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1st Specific Contract No 3436/R0-COPERNICUS/EEA.56731
Implementing Framework Service Contract
No EEA/IDM/R0/16/007/LOT1

Production of Very High Resolution Land cover/Land use datasets.
Reference years 2012 (geographic extension) and 2018 (new) including
change layer 2012-2018

Lot 1 Urban Atlas

Start date: 03-02-2017
End date: 01-02-2019

UA2012 DHM product – London Quality Check Report

Prepared by:

1. SUMMARY

Country	UNITED KINGDOM
City	London
Product name	UK001L2_LONDON _UA2012_DHM
Service provider	GAF AG (Germany)
Project leader	Andreas Uttenthaler
Area [sqkm]	1809 sqkm
Delivery date for QC	22/01/2018
External QC provider	SIRS (France)
Technical QC expert	Julie Payelleville
Reviewer	Sébastien Delbour
Delivery date after QC	09/02/2018

This document summarizes the results of the external Quality Check (QC) performed by SIRS for the high-resolution Digital Height Model (DHM) product covering the core area of the capital city of **London** (UNITED KINGDOM). A sampling approach has been adopted for performing this task and conformity standards applied are based on Urban Atlas specifications as described in *Annex 8 to the Tender Specifications - Detailed Tasks and Product Specifications* (table 6). Especially height information must be estimated within 3 m accuracy threshold.

Overall product acceptance: **YES**

General comment: ***Good product quality*** *without errors detected which significantly impact building height estimates at building block level*

2. FORMAT CONSISTENCY

|	
File format	Raster GeoTIFF 16-bit
Coordinate Reference System (CRS)	ETRS 1989 LAEA (Lambert Azimuthal Equal Area) EPSG 3035
Minimum Mapping Unit (MMU)	10 m x 10 m
Mapping area	Compliant
Attribute definition	Compliant
Height value range (m)	0 – 280 meters
Metadata	INSPIRE compliant

3. SAMPLING DESIGN

Overall classification and height value accuracy assessment is based on sampling units randomly selected. However, the mapping area is split using a reference grid with 5 km unit cell beforehand to set the condition not to select more than one sampling unit per grid cell. This ensures homogeneous

spatial distribution of samples over the whole mapping area. Otherwise, another condition must be respected: sampling units must correspond to Urban Atlas features which are identified as built-up area, also called building blocks. Therefore, sampling units are selected on restricted areas, i.e. polygon features from the following classes:

11100	Continuous Urban Fabric (S.L. > 80%)
11210	Discontinuous Dense Urban Fabric (S.L.: 50% - 80%)
11220	Discontinuous Medium Density Urban Fabric (S.L.: 30% - 50%)
11230	Discontinuous Low Density Urban Fabric (S.L.: 10% - 30%)
11240	Discontinuous Very Low Density Urban Fabric (S.L. < 10%)
11300	Isolated Structures
12100	Industrial, commercial, public, military and private units
12230	Railways and associated land
12300	Port areas
12400	Airports
14100	Green urban areas
14200	Sports and leisure facilities

The number of selected sampling units (or building blocks) for London is **50**.
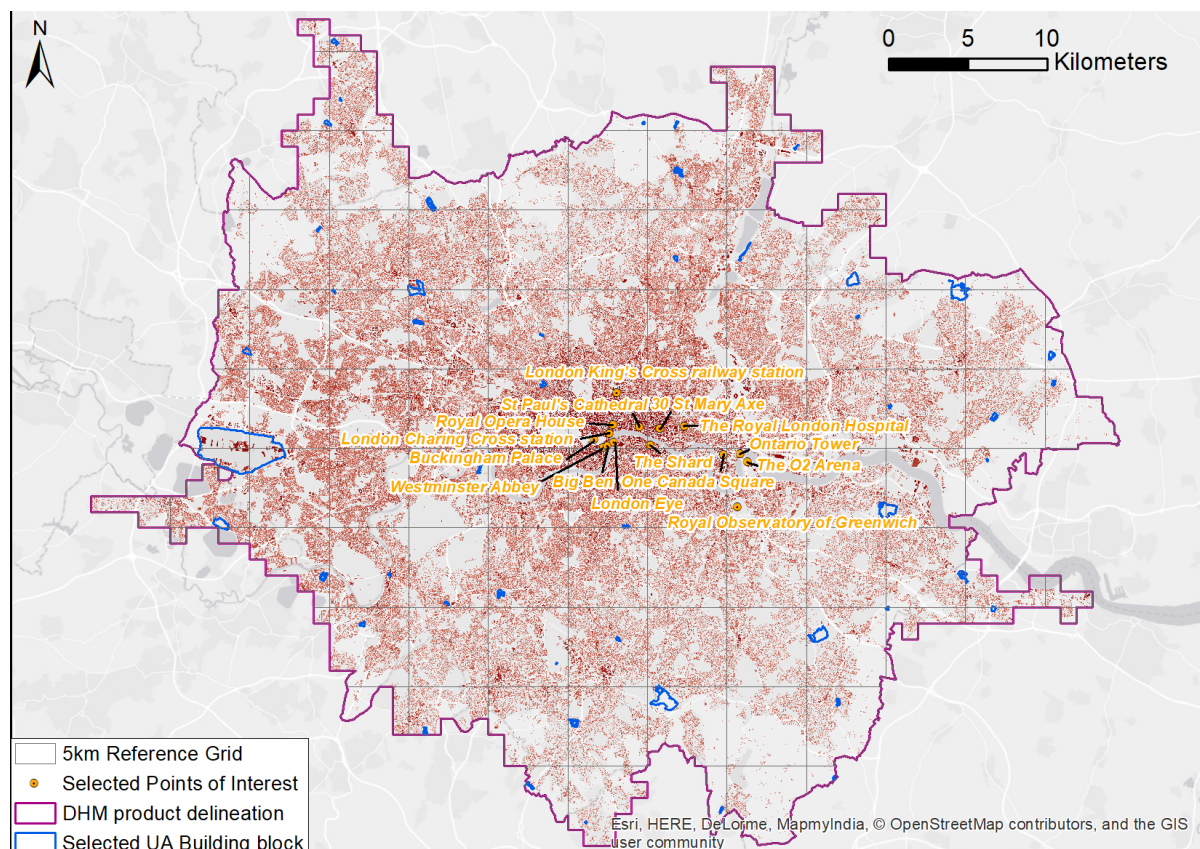
4. ACCURACY ASSESSMENT AT BUILDING LEVEL

Reference input data

- DHM product
- Building footprints from Open Street Map (OSM) or extracted by means of visual interpretation from Google Earth imagery in case of OSM data unavailability
- Google Earth Pro using 3D buildings and Street View mode

Methodology

- Selection of OSM building footprints with area > 100 m² and edge length > 10 m
- Detection of omissions/commissions and critical geolocation accuracy issues regarding building height information by means of visual comparison of DHM product with selected OSM building footprints and Google Earth VHR imagery
- Measurement of maximum building height with 3D Google Earth Pro tool and/or Street View mode by counting the number of building floors (height estimation based on surrounding buildings with height info and shadows if no 3D / Street View available)
- Evaluation of building height information itself (vertical accuracy) by means of comparison of DHM product and reference height values previously estimated with Google Earth Pro tools

Results

The number of sampling units covered by OSM data for London is **9** (building number mentioned in **BLUE**), while the remaining ones (2**7**) have been evaluated based on building footprints manually extracted (**PURPLE**). **7** samples with insufficient OSM or missing important buildings may have additional footprint extracted by CAPI.

Sample ID	Sample UA class	No of buildings	Omissions	Commissions	Geolocation accuracy	Vertical accuracy	Quality Level
35538-UK001L2	11100	1	0	0	✓	✓	✓
37947-UK001L2	11210	4	0	0	✓	✓	✓
40979-UK001L2	11210	1 + 6	0	0	✓	✓	✓
44585-UK001L2	11210	62	0	0	✓	✓	✓
47630-UK001L2	11210	27	5	1*	✓	✓	✓
52949-UK001L2	11210	13 + 42	0	0	✓	✓	✓
62618-UK001L2	11210	20	0	0	✓	✓	✓
62862-UK001L2	11210	9	0	0	✓	✓	✓
64210-UK001L2	11210	17	0	1*	✓	✓	✓
65921-UK001L2	11210	20	0	0	✓	✓	✓
66339-UK001L2	11210	20	0	0	✓	✓	✓
71575-UK001L2	11220	15	0	0	✓	✓	✓
72571-UK001L2	11220	15	0	0	✓	✓	✓
72719-UK001L2	11220	10	0	0	✓	✓	✓
74995-UK001L2	11220	5	0	0	✓	✓	✓
75245-UK001L2	11220	1 + 7	0	0	✓	✓	✓
77127-UK001L2	11220	3	0	0	✓	✓	✓
77904-UK001L2	11220	15	0	0	✓	✓	✓

78467-UK001L2	11220	**10**	0	0	✓	✓	✓
79472-UK001L2	11220	**14**	0	1*	✓	✓	✓
82697-UK001L2	11220	**9**	0	0	✓	✓	✓
83177-UK001L2	11220	**71**	0	1*	✓	✓	✓
84120-UK001L2	11220	**13**	0	0	✓	✓	✓
89986-UK001L2	11230	**10**	0	0	✓	✓	✓
109437-UK001L2	12100	**4**	0	0	✓	✓	✓
110936-UK001L2	12100	**1**	0	0	✓	✓	✓
112206-UK001L2	12100	**6**	0	0	✓	✓	✓
112868-UK001L2	12100	**1**	0	0	✓	✓	✓
112907-UK001L2	12100	**4**	0	0	✓	✓	✓
117791-UK001L2	12100	**1 + 13**	0	0	✓	✓	✓
120350-UK001L2	12100	**26**	0	0	✓	✓	✓
125995-UK001L2	12100	**4**	0	0	✓	✓	✓
126003-UK001L2	12100	**2 + 6**	0	1*	✓	✓	✓
130084-UK001L2	12400	**150**	0	0	✓	✓	✓
132460-UK001L2	14100	**1 + 3**	0	0	✓	✓	✓
134955-UK001L2	14100	**3**	0	0	✓	✓	✓
138011-UK001L2	14200	**1**	0	0	✓	✓	✓
138093-UK001L2	14200	**1 + 2**	0	0	✓	✓	✓
138529-UK001L2	14200	**1**	1	0	✓	-	-**
139244-UK001L2	14200	**3**	0	1*	✓	-	-**
140407-UK001L2	14200	**5**	0	0	✓	✓	✓
140981-UK001L2	14200	**1**	0	0	✓	-	-**
141779-UK001L2	14200	**1**	0	0	✓	✓	✓

* Commission of elements like trees or gardens.

** No 3D or Street View available for evaluate

✓ **Good** (i.e. no or very few errors)

≈ **Medium** (i.e. several errors but not critical in terms of value or amount)

✗ **Poor** (i.e. several critical errors in terms of value or amount)

5. ACCURACY ASSESSMENT AT BUILDING BLOCK LEVEL

Reference input data

- DHM product
- Google Earth Pro using 3D buildings and Street View mode

Methodology

- Report in the attribute table of sampling units (UA building blocks) of the maximum height value from the DHM product by computing zonal statistics
- Conversion of the sampling unit layer in 3D shapefile
- Import in Google Earth Pro and visualization of those UA building blocks in 3D mode

- Vertical accuracy assessment by means of visual comparison of 3D UA building blocks with the top of 3D buildings in Google Earth or using Street View mode for estimating the average building height if no 3D buildings available

Results

Sample ID	Sample UA class	Maximum height value from DHM product [m]	Estimated height value from Google Earth [m]	Absolute height difference [m]	Quality Level
35538-UK001L2	11100	21	20	1	✓
37947-UK001L2	11210	8	8	0	✓
40979-UK001L2	11210	8	8	0	✓
44585-UK001L2	11210	11	8	3	✓
47630-UK001L2	11210	12	10	6	✓
52949-UK001L2	11210	24	22	2	✓
62618-UK001L2	11210	12	10	2	✓
62862-UK001L2	11210	14	15	1	✓
64210-UK001L2	11210	11	10	1	✓
65921-UK001L2	11210	7	8	1	✓
66339-UK001L2	11210	12	9	3	✓
71575-UK001L2	11220	8	9	1	✓
72571-UK001L2	11220	8	9	1	✓
72719-UK001L2	11220	10	9	1	✓
74995-UK001L2	11220	7	8	1	✓
75245-UK001L2	11220	12	9	3	✓
77127-UK001L2	11220	8	7	1	✓
77904-UK001L2	11220	8	9	1	✓
78467-UK001L2	11220	8	8	0	✓
79472-UK001L2	11220	8	10	2	✓
82697-UK001L2	11220	11	10	1	✓
83177-UK001L2	11220	15	12	3	✓
84120-UK001L2	11220	7	9	2	✓
89986-UK001L2	11230	8	9	1	✓
98906-UK001L2	11240	-	-	-	-**
109437-UK001L2	12100	8	7	1	✓
110936-UK001L2	12100	8	6	2	✓
112206-UK001L2	12100	8	9	1	✓
112868-UK001L2	12100	25	25	0	✓
112907-UK001L2	12100	19	16	3	✓
117791-UK001L2	12100	11	9	2	✓
120350-UK001L2	12100	33	30	3	✓
125995-UK001L2	12100	9	6	3	✓
126003-UK001L2	12100	9	6	3	✓
130084-UK001L2	12400	87	84	3	✓
132460-UK001L2	14100	7	7	0	✓
132600-UK001L2	14100	-	-	-	-**

133602-UK001L2	14100	-	-	-	-**
134955-UK001L2	14100	6	5	1	✓
135808-UK001L2	14100	-	-	-	-**
136700-UK001L2	14100	-	-	-	-**
138011-UK001L2	14200	8	8	0	✓
138093-UK001L2	14200	9	8	1	✓
138529-UK001L2	14200	7	-	-	-*
139244-UK001L2	14200	13	-	-	-*
140407-UK001L2	14200	8	8	0	✓
140981-UK001L2	14200	11	-	-	-*
141038-UK001L2	14200	-	-	-	-**
141147-UK001L2	14200	-	-	-	-**
141779-UK001L2	14200	7	4	3	✓

* No 3D or Street View available for evaluate.

** No building to evaluate in this sample.

6. ACCURACY ASSESSMENT FOR LANDMARK BUILDINGS

Reference input data

- DHM product
- Google Earth Pro using 3D buildings and Street View mode

Methodology

Vertical accuracy assessment of a series of landmark buildings by means of comparison of height information from DHM product with the one from 3D buildings in Google Earth or using Street View mode for estimating the building height if no 3D buildings available

Results

Landmark Building	WGS84 coordinates	Height value from DHM product [m]	Estimated height value from Google Earth [m]	Absolute height difference [m]	Quality Level
Buckingham Palace	0° 8.241' W 51° 30.197' N	28	28	0	✓
Westminster Abbey	0° 7.696' W 51° 29.974' N	60	61	1	✓
Big Ben	0° 7.472' W 51° 30.038' N	97	94	3	✓
London Eye	0° 7.151' W 51° 30.196' N	135	135	0	✓
London Charing Cross station	0° 7.471' W 51° 30.479' N	53	56	3	✓
St Paul's Cathedral	0° 5.906' W 51° 30.834' N	110	110	0	✓
30 St Mary Axe	0° 4.814' W 51° 30.864' N	180	180	0	✓
Royal Observatory of Greenwich	0° 0.031' W 51° 28.611' N	13	12	1	✓

The O2 Arena	0° 0.196' E 51° 30.175' N	50	50	0	✔
London King's Cross railway station	0° 7.395' W 51° 31.861' N	31	32	1	✔
Royal Opera House	0° 7.357' W 51° 30.777' N	46	47	1	✔
One Canada Square	0° 1.174' W 51° 30.295' N	235	235	0	✔
The Shard	0° 5.186' W 51° 30.267' N	306	306	0	✔
The Royal London Hospital	0° 3.491' W 51° 31.072' N	90	91	1	✔
Ontario Tower	0° 0.276' W 51° 30.409' N	105	104	1	✔

✔ **Good** (i.e. compliant with the technical specification which is 3 m vertical accuracy)

≈ **Medium** (i.e. out of the technical specification with error between 3 and 6 m)

✘ **Poor** (i.e. out of the technical specification with error superior to 6 m)