can not directly inspect the coordinate system. The coordinate frame has to be defined in advance in order to import and land data with correct coordinates. By using the header file it is possible to determine the coordinate system. Then, the relevant coordinate system can be defined in advance to begin the import process.	
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	6.1.2) Attach screenshots	 *Figure 3, The coordinate system is defined to geo-reference and import the data.*
	6.2) short comments to the previous question (optional)	For the purpose of visualization based on the coordinate system, the WEGA-3D is called. In the case of importing, the model will be located with respect to the coordinate system defined in the novaFACTORY in advance.

	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	Yes
	9.1.1) What are the tools needed to set the correct CRS, or where is it possible to set it in the software?	The software requires defining the coordinate system in advance. Then, the data can be imported in the right coordinate system.
	9.1.2) Attach screenshots	 *Figure 4, the coordinate system definition.*
Semantic	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes

	10.1.2) Attach screenshots	 *Object selection and attributes table and hierarchy presentation (all information stored in the data format)* *Figure 6, 3D PDF of the Rotterdam CityGML (RotterdamLOD12.gml) data as a visualization example.* *Figure 5, 3D model visualization in WEGA-3D* 
	10.2) short comments to the previous question	As it is presented in the Fig.5 the imported model represents 3D buildings in WEGA-3D. Additionally, the appearances in this CityGML data will be attached to the model and can be exported and visualized in a 3D PDF format (Fig.6).
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	Yes
	12.1) Are the attributes present in the CityGML entities retained and consistent?	Yes
	13.1) Are the relationships between the objects retained?	Yes

Geometry	14.1) Is geometry read correctly?	Yes
	15.1) Did normals change?	No
	15.1.2) Attach screenshots	 *Figure 7, The visualization in order to check the normals on the objects.*
View	16.1) Is it possible to view the model in 3D?	Yes
	16.2) short comments to the previous question (optional)	It is possible in the WEGA-3D component to have a 2D and 3D at the same time with the side by side window (Fig.8).
	17.1) Is it possible to view the model in 2D?	No
	17.2) short comments to the previous question (optional)	 *Figure 8, 3D and 2D visualization windows in WEGA-3D.*
Edit	18.1) Is it possible to edit the model?	Yes

	18.1.1) What editing is possible (attributes, geometry, georeferencing, please add details)?	Through the plug-in software tridicon© Editor as an implemented Module in the novaFACTORY it is possible to edit the buildings and their properties. Additionally by using SketchUp- PlugIn in novaFACTORY as a editing tool, the attributes of buildings can be edited. In the WEGA-3D the main aim is to visualize/analyze the model in 3D next to a 2D window. However, it is possible to edit the details, attributes using a third party plugin software in the novaFACTORY such as tridicon® Editor Module to do the editing on the building objects.
		 *Figure 17, SketchUp (left) visualization and CityDiscoverer (right).*
Query	19.1) Is it possible to query the model and the attributes?	Yes
	19.1.1) What kinds of query are possible?	It is possible to make a query which is focused on any attributes of the objects such as height attributes, area size and etc.

	19.1.2) Attach screenshots	 *Figure 9, The measurement illustration in 3D and 2D views.*  *Figure 10, Query from objects.*
Analysis	20.1) Is it possible to analyse the objects and the model?	Yes
	20.1.1) What analysis are possible? Do you know if the results are reliable? How much time is needed to perform them?	Analysis such as height profile, visual axes, object shadows or classification/selection of 3D buildings based on a threshold.

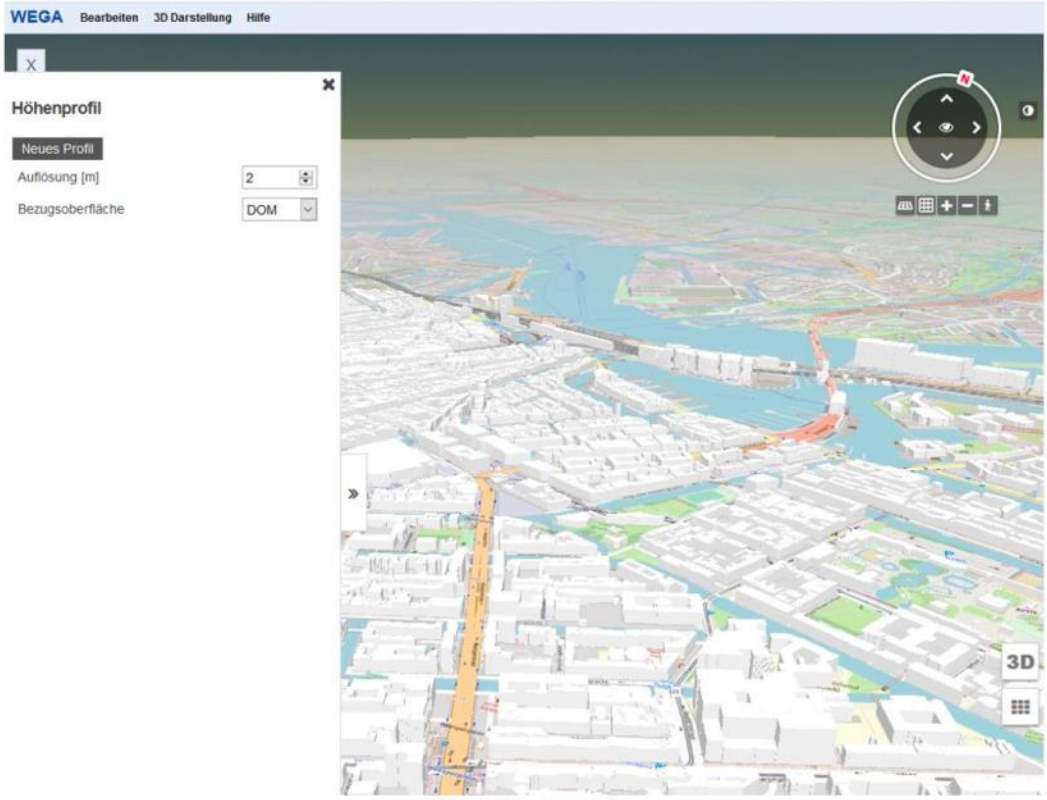
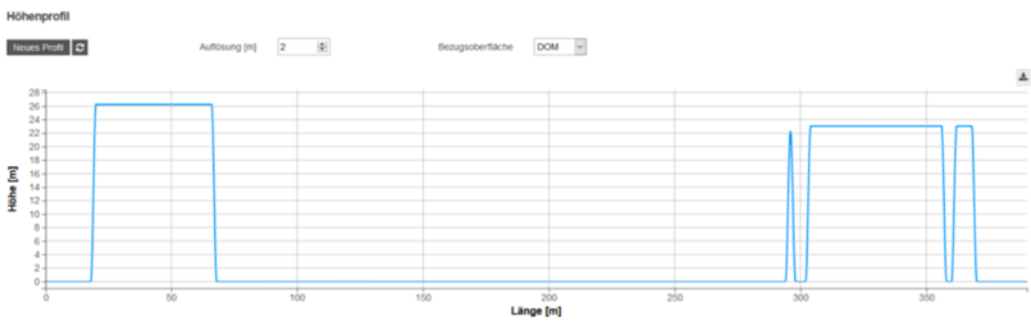
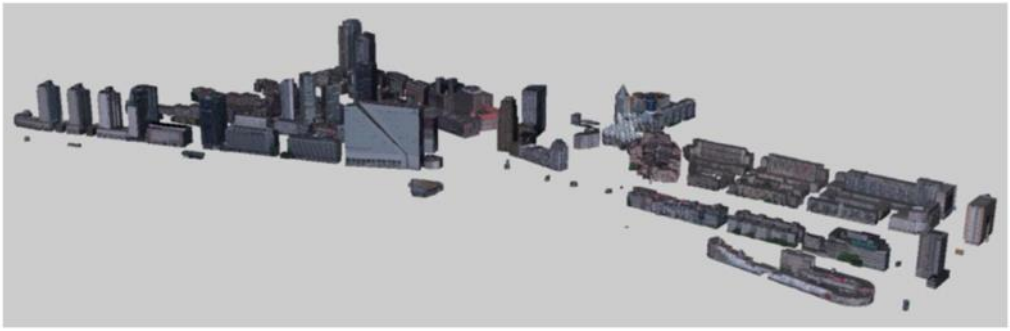
	20.1.2) Attach screenshots	 *Figure 24, Analysis.*  *Figure 11, An example of a height profile acquisition in WEGA-3D.*
	20.1.3) Time required to perform the analysis about the model itself (type 1)	less than a minute
Export	You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:	The software has also export abilities
	21.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	No
	21.1.2) Attach screenshots and files	As an interesting example Fig.14 shows a 3D PDF export of the Rotterdam.glm model:  *Figure 15, 3D PDF export view from the Rotterdam.gml*

Figure 14, Automatic production of 3D buildings.

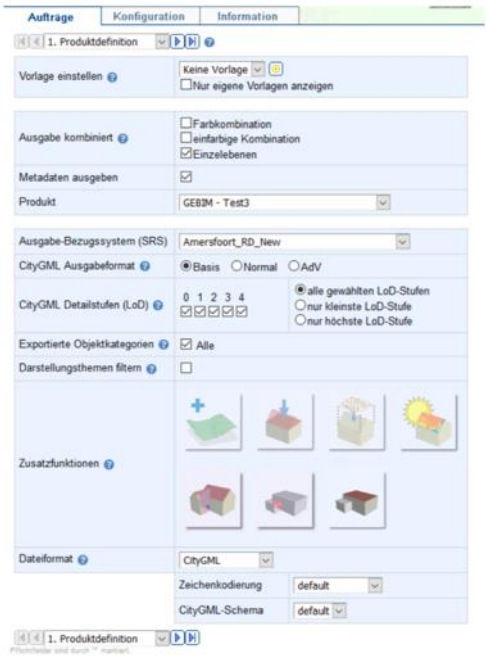


Figure 13, CityGML export setting.

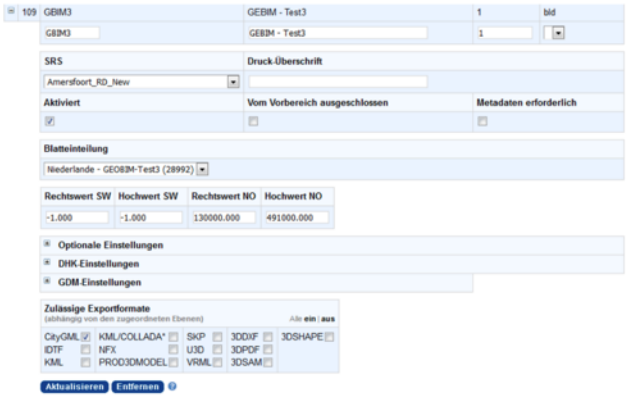


Figure 12, CityGML export.

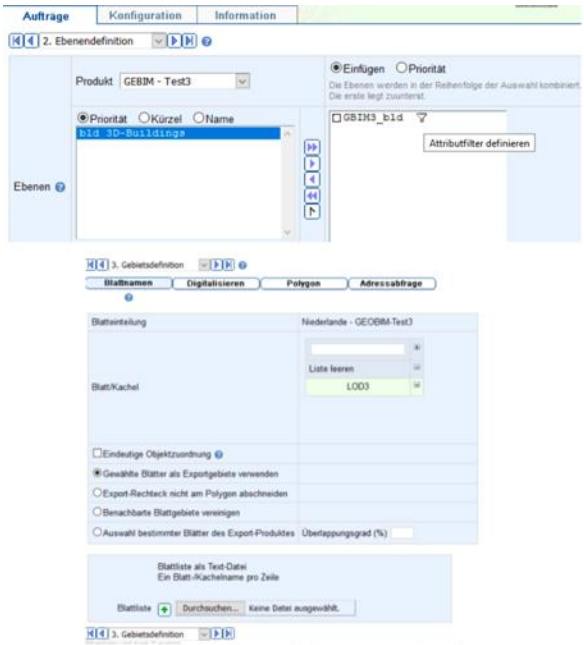
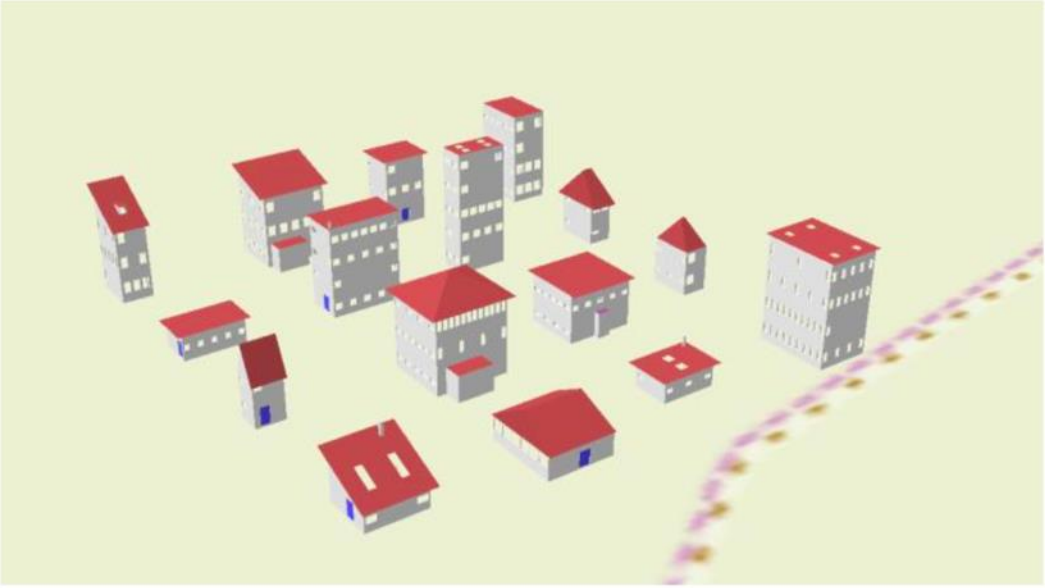


Figure 18, Export Module setting in detail.

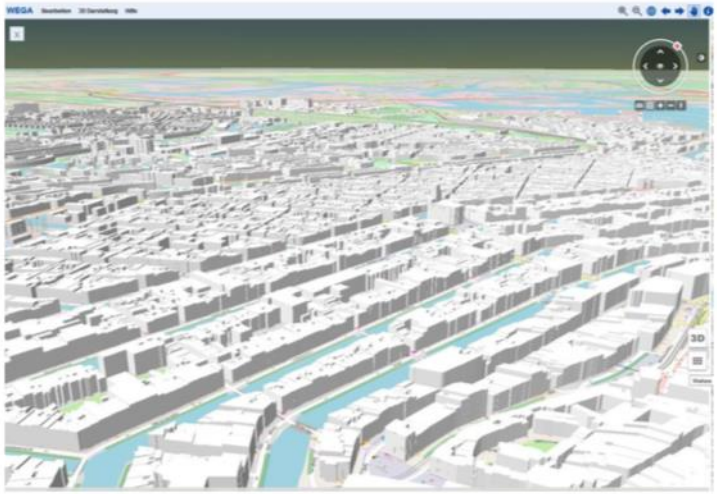
21.2) short comments to the previous question (optional)	The export phase consists of the following main steps: LoDs details, type of export format, CityGML schema, coordinate reference system and metadata.
22) How long does it take for the data to be exported to CityGML?	1-5 minutes

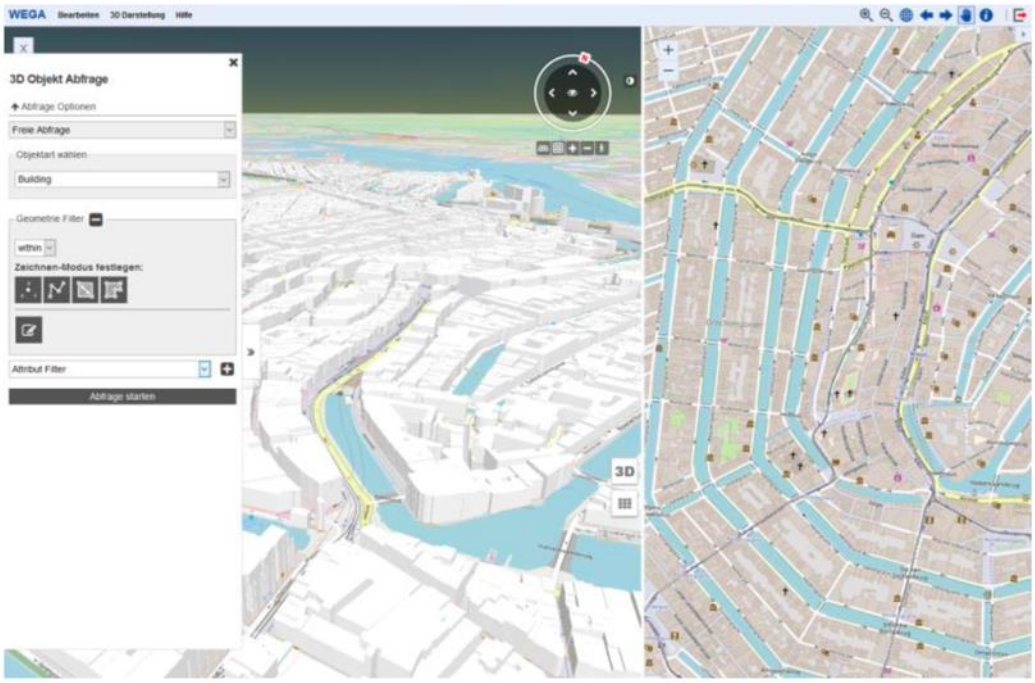
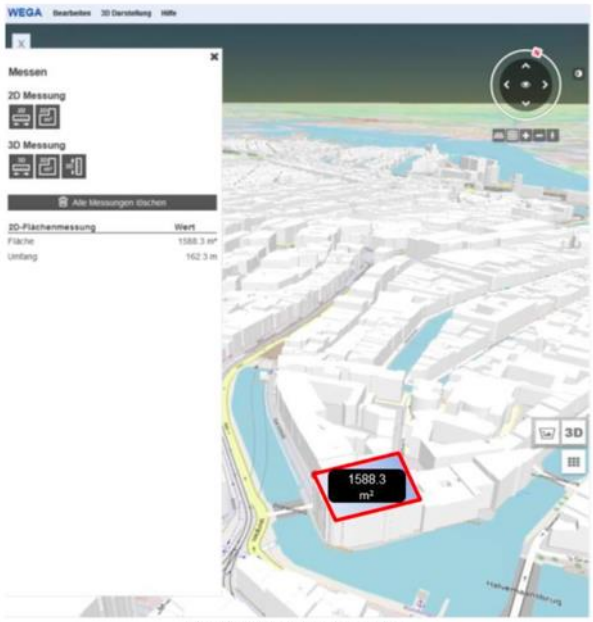
Test with BuildingsLoD3.gml

How long does it take,		
	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate

	Inspect the objects linked to the queried one through a relationship	the software does not allow this
Geor ef	24.1) Does the model maintain its correct dimensions and proportions?	Yes
Geometry	29.1) Is geometry read correctly?	Yes
	29.1.2) Attach screenshots	 *Figure 16, 3D visualization of the BuildingLOD3.gml data.*
Analysis	35.1) Is it possible to analyse the objects and the model?	Yes
	35.1.3) Needed time to perform the analysis about the model itself (type 1)	It's almost immediate
	35.1.4) Needed time to perform the analysis about the model performance (type 2)	It's almost immediate
Export	You arrived at the end of the phase 1: "Import and manage the file in the software".Now choose:	The software has also export abilities
	37) How long does it take for the data to be exported to CityGML?	less than a minute

Test with amsterdam.gml		
How long does it take, approximately,	Import (and visualise, if the software allows it) the model	20 minutes - 1 hour
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	the software does not allow this

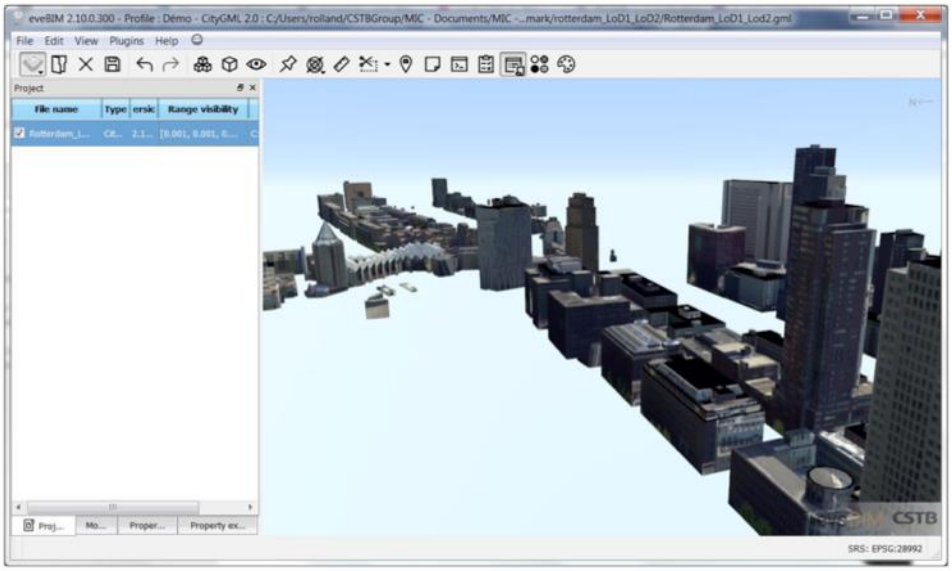
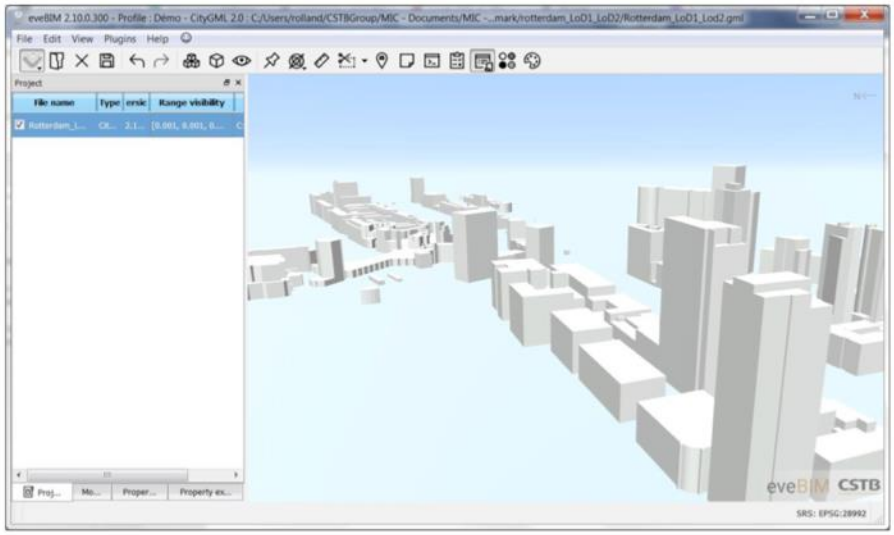
View	50.1.2) Attach screenshots	 *Figure 20, 3D visualization.*
		 *Figure 21, 3D visualization of Amsterdam.gml*

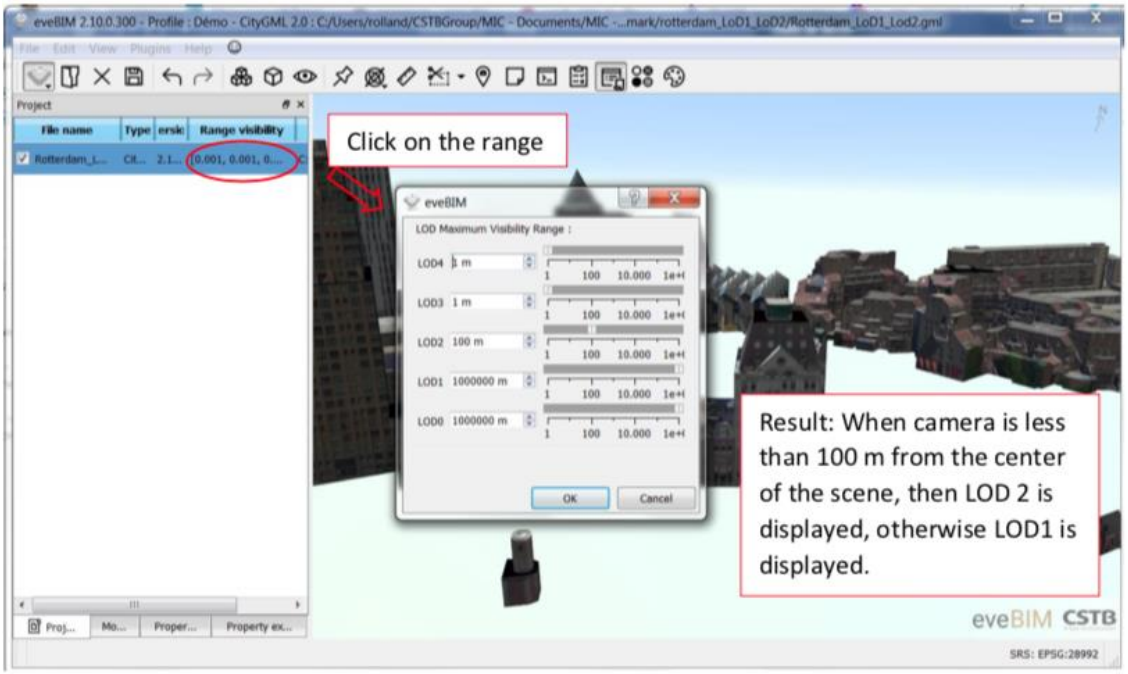
Query	54.1.1) What kinds of query are possible?	It is possible to make a query which is focused on any attributes of the objects such as height attributes, area size and etc.
	54.1.2) Attach screenshots	 *Figure 22, Quary setup, WEGA-3D.*
Analysis	55.1) Is it possible to analyse the objects and the model?	Yes
	55.1.2) Attach screenshots	 *Figure 23, 3D and 2S measurements.*
	55.1.3) Needed time to perform the analysis about the model itself (type 1)	less than a minute
Export	You arrived at the end of the phase 1: "Import and manage the file in the software".Now choose:	The software has also export abilities
	57) How long does it take for the data to be exported to CityGML?	20 minutes - 1 hour
Final notes		

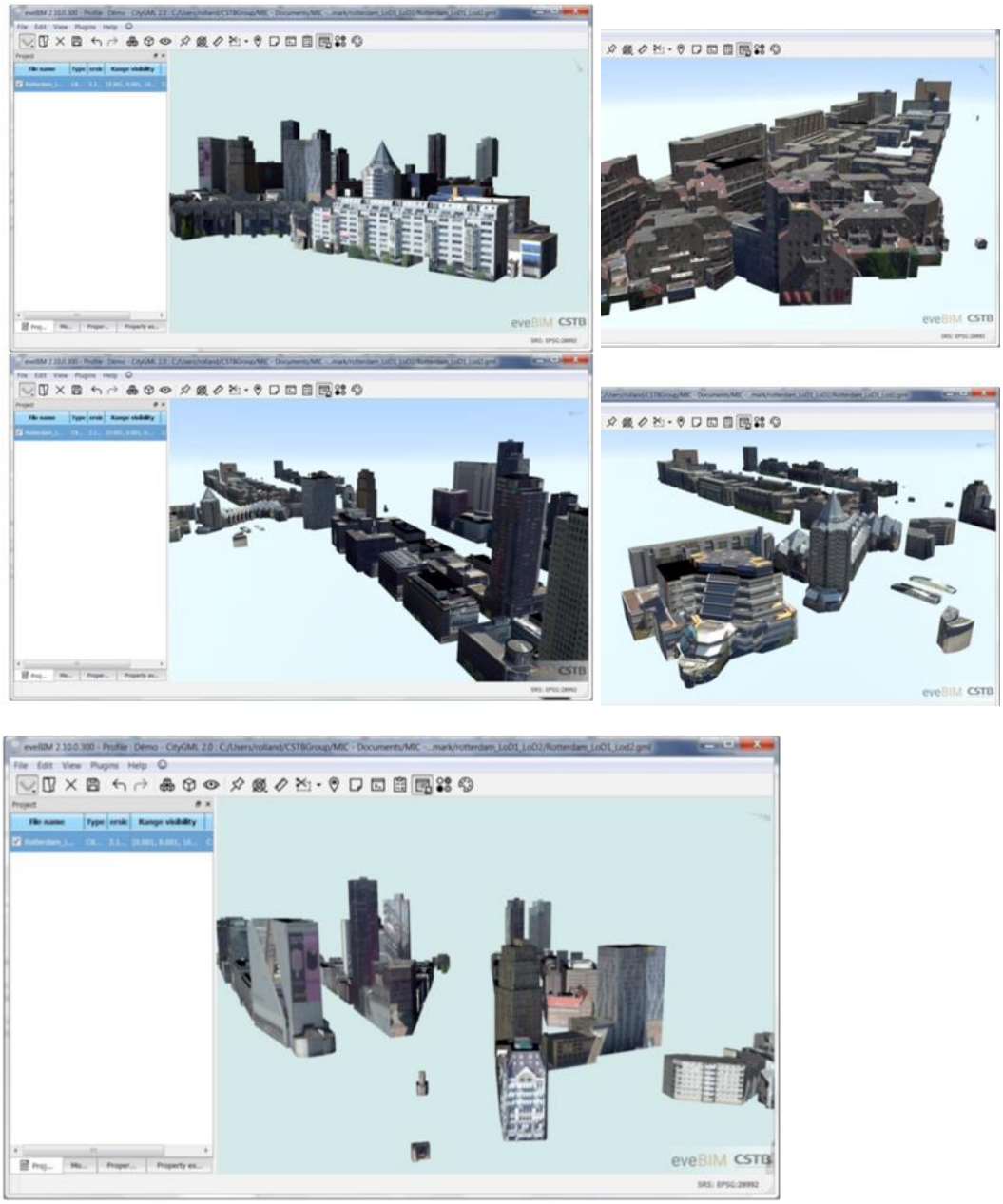
	Kind of CityGML management possible	Import Export View Query Edit (through additional plug-ins) analyse
	58) Would you like to share any other comments or observations?	The software uses a relational database for data storage. Oracle, PostGreSQL and MS SQL Server are supported by the software. Oracle was used in the benchmark Task 3 experiment.

eveBIM

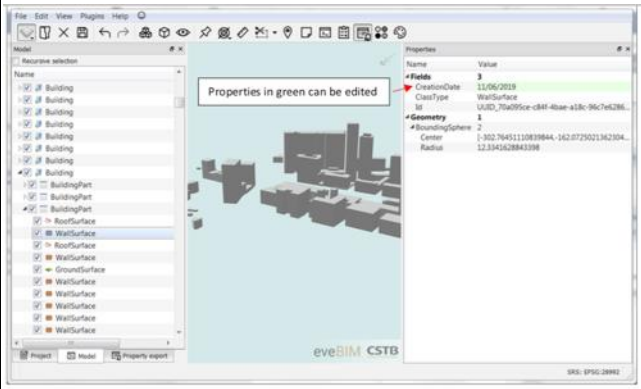
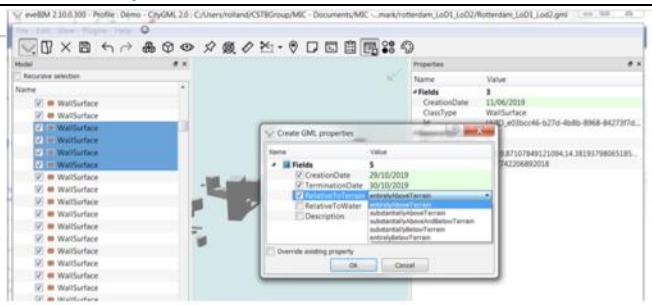
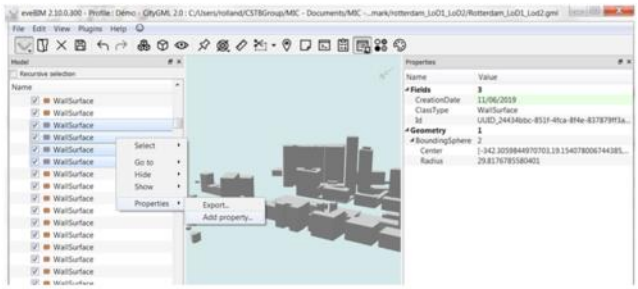
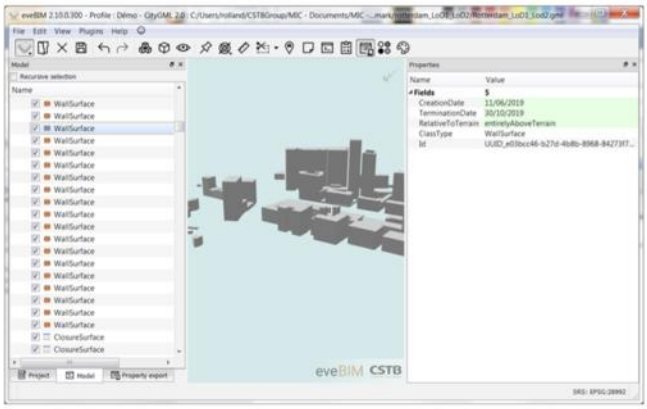
Software	Software Name	**eveBIM [2.10.0]**	developer	CSTB https://logiciels.cstb.fr/contact/?dmd=telechargement&log=eveBIM%20derni%C3%A8re%20version&th=bim-et-maquette-numerique			
	Proprietary or open source software?			Kind of software			
	proprietary			GIS			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	DELL Precision 5510 - 2018	Windows 7 professionel	Intel(R) Xeon(R) CPU E3-1505M v5	NVIDIA M1000M	16 Go	953	276
ADE	1.1) Does the software support CityGML ADEs?			Yes			
	1.1.1) Are they directly managed without any change in the settings / specific tools / plugins?			Yes			
	Kind of ADE information management possible			it can be viewed and inspected			
	1.2) Add short comments to the previous questions	Energy ADE 0.8.0 and utilityNetwork 0.9.0 are managed in eveBIM 2.10.0. We have integrated also our own ADE. The process for integrating an ADE is mainly automatic. It remains however a small manual part that requires the development of specific code					
Data format	2.1) Does the software support this CityGML data in native format?			Yes			
	2.2) short comments to the previous question (optional)			eveBIM can open IFCéx3, IFC4, CityGML and shapifiles format			
Test with RotterdamLoD12.gml							
How long does it take, approximately,	Import (and visualise, if the software allows it) the model						
	Zoom into the model to see more detail			5-20 minutes			
	Pan the model			it's almost immediate			
	Rotate the model			it's almost immediate			
	Query an object			it's almost immediate			
	Inspect the objects linked to the queried one through a relationship			it's almost immediate			
Import	Was any error reported when importing the file?	Long time to load the file ~12 minutes. If we load without texture it's much faster					
LoD	4.1) How are the different LoDs read/managed in the software?	They are all read and managed in the software and a consistent multi-LoD view and management is possible by visualising / managing / analysing the objects in the different connected LoDs.					
	4.2) Please, give more details and examples	eveBIM display a LOD depending on the range of visibility (for example LOD 4 used when camera is between 0 to 100 m from the center of the scene, LOD 3 between 100 to 1000, ...). These ranges of visibility can be configured for all the files (by defaut) and can be override for each file. So we don't manage the LOD object by object but we can display a particular LOD for all the scene					

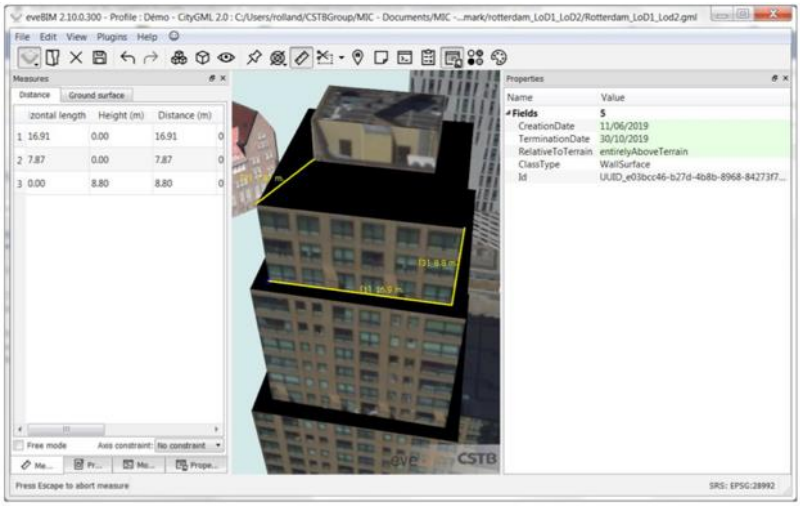
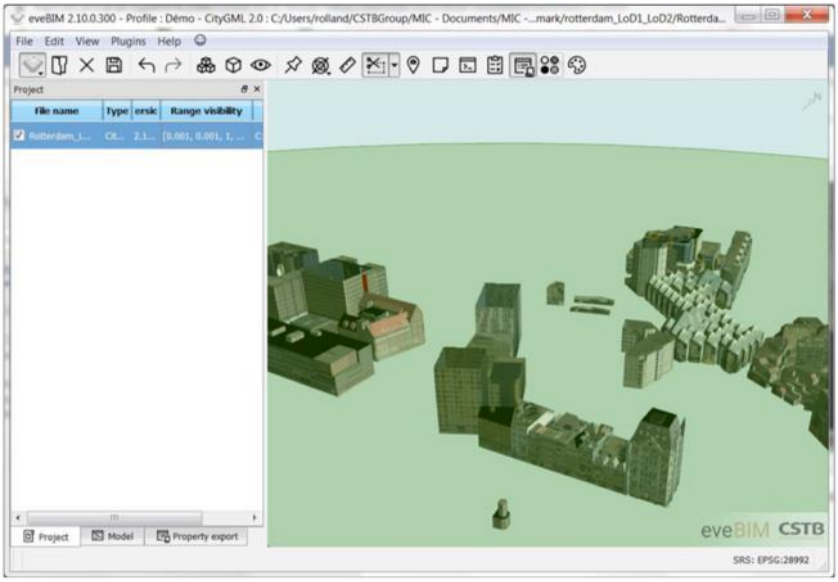
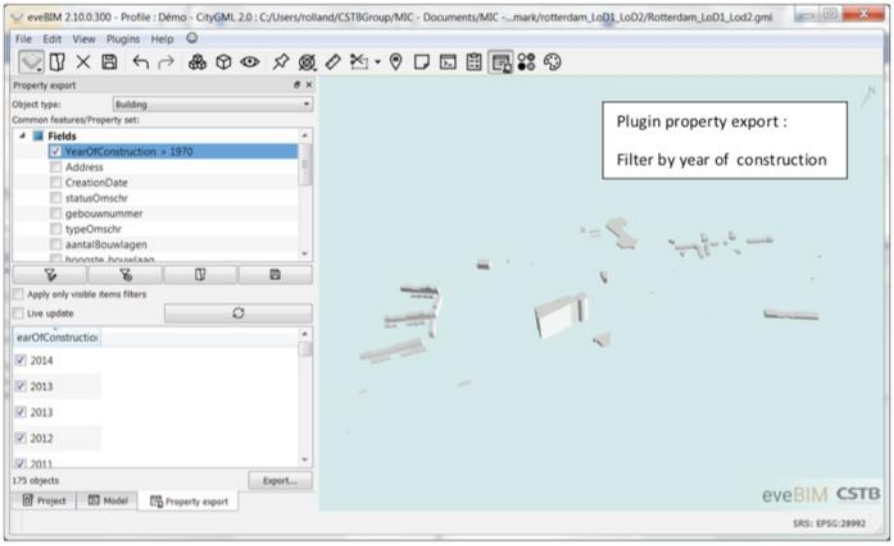
	4.3) Attach screenshots	 *Figure 1 eveBIM with model Rotterdam_LoD1_Lod2 loaded → LOD 2 displayed*  *Figure 2 eveBIM with model Rotterdam_LoD1_Lod2 loaded → LOD 1 displayed*

			
⊢ ⊠	Can the textures be visualised correctly?		Yes



Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes
	5.2) Add short comments to the previous questions (optional)	You can see the CRS bottom right of the application. You can also see the CRS by clicking on a CityGML object
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	7.2) short comments to the previous question (optional)	eveBIM is muti files and allows the load of files with different CRS and elevation
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	8.2) short comments to the previous question (optional)	Several files can be loaded with eveBIM (with different CRS, elevation and orientation). So it has to manage correctly the orientation.
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	No
	9.2) short comments to the previous question	The CRS is given in the envelop. In the application, the first found is the reference. If there are other CRS, then eveBIM reproject the data in the first found

Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	10.2) short comments to the previous question (optional)	No translation done
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	Yes
	11.2) short comments to the previous question (optional)	We have the differnts kind of object type (CityModel Buildings WallSurface RoofSurface GroundSurface BuildingPart, ClosureSurface, ...)
	12.1) Are the attributes present in the CityGML entities retained and consistent?	Yes
	12.2) short comments to the previous question (optional)	I've test with the info found in geoBIM data. We have the same info except for Element 5: eveBIM don't display that it's a lod2MultiSurface
	13.1) Are the relationships between the objects retained?	No
Geo metr	14.1) Is geometry read correctly?	Yes
View	16.1) Is it possible to view the model in 3D?	Yes
	16.2) short comments to the previous question (optional)	In eveBIM, we can simulate the date and hour of the day. Then we can see the difference of color on the faces.
	17.1) Is it possible to view the model in 2D?	No
Editing	18.1) Is it possible to edit the model?	Yes
	18.1.1) What editing is possible (attributes, geometry, georeferencing, please add details)?	We can modify attributes (also codelist attributes). We can also add new attributes (add only the attributes defined in CityGML norm or in the ADE). You can modify several attributes in a same time
	 Figure 1 eveBIM: Edit proerty from properties view	 Figure 3 Properties defined in the CityGML Schema can be added
	Method 2: Add or modify properties (defined in the CityGML Schema)  Figure 2 Select objects and click right, chosse menu 'Add property'	 Figure 4 Results: properties are added and in this case overrided
	18.2) short comments to the previous question (optional)	editing attributes doesn't take time
Query	19.1) Is it possible to query the model and the attributes?	Yes
	19.1.1) What kinds of query are possible?	Measure, clipping plane, filter or export properties with some rules (example filter all the buildings with creationDate superior to ...)

	19.1.2) Attach screenshots	 *Figure 1 eveBIM: Measure tool*  *Figure 2 Clipping plane*  *Figure 3 eveBIM: filter by year of construction (>1970)*
Analysis	20.1) Is it possible to analyse the objects and the model?	No

Export	You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:	The software has also export-to-CityGML abilities
	21.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	No
	21.2) short comments to the previous question (optional)	CityGML can be saved. It's not an export.
	22) How long does it take for the data to be exported to CityGML?	less then a minute
Test with BuildingsLoD3.gml		
How long does it take, approximately,	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	it's almost immediate
Export	37) How long does it take for the data to be exported to CityGML?	less then a minute
Test with amsterdam.gml		
	How long does it take, approximately, to: Import (and visualise, if the software allows it) the model	Insufficient memory on my computer Microsoft asks to close the application. However if the file is on 3DCityDB, eveBIM can be connected to it: In eveBIM, we have a plugin '3DCityDB Connector', so we could load it via this connector but it won't be tested.
Final notes		
	Kind of CityGML management possible	• Import • Export (save) • View • Query • Edit • Analysis

FME Data Inspector

Software	Software Name	**FME Data Inspector [2018.1]**	developer		Safe Software		
	Proprietary or open source software?				Kind of software		
	proprietary				3D viewer		
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	MacBook Pro 15" 2017	macOS 10.14.3	3.1GHz i7	Radeon Pro 560 4096 MB Intel HD Graphics 630 1536 MB	16 GB 2133 MHz LPDDR3	1TB	341 GB
ADE	1.1) Does the software support CityGML ADEs?	Yes					
	1.1.1) Are they directly managed without any change in the settings / specific tools / plugins?	No, it is required to attach the schema file.					
	Kind of ADE information management possible	it can be viewed and inspected, queried and analysed					
Data format	2.1) Does the software support this CityGML data in native format?	Yes					
Test with RotterdamLoD12.gml							
How long does it take, approximately,	Import (and visualise, if the software allows it) the model	1-5 minutes					
	Zoom into the model to see more detail	It's almost immediate					
	Pan the model	it's almost immediate					
	Rotate the model	it's almost immediate					
	Query an object	it's almost immediate					
	Inspect the objects linked to the queried one through a relationship	Less than a minute					
LoD	4.1) How are the different LoDs read/managed in the software?	One LoD can be selected and only the objects having the chosen LoD can be imported in the software to be visualised / managed / analysed I see only the LOD2 loaded and no option to switch between LODs.					
Georeferencing	5.1) Are you able to determine, by inspecting the data, the world (projected) coordinate reference system of the data as described in the data description?	Yes					
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes					

	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes
	8.1) Is the model oriented correctly with respect to the true North?	Yes
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	No
Semantics	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	Yes.
	12.1) Are the attributes present in the CityGML entities retained and consistent?	Yes.
	13.1) Are the relationships between the objects retained?	Yes
Geometr	14.1) Is geometry read correctly?	Yes
	Did the normal change?	No.
View	16.1) Is it possible to view the model in 3D?	Yes
	17.1) Is it possible to view the model in 2D?	Yes
Edit	18.1) Is it possible to edit the model?	No
Query	19.1) Is it possible to query the model and the attributes?	Yes
	19.1.1) What kinds of query are possible?	Search values of attributes, e.g. all objects where citygml_year_of_construction corresponds to a certain value
Analysis	20.1) Is it possible to analyse the objects and the model?	No
Export	You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:	The software has also export-to-CityGML abilities
	21.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	No
	22) How long does it take for the data to be exported to CityGML?	1-5 minutes
Test with BuildingsLoD3.gml		
How long does it take, approximately,	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	it's almost immediate
Export	37) How long does it take for the data to be exported to CityGML?	less then a minute
Test with amsterdam.gml		
How long	Import (and visualise, if the software allows it) the model	More than 1 hour
	Zoom into the model to see more detail	It crushes without completing the operation
	Pan the model	1-5 minutes
	Rotate the model	It crushes without completing the operation

	Query an object	1-5 minutes
	Inspect the objects linked to the queried one through a relationship	It crushes without completing the operation
	Be exported to CityGML	5-20 minutes
Final notes		
	Kind of CityGML management possible	• Import • Export (save) • View • Query

FME – Test 3

Software	Software Name	**FME [2019.2 b19800]**	developer	Safe Software			
	Proprietary or open source software?			Kind of software			
	proprietary			ETL			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	DELL Latitude3400	Windows 10.0.18362 64-bit	x64 i7-8586U	Nvidia GeForce MX-130	16 Go	940	405
ADE	1.1) Does the software support CityGML ADEs?			Yes			
	1.1.1) Are they directly managed without any change in the settings / specific tools / plugins?			Yes No special configuration is necessary to achieve ADE support other than to specify the path or paths to the ADE application schema within the 'Additional ADE schema files' reader or writer setting. ADE's are fully supported on both reader and writing.			
	Kind of ADE information management possible			it can be viewed and inspected, queried, analyzed			
	1.2) Add short comments to the previous questions	We have provided comprehensive CityGML support for more than a decade, so offer perhaps some of the most extensive support in the industry. We also provide citygml importers and exporters to many software vendors such as AutoDesk, ESRI and others. For ADE's we have experience support the IMGeo ADE, Energy ADE, Noise ADE , and a few research oriented ADE's such as Indoor ADE (from the OGC Indoor GML pilot) and INSPIRE ADE.					
Data format	2.1) Does the software support this CityGML data in native format?	Yes. CityGML is OGC GML with the CityGML standard group of application schemas. We support CityGML v0.4, 1.0, 2.0 and have done extensive testing with the draft CityGML v3.0 schemas. V3.0 uses our generic GML reader / writer for now which is more flexible.					
	2.2) short comments to the previous question (optional)	Once a CityGML model is imported, it is loaded into an internal FME FFS feature store file and spatially indexed. This allows for instantaneous or near instantaneous viewing and interaction. FME also exposes the complete feature model, include any XML attributes and series attributes which are represented as lists. On the geometry FME shows the source feature type, extents, coordinate reference system (CRS), and the complete geometry model. The complete, nested geometry model can be explored including geometry names, types, LOD parameters, gml_ids, appearances, textures etc. Anything visible in the Inspector can be exposed and manipulated within an FME workspace workflow which allows full automation of transformation processes.					
Test with RotterdamLoD12.gml							
How long does it take, approximately,	Import (and visualise, if the software allows it) the model			1-5 minutes			
	Zoom into the model to see more detail			It's almost immediate			
	Pan the model			it's almost immediate			
	Rotate the model			it's almost immediate			
	Query an object			it's almost immediate			
	Inspect the objects linked to the queried one through a relationship			Less than a minute			

Import	Was any error reported when importing the file?	No errors or warnings in the reader log when opening Rotterdam_LoD1_Lod2.gml in FME Data Inspector. Also, no errors were reported when importing the dataset into a workspace in FME Workbench. However, it should be noted that the reader does not do a complete validation of the CityGML features. FME does not enforce schema consistency on read – it basically reads whatever it can. Then it is up to the user to use Data Inspector or diagnostic workflows such as the CityGML validation workflow described below that uses GeometryValidator to find problems with 3D surfaces and volumes. Often, because the writer enforces the schema, some problems may not surface until writer time. Note that there is a Validation flag that can be set on the reader which will make the reader evaluate the source CityGML against the CityGML and or ADE application schemas. Note that setting Validation = true did not raise any warnings on reading this dataset. However, application schema validation typically has little to no bearing on most types of geometry validation.
LoD	4.1) How are the different LoDs read/managed in the software?	Different LODs are handled as separate, named geometries, format attributes and geometry traits. In FME, geometry traits are the equivalent of attributes, but they are values that are stored within the nested structure of the geometry. This allows FME to model different gml_ids, apprearances and geometry names within a nested geometry structured required by CityGML.
Textures	Can the textures be visualised correctly?	Yes, in most cases the textures appear to be visualized correctly. There were some problems observed, such as walls and roofs that did not appear to have textures. Some of this is caused by coincident surfaces, such as when a Building envelope solid obscures an underlying Wall surface. This can be rectified by viewing one layer at a time. Other texture display problems may be a result of missing texture references. However, with this and many datasets, display problems are typically caused by wrong surface orientation or other geometry problems – see info on analysis / validation below.
Georeferencing	5.2) Add short comments to the previous questions (optional)	It is important to remember that when reading datasets with FME, the source coordinate system denotes what CRS the data already is in and the destination CRS (in the case of a workspace) denotes the desired CRS for the output. Changing the source CRS does not reproject the dataset, but rather just retags it. For formats like CityGML which have comprehensive CRS support, typically the source CRS does not need to be set at all as FME will auto recognize it. Sometimes the dataset is missing a proper CRS reference. Another problem is that sometimes the axis order of the geometry vertices is not consistent with the CRS. In these, when the source CRS and axis order are known, these reader settings can be used to override or set them when they are missing or incorrect in the source.
	6.1) Are the world (projected) coordinates taken into account when locating the model in the software's coordinate reference system?	Yes Amersfoort RD 2008 (EPSG 28992), with metres as unit of measurement
	7.1) Are the "real-world" elevation values (heights) considered when locating the model in the software (z)?	Yes According to the datum specification above, the height is based on Amersfoort 2008 which is ultimately based on the BESSEL 1841 Ellipsoid We are not sure of the exact origin for EPSG: 28992, since these are likely modelled as geocentric coordinates. For the purposes of this dataset, the vertical origin is likely best considered to be 0. That is, 0 likely coincides with some mean high tide value. Notice that in the screen shot above, the vertical extents are from 3.0 to 9.7 metres, which would be consistent with 0 representing sea level. FME supports height measurements in 5 possible different ways and can convert between them: • Leave unchanged • Relative to ellipsoid or geocentric • Ellipsoid height to orthometric height • Conversion between vertical datums • Use of Offsetter, Affine and AffineWarper transformers to specify a implement a specific height transformation.

	7.2) short comments to the previous question (optional)	For FME, as for many formats, the CRS and georefencing are read automatically and stored on the features. If the destination coordinate system is set to a different CRS than the source FME automatically reprojects the feature to the destination CRS. Alternatively, a reprojection transformer can be used to control the exact method of reprojection, including horizontal and vertical datum and grid shifts.
	8.1) Is the model oriented correctly with respect to the true North?	Yes The model coordinates are in EPSG:28992 / Netherlands-RDNew-2008 so no further orientation is required.
	9.1) When you import the data, Is it necessary to set the correct CRS manually?	No
	10.1) Is the eventual translation consistent with the CityGML definitions?	Yes
	11.1) Are the hierarchical relationships consistent with the CityGML hierarchy?	Yes. hierarchical relationships are maintained through gml_id, gml_parent_id relations. This can be observed in Fig.4 and Fig.5 above, where the gml_parent_id of the WallSurface is the gml_id of the parent building. Within the feature object structure it can be observed that the geometries belong to the parent feature and the solid and surface geometries are composed of simpler face and polygon geometries many of which have their own gml_ids and properties. These are all consistent with the source GML structures and relationships.
	11.2) short comments to the previous question (optional)	No problems or errors with hierarchical relationships were observed with this dataset. If there were problems with such relationships, often the validate on write would pick them up. When we reran the Task3_Rotterdam_citygml2citygml.fmw with validation = true, no errors where observed. This validation process does not use FME. Rather it invokes the Apache Xerces open source XML parsing library, which has methods for comprehensive checks of XML against applications schemas. Note that if there were problems such as gml_parent_ids on a feature with no feature with that gml_id found in the dataset, the log would show a warning about orphaned features. Also, Geometry Validator can be used to find geometries with null or missing component geometries (null faces for example).
Semantics	12.1) Are the attributes present in the CityGML entities retained and consistent?	Yes. This is proven by the Task3_Rotterdam_citygml2citygml.fmw round trip. No data loss was observed.
	12.2) short comments to the previous question (optional)	I've test with the info found in geoBIM data. We have the same info except for Element 5: eveBIM don't display that it's a lod2MultiSurface
	13.1) Are the relationships between the objects retained?	Yes
	14.1) Is geometry read correctly?	Yes
	Did the normal change?	No. If they were we would likely see inconsistencies with how the source dataset is read and displayed vs how the round trip dataset (created by the round trip workspace) Rotterdam_LoD1_Lod2_fme.gml is displayed.
	16.1) Is it possible to view the model in 3D?	Yes
	17.1) Is it possible to view the model in 2D?	Yes
Geo metr	18.1) Is it possible to edit the model?	Yes
View	18.1.1) What editing is possible (attributes, geometry, georeferencing, please add details)?	FME Data Inspector does not have any edit functionality, so the edit was made in an FME Workspace that reads the whole CityGML file, makes a change and then writes it back out. An AttributeCreator and is used to define new values for the Building attributes and then they are written back out to the destination Building feature type. Edits to geometry traits and names are typically made with GeometryPropertySetter.
	18.2) short comments to the previous question (optional)	For editing individual features there are likely CityGML editors that offer better interactive edit functionality. FME is suitable for rule based edits and updates for groups of features using a workflow defined in a FME workspace.
	17.1) Is it possible to view the model in 2D?	Yes

Editing	18.1) Is it possible to edit the model?	Yes
	18.1.1) What editing is possible (attributes, geometry, georeferencing, please add details)?	FME Data Inspector does not have any edit functionality, so the edit was made in an FME Workspace that reads the whole CityGML file, makes a change and then writes it back out. An AttributeCreator and is used to define new values for the Building attributes and then they are written back out to the destination Building feature type. Edits to geometry traits and names are typically made with GeometryPropertySetter.
Query	19.1) Is it possible to query the model and the attributes?	Yes, attributes
Analysis	20.1) Is it possible to analyse the objects and the model?	Many types of analysis are possible from validation attributes and geometry, to basic statistics such as Volume and Area, to more complex domain specific analysis such as using slope and aspect to compute solar potential for PV. Because of the flexible Workbench interface for developing FME workspace workflows, the types of analysis are only limited by the imagination and expertise of the author. For the purposes of this exercise, given time limitations, the analysis performed was simply a GeometryValidation to analyze Rotterdam citygml geometries for potential problems related to surface and solids
Export	You arrived at the end of the phase 1: "Import and manage the file in the software". Now choose:	The software has also export-to-CityGML abilities
	21.1) Are any pre-processing or setting changes needed in the software to enable a consistent export?	No
	21.2) short comments to the previous question (optional)	CityGML can be saved. It's not an export.
	22) How long does it take for the data to be exported to CityGML?	less then a minute
Test with BuildingsLoD3.gml		
How long does it take, approximately,	Import (and visualise, if the software allows it) the model	it's almost immediate
	Zoom into the model to see more detail	it's almost immediate
	Pan the model	it's almost immediate
	Rotate the model	it's almost immediate
	Query an object	it's almost immediate
	Inspect the objects linked to the queried one through a relationship	it's almost immediate
Export	37) How long does it take for the data to be exported to CityGML?	less than a minute
Final notes		
	Kind of CityGML management possible	• Import • Export (save) • View • Query • Edit • Analysis