SKA1-LOW CONFIGURATION COORDINATES – COMPLETE SET

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1 Purpose

This document, which will be an Applicable Document in the Level 1 Requirements Specification for SKA1, is a full definition of the SKA1-low station coordinates.

2 Context

The document describes the SKA1-low configuration, optimised for a variety of priority science uses, and informed by consultation with potential users of the telescope (see Section 6). The document is based primarily on science and calibration requirements for SKA1-low, as motivated in [4]. It is entirely descriptive and does not provide any motivation.

3 References

The following documents are referenced here. In the event of conflict between the contents of the referenced documents and this document, this document shall take precedence.

[1] 'SKA1 System Baseline Design', P.E. Dewdney, W. Turner, R. Millenaar, R. McCool, J. Lazio, T. J. Cornwell, SKA Document SKA-TEL-SKO-DD-001, Mar 12, 2013.

[2] 'SKA1 Array Configurations', R. Braun and P. E. Dewdney, SKA Document SKA-OFF.AG.CNF-SKO-TN-001, May 16, 2014.

[3] 'SKA1-low Configuration Coordinates', P. E. Dewdney, SKA-TEL-SKO-0000422, Rev 1, Dec. 16, 2015.

[4] 'SKA1-Low Configuration – Constraints & Performance Analysis', P. E. Dewdney, J. Wagg, R. Braun, W. Turner, SKA-TEL-SKO-0000557, Rev A, May 31, 2016.

[5] 'NIMA TR8350.2, Department of Defence World Geodetic System 1984', 3rd Edition Amendment 1, 3 January 2000.

4 Scope

The scope of this document is to build on the definition of station locations consistent with [3]. It

- Provides the locations of all the individual stations,
- Confirms the sizes of stations within defined bounds.

5 Assumptions

The following assumptions are made:

- The total number of antenna elements contained in the SKA1-low array is 131,072.
- The diameter of stations will remain within 45 m. This will be influenced by the area occupied by the antenna elements, which is not yet final, including sufficient area to randomise their positions effectively.[1]

6 Definitions

Station

A circular array of antenna elements that has a clear physical boundary, whose output signals are connected individually to the SKA1-low beam-former.

Station diameter

The diameter of a circle that is a best-fit circle to the outer boundary of the array of antenna elements that make up a station.

Central area

[1] As well as this, there will have to be sufficient space around the antenna elements to access them for servicing.

An area 1700 m in radius with a centre at the centre of the array. This is defined mainly to be consistent with previous documentation.

Core

An area 1000 m in diameter within which the individual stations are randomly located with no overlap.

Cluster

A group of six stations placed randomly around a cluster location, defined for stations outside the core area.

Cluster location

The position of a cluster outside the core area.

Cluster diameter

The diameter of the area within which individual station are located.

7 Description

Reference [1] contains an initial outline of outer station positions for SKA1-low. These were further refined in [2]. The central location in [1] underwent scrutiny in Australia, which resulted in a change in the location for the core that is flood-free and provides protection from potential ASKAP RFI.

As a result of discussions with potential users in Dec, 2015, it became possible to define the locations of clusters of stations. The locations of these clusters, forming an approximate 3-armed spiral, are contained in [3], and are shown in Figure 1.

After similar discussions in Feb, 2016 it became possible to define the sizes and configurations of individual stations. A summary of the result is as follows:

- Individual stations will be 35-45 m in diameter.
- 256 antenna elements will be placed randomly inside each station, which means that there will be 512 stations all together.
- The core, with a diameter of ~1 km will contain a non-overlapping, random configuration of stations.
- Stations will be clustered in groups of 6 outside the core area, randomly placed within an area 100-150 m in diameter at each location[2].
- Each arm of the spiral will contain 16 clusters, including 4 inside the central area.

Small adjustments of the positions of some of the stations are expected, as more detailed surveys and servicing plans are developed and carried out in 2016. Also, if stations become significantly larger because of adjustments made to the size of antenna elements, some station positions within a cluster may have to be adjusted. Any proposed changes will be documented, recorded and assessed in a subsequent engineering change proposal (ECP).

Figure 1 shows the positions of cluster locations outside the central area. Figure 2 is an enlarged view of an area 8 km wide, showing the clusters inside the central area and the stations in the core. Figure 3 is similar, for a 4-km wide area. The positions of individual stations can be seen at this scale. Figure 4 shows the positions of individual stations in the core area. Figure 5 is the same as Figure 4, except that it contains labels. Figure 6 is an expanded view of a typical cluster of stations.

The longitudes and latitudes all the stations and the centre of the array are provided in Appendix I (Table 1), based on the WGS84 system [5].

[2] The final size of stations will depend on the size of the final antenna elements.

A labelling system provides unique identifiers for the stations (see Appendix I):

- Individual stations within the core are given a number.
- Stations in clusters are given a 2-part number. The first part identifies the cluster location; the second part identifies the station within the cluster.
- Clusters labels contain a single letter designating the 'spiral arm' on which they are located, followed by a number from 1-16.
- Station numbering within a cluster location (1-6) in order of South to North (e.g. Figure 6).
- The spiral arm designation is based on the general direction of the outermost part of the spiral, namely 'N' (north), 'E' (east), 'S' (south).

Several of the figures in this document contain these labels.

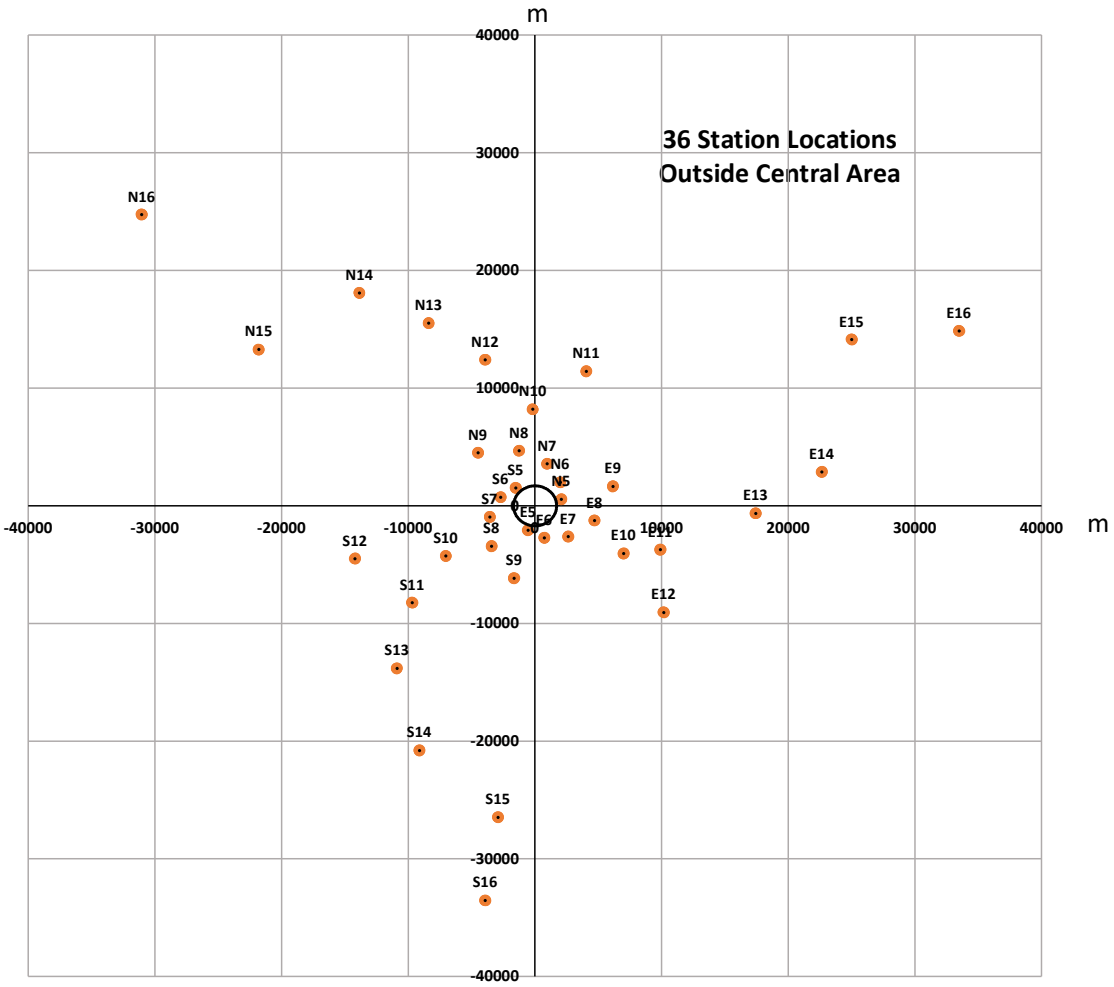

Figure 1: The configuration of the 36 cluster locations outside the central area, 12 on each spiral arm.

Notes:

i. The circle at the centre is the SKA1-low Central Area.
ii. Top is north, right is east.
iii. The scale is metres.
iv. Only the 36 Outer Station locations are shown.
v. The numbering system is discussed in the text.

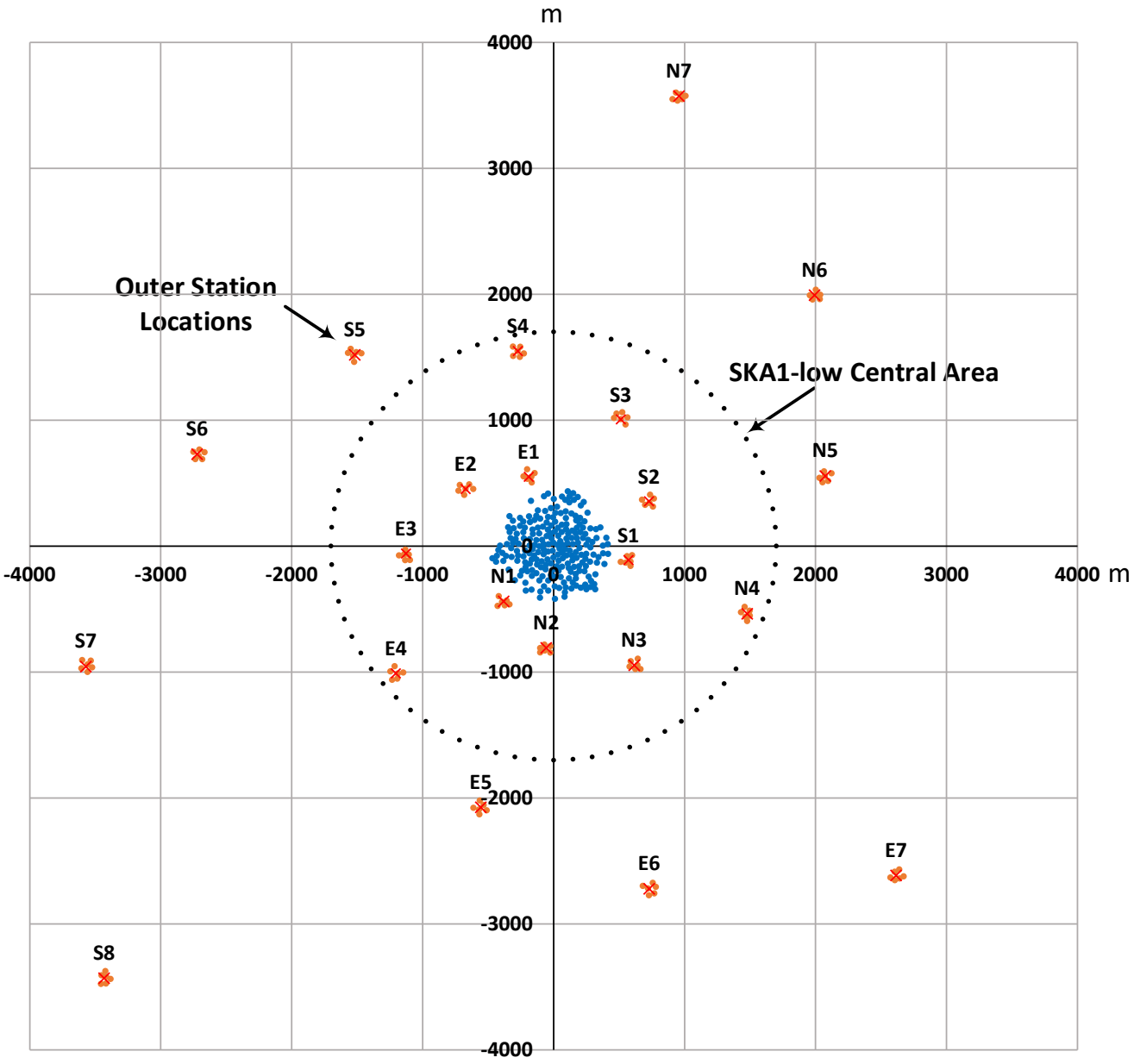

Figure 2: The SKA1-low configuration at a 4 km scale. The central area is bounded by the dotted circle. The red crosses are the positions of the cluster locations.

Notes:

i. Top is north, right is east.
ii. The scale is metres.
iii. The blue dots are stations in the core.
iv. The black dots are clusters of stations within the central area.
v. The orange dots are clusters of outer stations.
vi. The small red crosses are the locations of clusters defined in [3].
vii. The numbering system is discussed in the text.

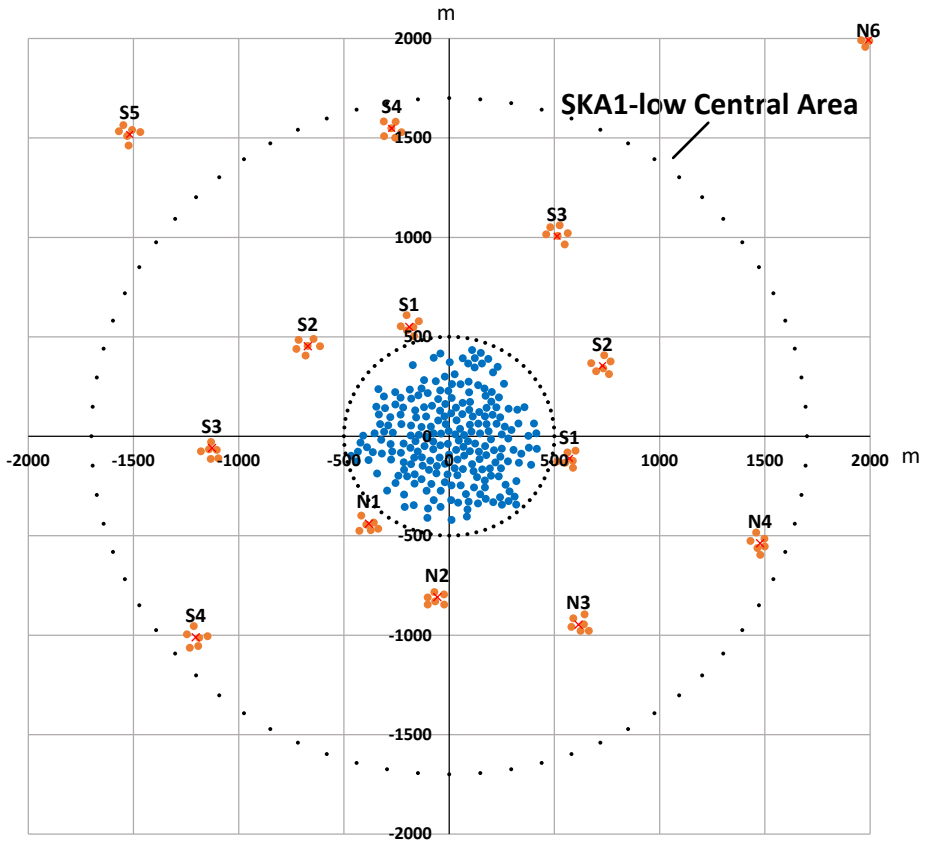

Figure 3: The SKA1-low configuration at a 2 km scale. The central area is shown inside the large dotted circle. The core area is inside the small dotted circle. The red crosses are the positions of the cluster locations.

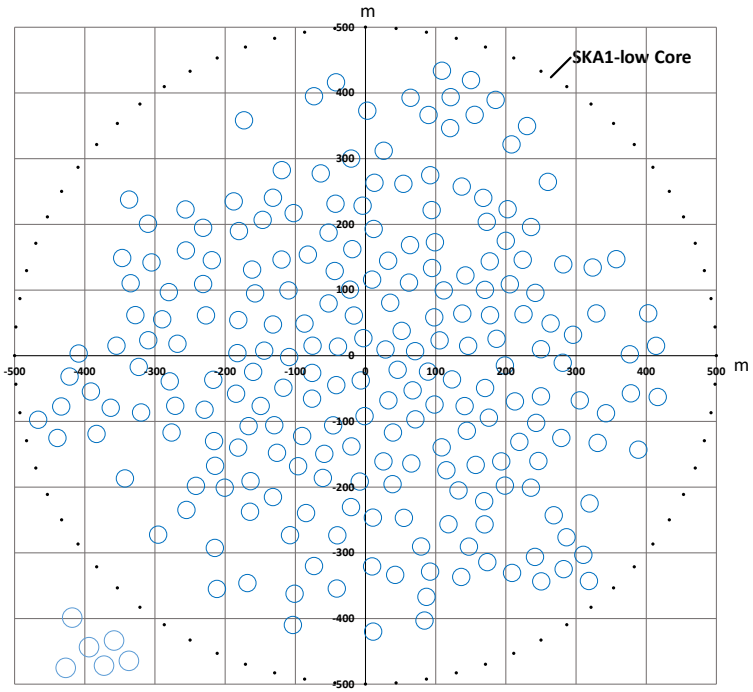

Figure 4: The core area showing the locations of individual stations. One cluster of stations is shown in at the lower left.

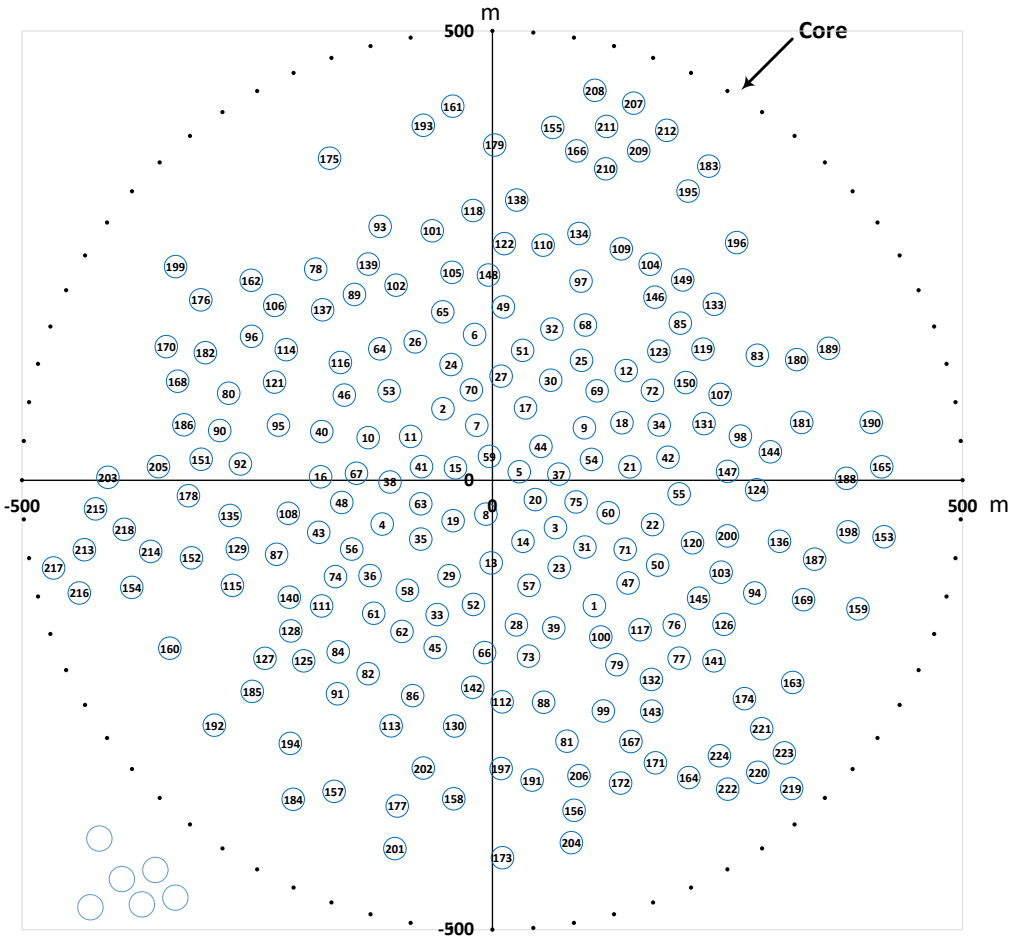

Figure 5: The same as Figure 4 with each station showing a label for each station.

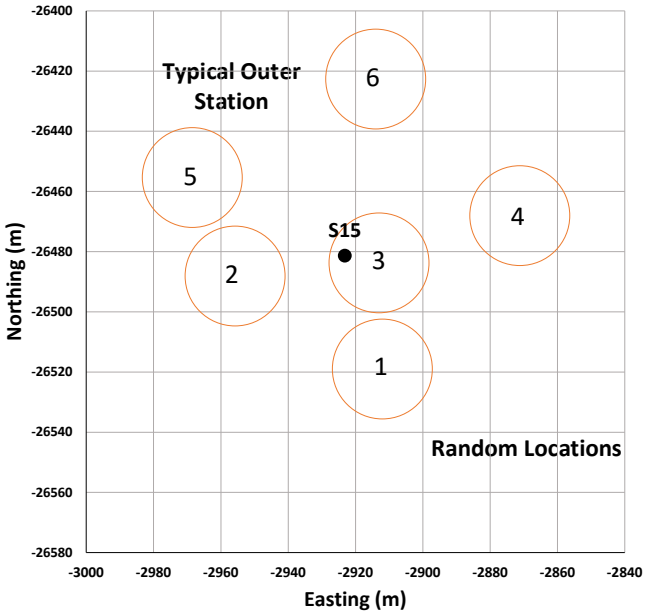

Figure 6: An example of the configuration of an individual cluster, S15 in Figure 1. Each circle is an individual station. The 6 stations in each cluster are randomly located within the cluster and are labelled from south to north.

Appendix I

Table 1 below contains the WGS84[3] referenced set of locations for the SKA1-low Outer Stations, as illustrated in Figure 1 in the main text above.

Table 1: WGS84 Positions of SKA1-low Stations			
Station ID	Label	Longitude	Latitude
0	Array Centre	116.7644482	-26.82472208
1	C1	116.7655399	-26.82598212
2	C2	116.7639199	-26.82400458
3	C3	116.7651234	-26.82519844
4	C4	116.7632707	-26.8251632
5	C5	116.7647362	-26.82463766
6	C6	116.7642597	-26.82325862
7	C7	116.7642824	-26.82416999
8	C8	116.76438	-26.82506289
9	C9	116.7654336	-26.82419534
10	C10	116.7631211	-26.82429413
11	C11	116.7635745	-26.82428184
12	C12	116.7658808	-26.82362068
13	C13	116.7644358	-26.8255531
14	C14	116.7647771	-26.82533563
15	C15	116.764054	-26.82459854
16	C16	116.7626123	-26.82468757
17	C17	116.7648029	-26.82399616
18	C18	116.7658352	-26.82414453
19	C19	116.7640291	-26.82512808
20	C20	116.7649085	-26.82491591
21	C21	116.76592	-26.82458807
22	C22	116.7661627	-26.82516717
23	C23	116.7651635	-26.82559726
24	C24	116.7640078	-26.82355978
25	C25	116.7654027	-26.82351788
26	C26	116.763623	-26.82333348
27	C27	116.7645438	-26.82367721
28	C28	116.7647061	-26.82617453
29	C29	116.7639855	-26.82568058
30	C30	116.7650723	-26.82371812
31	C31	116.7654382	-26.82539298
32	C32	116.7650863	-26.82320406
33	C33	116.7638584	-26.82607063
34	C34	116.7662326	-26.82416669

[3] WGS84 is an Earth-centred, Earth-fixed terrestrial reference system and geodetic datum [5].

35	C35	116.7636826	-26.825313
36	C36	116.7631402	-26.8256788
37	C37	116.7651604	-26.82466117
38	C38	116.7633534	-26.82474063
39	C39	116.7651052	-26.82620429
40	C40	116.7626254	-26.82423371
41	C41	116.7636904	-26.82458619
42	C42	116.7663276	-26.82449107
43	C43	116.7625929	-26.82524526
44	C44	116.7649674	-26.82438176
45	C45	116.7638367	-26.82640251
46	C46	116.7628656	-26.8238663
47	C47	116.7659002	-26.82575495
48	C48	116.7628386	-26.8249453
49	C49	116.7645657	-26.82298227
50	C50	116.7662168	-26.82557408
51	C51	116.7647726	-26.82341861
52	C52	116.7642471	-26.82596996
53	C53	116.7633445	-26.8238249
54	C54	116.7655102	-26.82451286
55	C55	116.7664459	-26.8248581
56	C56	116.7629456	-26.8254135
57	C57	116.7648417	-26.82577849
58	C58	116.7635399	-26.82582645
59	C59	116.7644183	-26.82448199
60	C60	116.7656886	-26.82504806
61	C61	116.7631797	-26.82605715
62	C62	116.7634832	-26.82624136
63	C63	116.763684	-26.82495975
64	C64	116.7632454	-26.82340203
65	C65	116.7639195	-26.82303146
66	C66	116.7643659	-26.82645226
67	C67	116.762996	-26.82465271
68	C68	116.7654434	-26.82316337
69	C69	116.7655698	-26.82382532
70	C70	116.7642254	-26.82381443
71	C71	116.7658689	-26.82541509
72	C72	116.7661605	-26.82381893
73	C73	116.7648361	-26.82648871
74	C74	116.762772	-26.82568999
75	C75	116.7653454	-26.82494098
76	C76	116.7663944	-26.82617565
77	C77	116.7664468	-26.82650837
78	C78	116.7625601	-26.82260188

79	C79	116.7657815	-26.82657439
80	C80	116.7616289	-26.82384839
81	C81	116.7652462	-26.82734339
82	C82	116.7631213	-26.82666532
83	C83	116.7672825	-26.82346752
84	C84	116.7627999	-26.82644619
85	C85	116.7664591	-26.82314495
86	C86	116.7635966	-26.82688522
87	C87	116.7621415	-26.8254654
88	C88	116.764998	-26.82695038
89	C89	116.7629746	-26.82285708
90	C90	116.7615335	-26.82422313
91	C91	116.7627927	-26.82686624
92	C92	116.7617537	-26.82455842
93	C93	116.7632495	-26.82217299
94	C94	116.7672552	-26.82585337
95	C95	116.7621609	-26.82416921
96	C96	116.761874	-26.82327722
97	C97	116.7653964	-26.82272323
98	C98	116.7671022	-26.82427994
99	C99	116.7656369	-26.82703905
100	C100	116.7656085	-26.82629731
101	C101	116.763807	-26.82221824
102	C102	116.7634192	-26.82276293
103	C103	116.7668948	-26.82564607
104	C104	116.7661372	-26.82255359
105	C105	116.7640186	-26.82263542
106	C106	116.7621211	-26.82296638
107	C107	116.7668842	-26.82385968
108	C108	116.7622668	-26.82505449
109	C109	116.7658279	-26.82239906
110	C110	116.7649912	-26.82236118
111	C111	116.7626226	-26.82598492
112	C112	116.7645539	-26.82694785
113	C113	116.7633663	-26.82718924
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185	C185	116.7618808	-26.82684172
186	C186	116.7611495	-26.82416534
187	C187	116.7678962	-26.82551428
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