2007 SPOT BUILDING COUNT UPDATE REPORT

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1 INTRODUCTION

Satellite Remote Sensing can be considered an essential data source of land information as they provide valuable and timely information for interpreting the landscape. Higher spatial resolution satellite imagery and Geographic Information Systems (GIS) offer a cost effective way to plan, monitor and manage, amongst others, settlements growth.

SPOT 5 Satellite offers a higher spatial resolution and swath that allow us to capture the location of dwelling units and any other building structures like schools, churches, shops, etc in formal and less dense areas. This information is captured in a GIS environment. SPOT 5 satellite offers the capability to revisit the same area every 26 days. This allows us to update GIS layers regularly. These layers can be analysed against existing GIS layers and other non spatial data, and can be used for planning, monitoring and managing services such as electricity, to the people.

2 OBJECTIVE

The main objective of this study is to map the location of new dwelling units and electrifiable structure in South Africa off SPOT 2.5m images acquired between 2006 and 2007. This will be done by updating SPOT Building Count base layer that was created using SPOT 2.5m acquired between 2005 and 2006. Once captured, point and density polygon data will be analysed against proclaimed land which is essentially land that is electrifiable and includes areas with existing SG cadastral coverage as well as tribal lands and non proclaimed land which is essentially areas outside of tribal lands and those without SG cadastral coverage.

Eskom will use this data set to identify the electrification backlog in the regions. This data set, together with other geospatial layers and non spatial information will be used to design and plan specific electrification networks. This data set has benefits for other organs of state, such as providing addresses for postal delivery by the South African Post Office, developing an authoritative address register that can be utilised by departments such as Home Affairs, meeting the requirements for FICA, and assisting with the improvement of service delivery at local municipality level.

3 DATA CAPTURING

3.1 METHODOLOGY

2005/6 SPOT Building Count base layer is overlain onto SPOT 2.5m images acquired between 2006 and 2007 in a GIS environment. New dwelling units or building structures are identified by panning the image at 1: 20 000 scale. One found these areas are mapped at 1: 5000 scale. Points are used to map location of dwelling units and building structures while informal dense areas

are represented by polygons. The figures below show some examples of areas where growth occurred between the years of mapping.

Figure 1: SPOT 2.5m image showing growth in rural area

Figure 2: SPOT 2.5m image showing new developments (RDP houses)

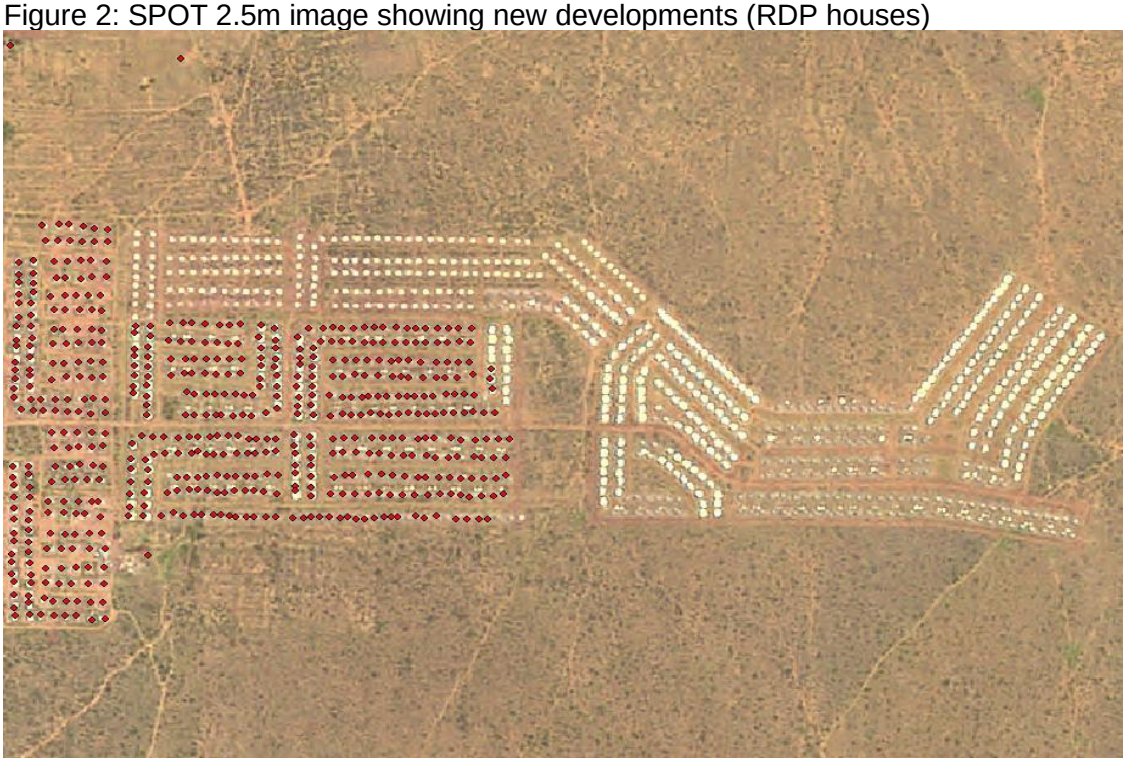
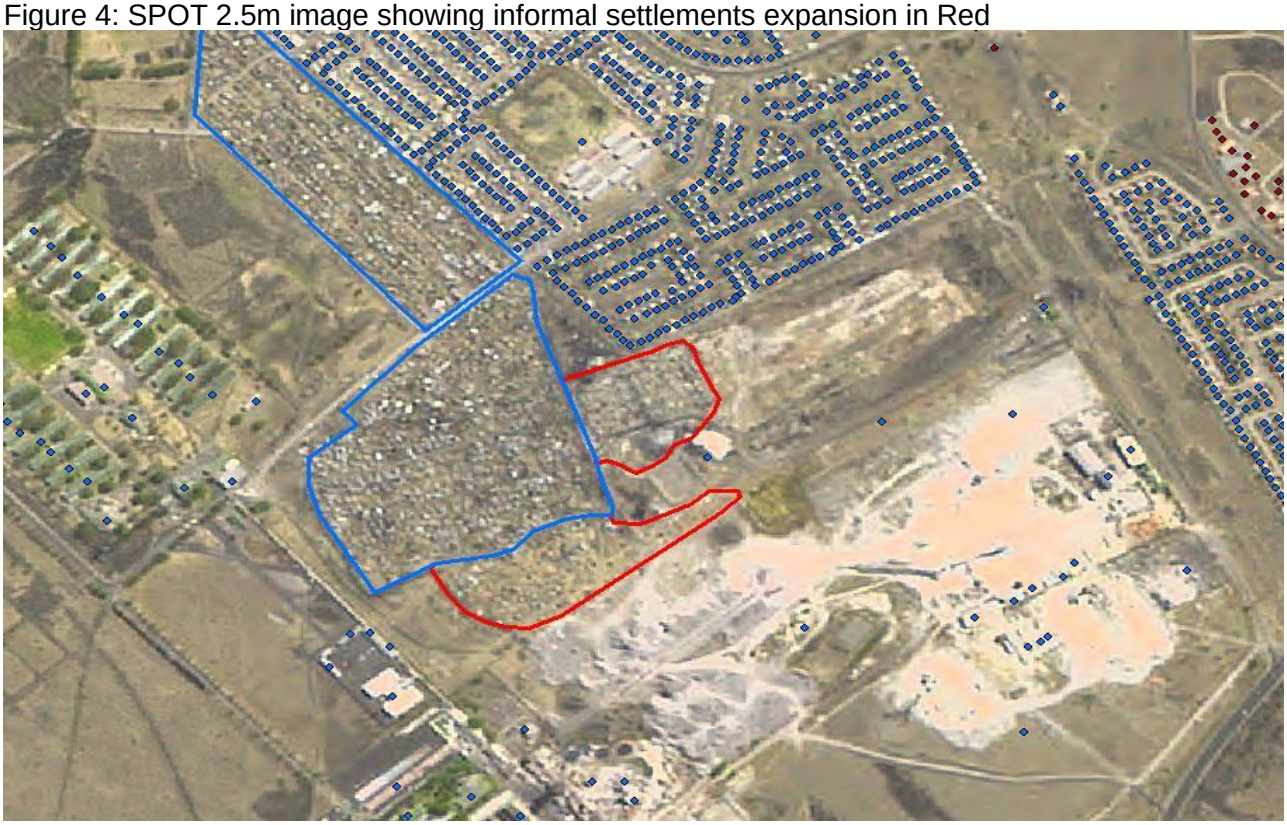


Figure 3: SPOT 2.5m image showing growth in urban area

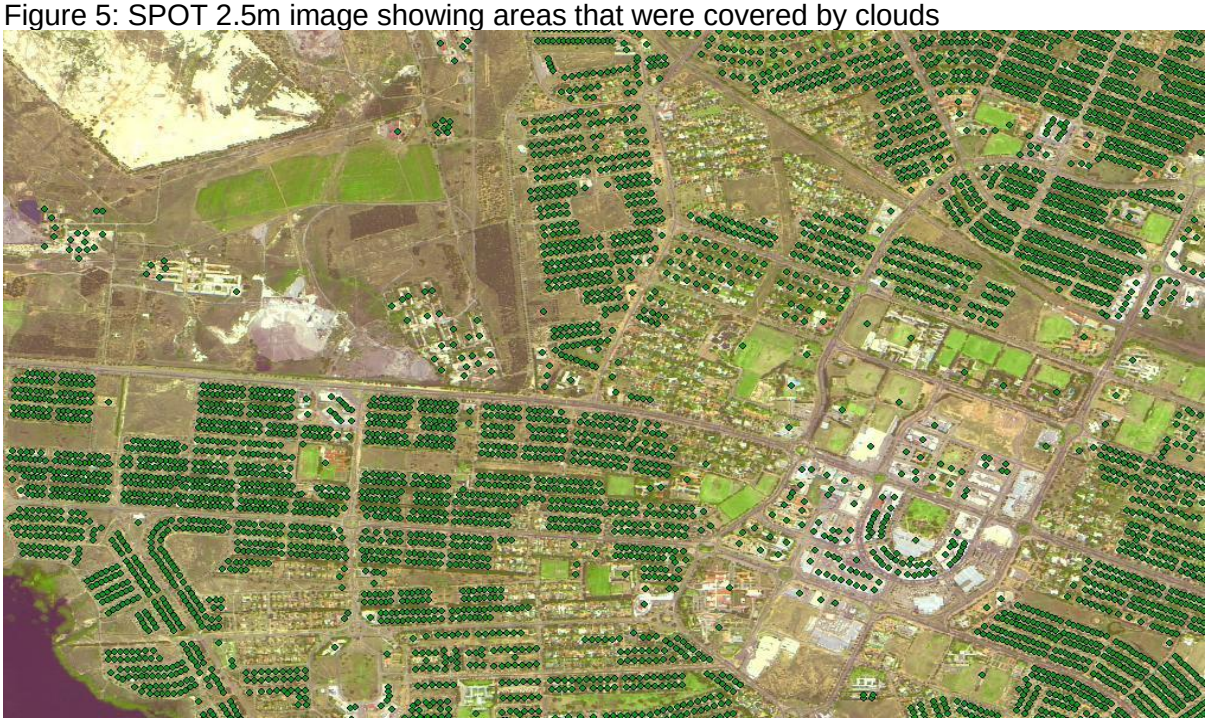
Figure 4: SPOT 2.5m image showing informal settlements expansion in Red



3.2 OTHER AREAS MAPPED

- Areas that were covered by clouds during capturing of 2005/6 SPOT Building Count are also mapped. The figure below shows areas in Welkom that were covered by clouds during the capturing of 2005/6 SPOT Building Count mapping.

Figure 5: SPOT 2.5m image showing areas that were covered by clouds



- Areas where STATSSA points are off the dwellings

Figure 6: new accurate points are mapped in green

3.3 MAPPING RULES

The following general mapping methodologies are applied during the capturing of new dwellings and buildings.

- One point per possible rural housing structure
- One point per individual identifiable building structures in the farms
- One point per grouping of housing structures as found in KZN and Eastern Cape
- One point per formal and informal cadastre polygon, few exception exist based on the accuracy of the cadastral
- One point per school
- One point per individual identifiable building in mines and quarries
- One point per individual identifiable building in resorts
- One point per individual identifiable building in industrial and commercial areas
- One point per one or group of silos
- One point per one or group of reservoirs
- A polygon is mapped around informal dense areas

The following structures are classified

1. School
2. Complex/Hostel
3. Mine/Quarry
4. Resort

3.4 CLASSIFICATION OF EXISTING POINTS AND POLYGONS

A new field was added in the base layer attribute table where all 2005/6 points and polygons representing dwellings that were relocated or no longer exist in 2006/7, are labelled with a 1. These areas are extracted from the base layer and can be used to identify areas where dwelling units or buildings were demolished.

Figure 6: SPOT 2.5 2007 image showing where people were relocated because of the expansion of the mine

Areas where there were errors of commission during the capturing of 2005/6 SPOT Building Count base layer are also flagged with a 1 under “2007update” field in the attribute table, see example in the figure below

Figure 7: Green represents error of commission during the capturing of the base layer

Areas where STATSSA points are not accurately representing the image are also labelled with a 1, see figure below

Figure 8: 2007 SPOT image showing STATSSA points that are flagged

Areas where there is a shift between the images acquired in 2005/6 and 2006/7 are also extracted and flagged with a 2. The shift is caused by difference in position error between two images of the same area acquired at different times, see figure below:

Figure 8: 2007 images showing where points are shifted by few meters from the dwellings.

4 RESULTS AND ANALYSIS

4.1 RESULTS ATTRIBUTES

All the points and polygons layers are saved as shapefiles, (.shp) and linked to an attribute with the following common fields:

Table1

Field name	Description
FID	feature ID, Automatically created in ArcGIS
Shape	point/polygon
CLASS_NAME	class name
BASE_YEAR	Year feature was captured and included
ESKOM_FSA	Eskom Field Service Area
ESKOM_RED	Name of regional electricity distributor
PROV	province
MUNIC	local municipality
ESKOM FSA	Eskom Field Service Area
TRIBAL_AUT	tribal authority
PROCLAIMED	points or polygons intersect that intersect with any cadastral boundary
INT_ERVEN	points or polygons intersect with urban cadastral boundary
INT_FARM	points or polygons intersect with farm cadastral boundary
INT_FARMPN	points or polygons intersect with farm portion cadastral boundary
INT_AGRHLD	points or polygons intersect with agricultural holding cadastral boundary
INT_PARK	points or polygons intersect with park cadastral boundary
INT_TA	points or polygons intersect with tribal authority cadastral boundary
SUB_HV_DES	name of high voltage substation within 450m buffer
SUB_MV_DES	name of medium voltage substation within 450m buffer
TRNFM_NAME	name of the transformer within 450m buffer

4.2 ANALYSIS OF THE RESULTS

The results show that 374 463 new dwellings units and building structures, and 107 dense informal settlements exist between the years of mapping. This represents about 3.35% growth, excluding informal settlements expansions.

About 19% growth occurred in Vryburg FSA, whereas Port Elizabeth and Groblersdal have less than one percent growth.

95.60 % of 374 463 new dwellings mapped are proclaimed, i.e. they intersect with one or more cadastral boundaries.

About 1% of the previously mapped dwelling/buildings were demolished or do not exist on 2006/7 images. The majority of these dwelling units/structures

were errors of commission during the mapping of the base layer, as shown in Figure 7. The analysis of the results is shown in the tables below.

Table 2

ESKOM_FSA	Existing dwellings/buildings	Existing dense polygons	New Dwellings/buildings	New dense polygons	non existing dwellings/buildings	non existing dense polygons
Bellville	601470	509	13218	0	9465	108
Benoni	346813	2378	4963	1	2050	33
Bethlehem	298452	0	6563	0	911	0
Bloemfontein	293514	57	10834	16	9626	4
East London	388899	11	36644	0	10584	0
Empangeni	414740	1	10565	0	608	0
George	176506	43	10122	5	9058	0
Groblersdal	226284	0	1335	0	1077	0
Hazyview	238844	0	5059	0	5390	0
Kimberly	119683	37	1516	22	1516	0
Klerksdorp	215374	45	10255	11	3286	0
Margate	406708	15	25926	2	2425	0
Mmabatho	237489	0	2416	4	1227	0
Mthatha	397934	8	17486	0	1850	0
Nelspruit	267395	0	10106	0	365	0
Newcastle	350756	1	22802	0	811	0
Nigel	202567	0	4581	0	5016	0
Pietermaritzburg	876801	4	31295	5	7490	0
Pietersburg	465962	41	7296	0	1541	0
Port Elizabeth	400910	88	10461	1	3658	0
Pretoria	529101	3842	4265	0	4845	0
Queenstown	234253	0	3883	0	721	0
Randfontein	211550	2199	4983	5	5475	37
Rustenburg	184733	23	10199	7	429	0
Sandton	98802	420	2889	1	602	0
Secunda	148951	60	6630	0	635	8
Soweto	258396	269	9109	0	543	0
Thohoyandou	317320	0	16454	0	862	0
Tzaneen	373985	1	10216	0	554	0
Vereeniging	151712	4226	6115	0	1739	777
Vryburg	113691	2	27606	0	6	0
Warmbad	172911	0	3155	4	5415	0
Welkom	150061	50	3463	1	816	0
West Coast	178605	37	8557	0	1586	6
Witbank	172626	31	6104	14	1896	0
Worcester	103637	25	7392	8	2547	0
Total	10327435	14423	374463	107	106625	973
RED						
Northern	3098112	3998	80801	25	23009	0
Eastern	2049005	21	90588	7	11334	0
Central	1287014	7161	63372	21	12878	822
Southern	1421996	107	68474	1	16813	0
North Western	1411090	2522	31937	40	19935	36

Western	1060218	614	39289	13	22656	114	

Table 3

ESKOM_FSA	New Dwellings	Total Proclamed	% Proclaimed
Bellville	13218	11089	83.89
Benoni	4963	4921	99.15
Bethlehem	6563	6407	97.62
Bloemfontein	10834	10680	98.58
East London	36644	31585	86.19
Empangeni	10565	10536	99.73
George	10122	9990	98.70
Groblersdal	1335	1311	98.20
Hazyview	5059	5055	99.92
Kimberly	1516	1516	100.00
Klerksdorp	10255	10255	100.00
Margate	25926	24865	95.91
Mmabatho	2416	2371	98.14
Mthatha	17486	16473	94.21
Nelspruit	10106	10007	99.02
Newcastle	22802	22579	99.02
Nigel	4581	4550	99.32
Pietermaritzburg	31295	31100	99.38
Pietersburg	7296	7282	99.81
Port Elizabeth	10461	9363	89.50
Pretoria	4265	4201	98.50
Queenstown	3883	3552	91.48
Randfontein	4983	4928	98.90
Rustenburg	10199	10198	99.99
Sandton	2889	2874	99.48
Secunda	6630	6630	100.00
Soweto	9109	8959	98.35
Thohoyandou	16454	16268	98.87
Tzaneen	10216	10170	99.55
Vereeniging	6115	6083	99.48
Vryburg	27606	27510	99.65
Warmbad	3155	3150	99.84
Welkom	3463	3439	99.31
West Coast	8557	5428	63.43
Witbank	6104	6104	100.00
Worcester	7392	6558	88.72
Total	374463	357987	95.60
Northern	80801	80358	99.45
Eastern	90588	89080	98.34
Central	63372	62979	99.38
Southern	68474	60973	89.05
North Western	31937	31531	98.73
Western	39289	33065	84.16

Table 4

ESKOM_FSA	2006/7Total Dwellings/buidings	2006/7dense polygons	% growth, excluding info.dense
Bellville	605223	401	2.18
Benoni	349726	2346	1.42
Bethlehem	304104	0	2.16
Bloemfontein	294722	69	3.68
East London	414959	11	8.83
Empangeni	424697	1	2.49
George	177570	48	5.70
Groblersdal	226542	0	0.59
Hazyview	238513	0	2.12
Kimberly	119683	59	1.27
Klerksdorp	222343	56	4.61
Margate	430209	17	6.03
Mmabatho	238678	4	1.01
Mthatha	413570	8	4.23
Nelspruit	277136	0	3.65
Newcastle	372747	1	6.12
Nigel	202132	0	2.27
Pietermaritzburg	900606	9	3.47
Pietersburg	471717	41	1.55
Port Elizabeth	407713	89	2.57
Pretoria	528521	3842	0.81
Queenstown	237415	0	1.64
Randfontein	211058	2167	2.36
Rustenburg	194503	30	5.24
Sandton	101089	421	2.86
Secunda	154946	52	4.28
Soweto	266962	269	3.41
Thohoyandou	332912	0	4.94
Tzaneen	383647	1	2.66
Vereeniging	156088	3449	3.92
Vryburg	141291	2	19.54
Warmbad	170651	4	1.85
Welkom	152708	51	2.27
West Coast	185576	31	4.61
Witbank	176834	45	3.45
Worcester	108482	33	6.81
	10595273	13557	3.53
Reds			
Northern	3155904	4023	2.56
Eastern	2128259	28	4.26
Central	1337508	6360	4.74
Southern	1473657	108	4.65
North Western	1423092	2526	2.24
Western	1076851	513	3.65

5 QUALITY ASSURANCE

Quality assurance is done to quantify the accuracy of the product. An independent consultant was appointed to conduct this exercise. About 11646 random points were created inside the urban, rural and peri urban buffered layers. Areas where the errors of commission and omission were high were corrected.

1.5 square km grid is created around each random point. Table 5 below shows the amount of random points that will be used during the analysis

Table 5

Sample	Number of points	Area per point (km^2)	Total Area Sampled (km^2)	Total Urban SA (km^2)	% sampled
Urban Sample	545	1.5	817.5	7206	11.34
Rural Sample	5420	1.5	8130.0	1143481	0.71
Peri Urban Sample	5772	1.5	8658	127633	6.78

Figures 9 – 11 below shows examples of areas checked

Figure 9: peri urban sample

Figure 10: Rural sample

Figure 11: urban sample

The errors of commission and omission are calculated inside each grid. Error of commission is determined by the number of points mapped where there are no structures, whereas omission is determined by the number of dwelling units/ structures that are not mapped. The quality assurance results are shown in the tables below:

Table 6

Urban Sample

ESKOM FSA	Omission (%)	Commission (%)	Number of points checked
Bellville FSA	0	0.34	13
Benoni FSA	0.23	0.26	23
Bethlehem FSA	0.18	0.31	13
Bloemfontein FSA	0.19	0	16
East London FSA	0	0	26
Empangeni FSA	0.01	0.98	16
George FSA	0	0	2
Groblersdal FSA	0.17	0.51	7
Hazyview FSA	0	0	0
Kimberley FSA	0	0.39	8
Klerksdorp FSA	0.1	0.66	7
Margate FSA	0.41	1.11	8
Mmabatho FSA	0.044	0.89	10
Mthatha FSA	0.13	0.91	6
Nelspruit FSA	1.34	0	4

Newcastle FSA	0.15	1.01	30
Nigel FSA	0	0.29	6
Pietermaritzburg FSA	0	0	51
Pietersburg FSA	0.06	0.69	46
Port Elizabeth FSA	0.11	0.02	18
Pretoria FSA	0.01	0	34
Queenstown FSA	0.11	0.47	4
Randfontein FSA	0.24	0	12
Sandton FSA	0	0	12
Secunda FSA	0	1.20	6
Soweto FSA	0	0	22
Tzaneen FSA	0	0	1
Vereeniging FSA	0.39	0	12
Vryburg FSA	0	0.69	11
Warmbad FSA	0	0.53	12
Welkom FSA	0	0.79	4
West Coast FSA	0	0.8	6
Witbank FSA	0.18	0.57	4
Worcester FSA	0.23	0.75	4
	0.12	0.42	454

Table 7

Periurban Sample

ESKOM FSA	Omission (%)	Commission (%)	Number of points checked
Bellville FSA	0.078	0.062	120
Benoni FSA	0.25	0	44
Bethlehem FSA	0.43	1.37	167
Bloemfontein FSA	0.24	0	309
East London FSA	0	0	372
Empangeni FSA	0.58	0.44	191
George FSA	0.6	1.29	189
Groblersdal FSA	0.42	1.27	169
Hazyview FSA	2.11	15.4	32
Kimberley FSA	0.13	0.31	167
Klerksdorp FSA	0.19	0.12	141
Margate FSA	0.38	1.12	133
Mmabatho FSA	0.098	0.94	185
Mthatha FSA	0.72	1.87	187
Nelspruit FSA	0.63	0.14	104
Newcastle FSA	0.42	0.88	361
Nigel FSA	0.16	0.04	96
Pietermaritzburg FSA	0.03	0.09	191
Pietersburg FSA	1.17	1.03	530
Port Elizabeth FSA	0.21	1.29	243
Pretoria FSA	0.28	0.28	164
Queenstown FSA	0.50	1.16	258

Randfontein FSA	0.19	0	73
Sandton FSA	0.57	0.57	12
Secunda FSA	0.47	1.03	111
Soweto FSA	0.71	0	7
Tzaneen FSA	0.14	0.74	138
Vereeniging FSA	0	0	49
Vryburg FSA	0.13	0	205
Warmbad FSA	0.73	3	168
Welkom FSA	0	0.25	123
West Coast FSA	0.36	0.72	256
Witbank FSA	0.57	1.17	125
Worcester FSA	0.1	1.12	152
	0.4	1.11	5772

Table 8

Rural Sample

ESKOM FSA	Omission (%)	Commission (%)	Number of points checked
Bellville FSA	0	0.34	13
Benoni FSA	0	0	6
Bethlehem FSA	0.38	14.94	200
Bloemfontein FSA	0	0.38	448
East London FSA	0	0	55
Empangeni FSA	2.26	0.72	152
George FSA	0.48	0	556
Groblersdal FSA	0.31	1.38	31
Hazyview FSA	1.68	1.12	58
Kimberley FSA	0	0	397
Klerksdorp FSA	0	0.75	92
Margate FSA	0.064	2.84	99
Mmabatho FSA	0.33	1.64	188
Mthatha FSA	1.26	4.42	126
Nelspruit FSA	0.94	1.41	52
Newcastle FSA	0.35	0	133
Nigel FSA	0	1.35	24
Pietermaritzburg FSA	0	0	95
Pietersburg FSA	0	2.86	46
Port Elizabeth FSA	0	0	235
Pretoria FSA	0.66	0	32
Queenstown FSA	0.61	2.83	309

Randfontein FSA	0	0	11
Sandton FSA	0	0	1
Secunda FSA	0.48	4.55	75
Soweto FSA	0	0	
Tzaneen FSA	1.23	2.18	133
Vereeniging FSA	0	0	2
Vryburg FSA	0	0	307
Warmbad FSA	1.08	8.67	173
Welkom FSA	0	0	90
West Coast FSA	0.25	0.25	1020
Witbank FSA	3.26	17.39	65
Worcester FSA	0	0	196
	0.46	2.06	5420

6 CONCLUSION

The updated dwelling units or structures layer can be used as a planning tool for electrifications projects and also determine the electrification backlog. This data can also be used to monitor current projects and identify any substation overload.

Government departments and local municipalities can use this data as a supporting tool in making decisions affecting service delivery in the country. Private industries can also use this data to make informed decisions about their services.