



Delivery Report Denmark

EEA-FTSP-Sealing_CountryDeliveryReport-DK

Issue 1.1

Date Issued: 05.12.2007

European Environment Agency



Service Contract No. 3601/B2007.EEA.52942

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Document Release Sheet

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Distribution:	European Environment Agency		

Change Record

<i>Issue/Rev</i>	<i>Date</i>	<i>Page(s)</i>	<i>Description of Change</i>	<i>Release</i>
-	20.11.07	18	Release of issue 1	F1v0
F1v0	05.12.07	5,6,14	Sealing product and Image2006 Deviation shape file of Denmark delivered in one projection zone (UTM32)	F1v1

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1 INTRODUCTION

1.1 PURPOSE AND SCOPE

This document presents the country delivery report of EEA's Fast Track Service Precursor Sealing Product of Denmark.

According to the Tender Specifications, this report corresponds to deliverable 5 (38 Country delivery reports).

1.2 APPLICABLE DOCUMENTS

ITD-0490-PRO-0006	Proposal responding to EEA's Invitation for Tender, Technical Offer including Management Part –Issue 1

1.3 REFERENCE DOCUMENTS

EEA/IDS/07/001	Tender Specifications "GMES Fast Track Service on Land Monitoring", EEA, 2006
ISO9001	ISO 9001: 2000 Standard
ITD-QMS-POL-0001_Infoterra_Quality_Policy	Quality Policy Statement
QMS-ITD-MA-0011_QMSManual_I3.1	Quality Management System (QMS) Manual
ITD-UMS-POL-0001_Infoterra_Environmental_Policy	Declaration of Enterprise Environmental Policy
ITD-QMS-STD-0001-ControlOfDocumentation	Control of Documentation and Data
QMS-ITD-ST-0001_CSM	Customer Satisfaction Measurement
QMS-ITD-PR-0003_PM_ProductDevelopment_I4	Project Management, Product (Prototype) Development and Production

2 DATA SPECIFICATIONS

2.1 TECHNICAL PRODUCT SPECIFICATION

Content
<i>Raster dataset of built-up and non built-up areas including continuous degree of soil sealing ranging from 0 - 100% in full spatial resolution (20 x 20 m) with the associated metadata.</i>
Geographic coverage
<i>Denmark (DK)</i>
<i>Coverage [km²]: 43.094 km² (plus additional buffer of 200 meters outside of country border)</i>
Input data sources
<p><u>Input data provided by ESA:</u></p> <ul style="list-style-type: none"> ▪ <i>Orthorectified satellite data coverage for Europe (Image2006), acquired primarily in the reference year 2006 (+/- 1 year), covering two dates, used sensors SPOT 4 and 5 (HRVIR) and IRS-P6 LISS-III:</i> <ul style="list-style-type: none"> • <i>20 m resampled (with cubic convolution interpolation)</i> • <i>4 spectral bands</i> • <i>Max. 5% cloud coverage</i> • <i>Covering 2 dates, at least 6 weeks apart from the respect. scene selected for the first coverage</i> • <i>Orthorectified towards national projection systems (used DTM unknown)</i> • <i>Delivery on a country by country basis foreseen</i> • <i>Metadata to each scene</i> <p><u>Input data provided by EEA</u></p> <ul style="list-style-type: none"> ▪ <i>Dataset with national country borders (to be used for clipping the data at a national level) as defined and provided by the EEA</i> <p><u>Ancillary input data</u></p> <ul style="list-style-type: none"> ▪ <i>National Corine Land Cover 2000 data in vector format to be used for the stratification of the QA sample plots</i>
Methodology
<i>Supervised classification of built-up areas with following visual improvement of classification result and derivation of degree of soil sealing based on calibrated NDVI</i>
Geometric resolution
<i>Pixel resolution 20 x 20 m</i>

Coordinate Reference System
<i>Universal Transverse Mercator – UTM32</i>
<i>False_Easting: 500000,000000</i>
<i>False_Northing: 0,000000</i>
<i>Central_Meridian: 9,000000</i>
<i>Latitude_Of_Origin: 0,000000</i>
<i>Scale_Factor: 0,9996</i>
<i>Datum: D_WGS_1984</i>
Geometric accuracy (positioning scale)
<i>According to orthorectified satellite image base delivered by ESA</i>
Thematic accuracy (in %)
<i>Classification accuracy per hectare (based on 100 x 100 m grid) of built-up non built-up areas is > 85% (assessed according approach as described in chapter 4.1)</i>
Accuracy assessment approach
<i>Accuracy assessment based on random sample plots</i>
Delivery format
<i>IMAGINE Image (IMG)</i>
Data type
<i>Raster</i>
Raster coding
<i>Thematic pixel values</i>
<i>0 – Non-built up areas, water bodies inland</i>
<i>1-100 - sealing values for built-up areas</i>
<i>254 – Unclassifiable areas (clouds, shadows, etc.)</i>
<i>255 – No Data (No thematic information)</i>
Metadata
<i>According to EEA metadata standards (EEA MSGI specification)</i>
Ancillary Data – Mitigation shape file
<i>Metadata set per delivered country in vector format defining all areas which deviate from the ITT's EO data specifications (i.e. clouds, acquisition date). The vector layer is derived from image footprints and cloud cover information of Image2006 within the country border.</i>
<i>The attribute table contains information about WU identification and possible deviations from the standard specifications of Image2006:</i>
<ul style="list-style-type: none"> <i>[Cntr] Country Code;</i>

- *[SCU]* Number of Sub-Country unit containing the Working Unit;
- *[WU_ID]* Full name of the Working Unit;
- *[No_acqu]* Number of acquisitions within the WU; 0 = gap / no image available;
- *[Out_Veg]* No of acquisition dates outside of country-specific vegetation period;
- *[Below_6w]* Acquisition dates less than 6 weeks apart;
- *[Cloud_cov]* Thematic value indicating the cloud coverage: No clouds = 1; Clouds present in coverage 1 = 2; Clouds present in Coverage 2 = 3; Clouds present in both coverages = 4

2.2 ALGORITHMS USED

The aim of the image processing is to derive in a robust, reliable and reproducible way based on satellite images (Spot 4/5, IRS LISS) a raster dataset of built-up and non built-up areas including continuous degree of soil sealing ranging from 0 - 100% in full spatial resolution (20 x 20 m).

As the main challenge, the derivation of a continuous degree of soil sealing has to be solved. The proposed image processing approach is based on the fact that a reliable derivation of soil sealing degrees is not possible directly from the vegetation index. Low vegetation index values, which are characteristic for densely built-up areas are e.g. also found in bare soil areas of agricultural fields. Even when using multi-temporal satellite images with different acquisition dates in combination with bi-temporal, multi-spectral classification techniques the result may be improved, but the vegetation indices of two acquisitions are still too ambiguous.

Therefore, the proposed image processing approach will start with deriving a binary map of built-up areas and then further subdivide this area into 100 degrees of soil sealing, ranging from totally sealed surfaces (100% degree of soil sealing) up to built-up areas with extensive vegetation cover (1% degree of soil sealing). This allows the final user to aggregate the continuous values as required.

To be viable for this objective the classification methodology has to fulfil the following general criteria:

- Allow for local calibration of parameters used per working sub-area (as defined by satellite images) to overcome diversity of different regions in Europe and image immanent characteristics (such compensating for different settlement structures, ecozones, phonological and weather conditions).
- Deliver the required accuracy
- Maximise consistency and objectivity of the results all over Europe
- Maximise cost-efficiency under given constraints
- Maximise standardisation of production and working motivation of the analysts
- Secure realisation in due time.

Based on these criteria, the proposed methodological approach consists of the following main steps:

- a) Data preparation & management: Provision of spatial database of bi-temporal satellite images and derived working sub-areas ("Working Units" = WU) to be processed in the following steps
- b) Core processing, containing the 3 main processing steps:
 - (1) Hybrid automated classification with supervised and unsupervised elements, leading to binary maps of built-up area
 - (2) Manual correction of the binary built-up map to obtain the required quantitative thematic accuracy (85%) as well as good qualitative results
 - (3) Derivation of degree of soil sealing based on the NDVI (Normalised Difference Vegetation Index)
- c) Generation of sub-country / country data sets
- d) Accuracy assessment
- e) Re-projection & mosaicing, generation of seamless European dataset.

2.3 FORMAT DESCRIPTION

Delivery format
<i>ERDAS IMAGINE Image (IMG)</i> <i>Data Type: unsigned 8-bit</i> <i>Compression: Run-length encoding (ESRI)</i> <i>Number of bands: 1</i> <i>Pixel size: 20 m</i>
Data type
<i>Thematic Raster</i>
Metadata
<i>According to EEA metadata standards (EEA MSGI specification)</i>

2.4 METADATA

See European Environment Agency – Metadata Standard for Geographic Information (EEA-MSGI), Version 1.1a (18 August 2004).

The metadata is provided as XML-file and as PDF-document according to EEA Metadata Standard for Geographic Information (EEA-MSGI).

3 SUMMARY OF PRODUCTION

3.1 TIMETABLE, PRODUCTION MILESTONES

Delivery by ESA	Data Reception	Data Preparation		Received by SP	Production	
		Start	End		Start	End
09.07.2007	10.07.2007	11.07.2007	16.08.2007	16.08.2007	17.08.2007	19.10.2007

3.2 TECHNICAL PROBLEMS ENCOUNTERED, MITIGATION MEASURES

The technical discussion between the service providers and EEA of how to handle IMAGE2006 data which is not according to the ITT's specification (e.g. concerning cloud cover, acquisition dates), was ongoing during the entire production process of the soil sealing product for Denmark. Consequently, the final decision to implement the cloud coverage in the mitigation shape file came after the finalization of the raster product, thus cloud cover information was not included in the process of classification. A manually derived cloud mask is included in the mitigation shape file, however.

One gap with missing EO data was identified during the production process. The missing data has been requested from Metria and was used to classify the remaining area subsequently.

4 ACCURACY ASSESSMENT REPORT

4.1 DESCRIPTION OF APPROACH

The derivation of accuracy measures includes the following steps:

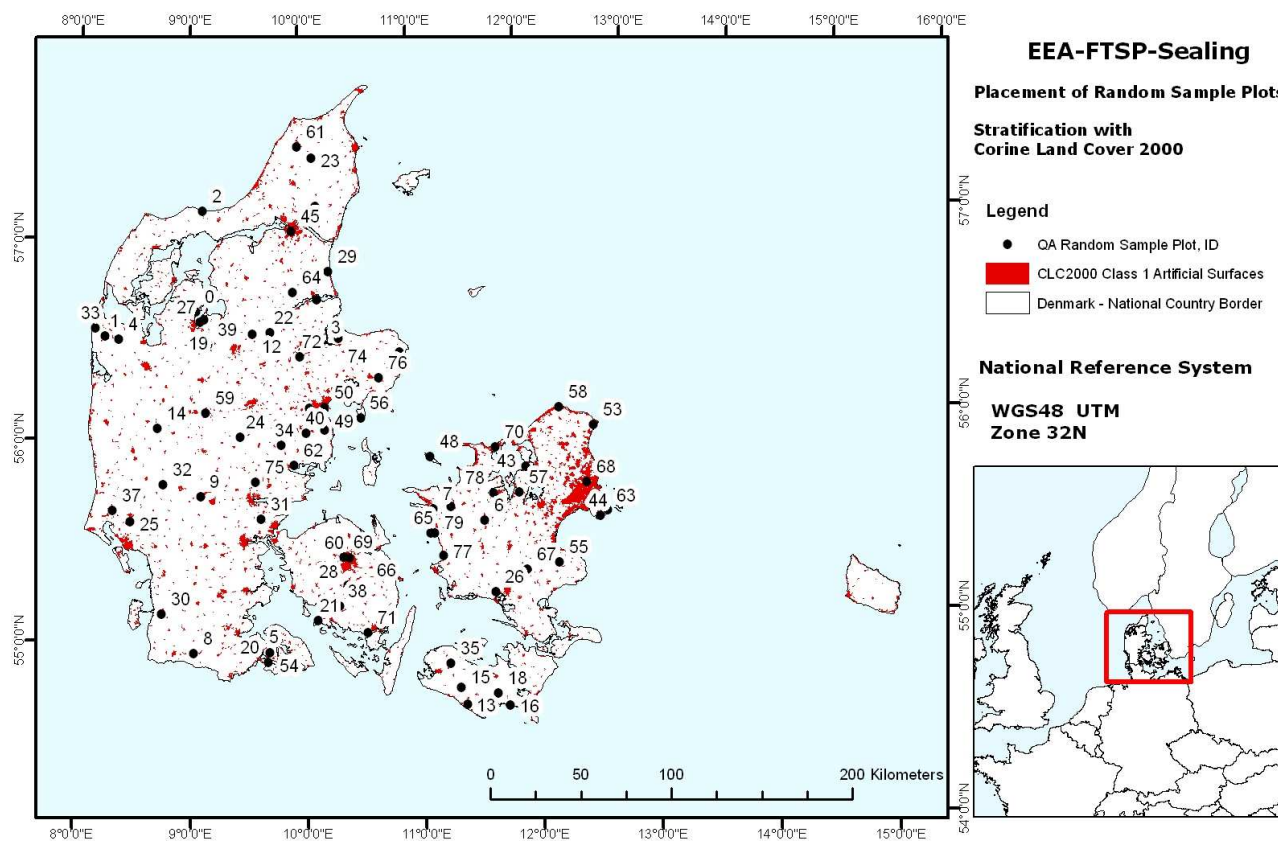
1. Definition of 100 x 100 m reference grid in national projection of the respective country assessed
2. Stratification of the area based on Corine Land Cover level I. To emphasize the accuracy assessment in the urban areas, 50 % of the sample plots are placed within CLC class Artificial Surfaces, the other 50 % are placed in the remaining classes.
3. Cluster based random sampling based on 100 x 100 m reference grid, defined per single nation, number of samples adapted to nation size in km²
4. Re-projection of reference samples to allow overlay with Google Earth
5. Estimation, if reference cell will be labelled as "built-up" according to EEA definition or not (80% threshold degree of soil sealing) taking into account the visibility of objects in the satellite images used for the production of the raster product (technically possible also when using Google Earth¹)
6. Estimation of overall accuracy to generate accuracy measure (overall accuracy, user accuracy, (commission error), producer accuracy (omission error), per single nation (for internal use & validation only) and for European dataset for publication by EEA.
7. Adaptation of statistics with regard to the mitigation shape file. All sample plots falling within areas of the raster product, where the underlying IMAGE2006 data has been identified to fail the ITT's specifications, are not included in the final statistics. This includes areas where
 - Less than two coverages of EO data are available
 - One or more acquisition dates are outside the defined acquisition window
 - The acquisition dates of the two coverages used are less than six weeks apart
 - Cloud cover is present in one or more coverage

The soil sealing raster product which is subject to the accuracy assessment is accepted as according to the specifications if the final statistics indicate an overall accuracy of more than 85 %.

¹ using web-based information input to a local server

4.2 SAMPLE PLACEMENT (STRATIFICATION, NUMBER & LOCATIONS OF SAMPLE SITES)

Overall number of sample plots : 80 (41 within CLC2000 Artificial Surfaces). The figure below shows the placement of sample plots (black dots) within CLC urban areas (red areas) and outside.



4.3 FINAL RESULT

The final accuracy assessment for the country product surpassed the threshold of an overall accuracy of 85 %.

	Classification			Producer's Accuracy	Omission Error
	>80%	<80%	Σ		
Validation	>80%	3	0	3	100,0%
	<80%	0	77	77	100,0%
	Σ	3	77	80	
	User's Accuracy	100,0%	100,0%		
	Commission Error	0,0%	0,0%		
	Overall Accuracy	100,0%			

5 DETAILED LIST OF PROVIDED DATA

- Raster dataset of built-up and non built-up areas including degree of soil sealing, 2006, in full spatial resolution (20 m x 20 m).
- ArcMap Legend File for raster data set for plotting a degree of soil sealing, aggregated to thematic classes
- ArcMap Legend File for raster data set for plotting a degree of soil sealing in a range from 1-100 %
- Mitigation shape file; metadata set per delivered country defining all areas which deviate from the ITT's EO data specifications.
- XML-Metadata of raster and vector data after EEA specifications
- EEA Metadata Stylesheet
- Report per Country with description of raster and vector data, country specific production & mitigation issues (the document at hand)
- Product inspection sheet for outgoing deliveries, ensuring product conformity of raster dataset
- National country borders in national projection

ANNEX 1: INTERPRETATION GUIDELINE FOR VISUAL CORRECTION

Objective

To produce a pixel-based high-resolution layer of built-up areas including degree of soil sealing for the EEA member states of homogeneous look & feel with an overall thematic accuracy of 85%.

Definition of Built-up Areas

Built-up areas according to the consortium definition are represented by a degree of soil sealing between 1 and 100%.

Built-up area therefore comprises pixels that are fully or partly covered by houses, roads, mines and quarries and any other facilities, including their auxiliary spaces, deliberately installed for the pursuit of human activities. Built-up area does not include any fully vegetated pixels, even if they are closely related to these activities (such as city parks and gardens), or any other unvegetated non-built-up open spaces covered with bare soil, sand, glacier, bare rocks or water.

(modified according to http://glossary.eea.europa.eu/EEAGlossary/B/built_up_land)

The FTS in Relation to Corine Land Cover

The FTS high resolution core land cover data is a complementary element of the GMES Fast Track Services. The data set will be a land cover product, reflecting actual ground cover on a pixel by pixel level rather than functional properties.

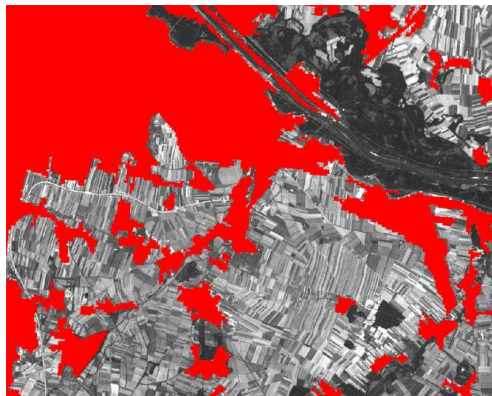
CLC level 1 class 'artificial surfaces' contains artificial surfaces and functionally related vegetated areas, reflecting the land use aspect. Therefore a significant part of this CLC level 1 class contains vegetated areas composed of fully vegetated pixels. However, in the FTS product only pixels that contain some built-up/sealed area will be included.

In addition, built-up pixels within all other CLC level 1 classes (which are not mapped in CLC according to the 25ha MMU) will be included according to the above definition. Fully vegetated or unvegetated non-built-up pixels will be excluded.

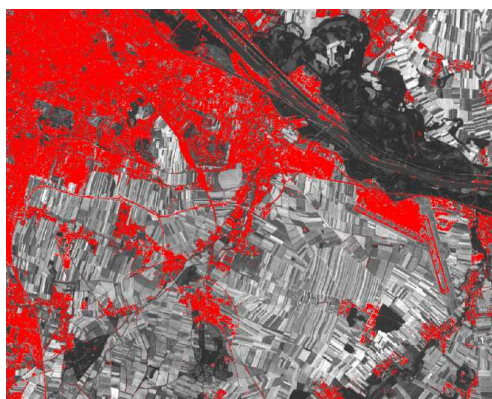
SPOT-4 satellite image over Vienna / Austria
(green band; 20m resolution)



CLC 2000 - level 1 class "artificial surfaces"



FTS high-resolution layer of built-up areas
(20m resolution)



Special Considerations

- The same definition of built-up areas shall apply for production and quality control.
- To ensure homogeneity across the whole of Europe, partially captured linear features outside of urban agglomerations (e.g. fragments of roads or railway lines) will not be completed by the manual post editing.
- Mines and quarries will be considered built-up areas according to the above definition.
- It is proposed to include a no-data class for unclassifiable areas (e.g., clouds) which is to be marked and identified during the process of manual interpretation.

ANNEX 2: LIST OF WORKING UNITS AND EO DATA USED

The following list provides information about the two coverages of EO data which were used to create the working units. The file name is identical to the WU identification within the mitigation shapefile's attribute table and contains the specifications of sensors, paths/rows and capture dates.

The full file name is explained in the following:

[Sensor Coverage 1]_[TrackFrame Coverage 1]_[Capture Date YY/MM/DD Coverage 1]_[Instrument Coverage 1]_[Sensor Coverage 2]_[TrackFrame Coverage 2]_[Capture Date YY/MM/DD Coverage 2]_[Instrument Coverage 2]

Table 1: List of Working Units used for the production of Denmark

UTM Zone	Working Unit
DK33	spot4_053236_060915_2i0_spot5_053236_050709_1j0
DK33	spot5_054237_050711_2j0_spot4_054237_060911_2i0
DK33	spot4_054237_060911_2i0_spot5_053236_050709_1j0
DK33	spot5_058238_060417_1j0_spot5_058238_060926_2j0
DK33	spot4_054238_060514_2i0_spot4_054238_060705_2i0
DK33	spot5_054237_060914_2j3_spot4_054237_060705_2i7
DK33	spot5_054237_060914_2j3_spot4_054237_060911_2i0
DK32	irsp6_023028_060725_l30_irsp6_023028_060911_l30
DK32	irsp6_024028_060612_l30_spot5_053236_060925_2j0
DK32	irsp6_024028_060612_l30_spot5_053237_060925_2j0
DK32	irsp6_020027_050901_l30_irsp6_021027_060715_l30
DK32	spot4_053238_060715_2i0_spot5_053238_060920_1j0
DK32	irsp6_020027_050901_l30_irsp6_021028_060715_l30
DK32	spot4_046233_060704_2i0_spot5_046233_060908_1j0
DK32	irsp6_024029_060916_l30_spot4_053239_060704_1i0
DK32	irsp6_023029_050425_l30_irsp6_024029_060916_l30
DK32	irsp6_023029_050425_l30_spot5_050238_060924_1j0
DK32	irsp6_021027_060715_l30_s4_045233_060504_2i4
DK32	irsp6_021027_060715_l30_s4_045234_060504_2i4
DK32	irsp6_023027_060911_l30_i6_023027_070322_l30
DK32	irsp6_022028_060720_l30_irsp6_023029_050425_l30
DK32	irsp6_023029_050425_l30_spot4_046238_060925_2i0
DK32	irsp6_021028_060715_l30_spot4_045237_060914_1i0
DK32	irsp6_021027_060715_l30_spot4_046234_060914_2i0
DK32	irsp6_023029_050425_l30_spot5_049238_060914_1j6
DK32	irsp6_021027_060715_l30_s5_045235_050903_1j0
DK32	irsp6_021027_060715_l30_spot5_046235_050905_2j0

DK32	irsp6_022028_060720_l30_spot4_046238_060925_2i0
DK32	irsp6_021028_060715_l30_spot4_045236_060914_1i0
DK32	irsp6_022028_060720_l30_spot4_046237_060915_2i0
DK32	irsp6_022028_060720_l30_spot4_046236_060910_1i0
DK32	irsp6_021028_060715_l30_spot4_046238_060925_2i0
DK32	irsp6_024029_060916_l30_spot4_053239_060715_2i0
DK32	irsp6_023028_060911_l30_irsp6_024028_060612_l30
DK32	irsp6_023028_060725_l30_irsp6_024029_060916_l30
DK32	irsp6_022026_050701_l30_spot4_046232_060831_1i0
DK32	irsp6_021028_060715_l30_spot4_046238_060503_2i0
DK32	irsp6_022026_050701_l30_spot5_046233_060908_1j0

ANNEX 3: SAMPLE PLOT VALIDATION SHEET

Sample Plot 100 x 100 m [ID]	FTSP Degrees of Soil Sealing [Mean Value]	FTSP Built up [TRUE / FALSE]	Reference Built up [TRUE / FALSE]	Compliance	Excluded by Mitigation Shape [TRUE / FALSE]
0	79,6	FALSE	FALSE	TRUE	FALSE
1	0,0	FALSE	FALSE	TRUE	FALSE
2	0,0	FALSE	FALSE	TRUE	FALSE
3	0,0	FALSE	FALSE	TRUE	TRUE
4	0,0	FALSE	FALSE	TRUE	FALSE
5	0,0	FALSE	FALSE	TRUE	FALSE
6	45,8	FALSE	FALSE	TRUE	FALSE
7	0,0	FALSE	FALSE	TRUE	FALSE
8	0,0	FALSE	FALSE	TRUE	FALSE
9	0,0	FALSE	FALSE	TRUE	FALSE
10	0,0	FALSE	FALSE	TRUE	TRUE
11	0,0	FALSE	FALSE	TRUE	TRUE
12	0,0	FALSE	FALSE	TRUE	FALSE
13	0,0	FALSE	FALSE	TRUE	FALSE
14	0,0	FALSE	FALSE	TRUE	FALSE
15	0,0	FALSE	FALSE	TRUE	FALSE
16	0,0	FALSE	FALSE	TRUE	FALSE
17	0,0	FALSE	FALSE	TRUE	FALSE
18	0,0	FALSE	FALSE	TRUE	FALSE
19	0,0	FALSE	FALSE	TRUE	FALSE
20	2,2	FALSE	FALSE	TRUE	FALSE
21	0,0	FALSE	FALSE	TRUE	FALSE
22	7,7	FALSE	FALSE	TRUE	TRUE
23	0,0	FALSE	FALSE	TRUE	FALSE
24	0,0	FALSE	FALSE	TRUE	FALSE
25	0,0	FALSE	FALSE	TRUE	FALSE
26	0,0	FALSE	FALSE	TRUE	FALSE
27	0,0	FALSE	FALSE	TRUE	FALSE
28	0,0	FALSE	FALSE	TRUE	FALSE
29	0,0	FALSE	FALSE	TRUE	TRUE
30	0,0	FALSE	FALSE	TRUE	FALSE
31	0,0	FALSE	FALSE	TRUE	FALSE
32	0,0	FALSE	FALSE	TRUE	FALSE
33	0,0	FALSE	FALSE	TRUE	FALSE
34	0,0	FALSE	FALSE	TRUE	FALSE
35	0,0	FALSE	FALSE	TRUE	FALSE
36	0,0	FALSE	FALSE	TRUE	FALSE
37	1,1	FALSE	FALSE	TRUE	FALSE

38	0,0	FALSE	FALSE	TRUE	FALSE
39	21,2	FALSE	FALSE	TRUE	FALSE
40	1,1	FALSE	FALSE	TRUE	FALSE
41	72,3	FALSE	FALSE	TRUE	FALSE
42	82,6	TRUE	TRUE	TRUE	TRUE
43	12,4	FALSE	FALSE	TRUE	FALSE
44	42,0	FALSE	FALSE	TRUE	FALSE
45	98,5	TRUE	TRUE	TRUE	FALSE
46	27,1	FALSE	FALSE	TRUE	FALSE
47	49,1	FALSE	FALSE	TRUE	TRUE
48	0,0	FALSE	FALSE	TRUE	FALSE
49	48,1	FALSE	FALSE	TRUE	FALSE
50	97,5	TRUE	TRUE	TRUE	FALSE
51	6,5	FALSE	FALSE	TRUE	TRUE
52	29,8	FALSE	FALSE	TRUE	FALSE
53	28,5	FALSE	FALSE	TRUE	FALSE
54	11,3	FALSE	FALSE	TRUE	FALSE
55	64,7	FALSE	FALSE	TRUE	FALSE
56	0,0	FALSE	FALSE	TRUE	FALSE
57	75,4	FALSE	FALSE	TRUE	FALSE
58	28,2	FALSE	FALSE	TRUE	FALSE
59	22,0	FALSE	FALSE	TRUE	FALSE
60	79,3	FALSE	FALSE	TRUE	FALSE
61	6,9	FALSE	FALSE	TRUE	FALSE
62	37,9	FALSE	FALSE	TRUE	FALSE
63	67,0	FALSE	FALSE	TRUE	FALSE
64	8,4	FALSE	FALSE	TRUE	TRUE
65	18,1	FALSE	FALSE	TRUE	FALSE
66	32,8	FALSE	FALSE	TRUE	FALSE
67	64,1	FALSE	FALSE	TRUE	FALSE
68	73,0	FALSE	FALSE	TRUE	FALSE
69	64,5	FALSE	FALSE	TRUE	FALSE
70	0,0	FALSE	FALSE	TRUE	FALSE
71	9,2	FALSE	FALSE	TRUE	FALSE
72	8,2	FALSE	FALSE	TRUE	TRUE
73	0,0	FALSE	FALSE	TRUE	FALSE
74	14,4	FALSE	FALSE	TRUE	TRUE
75	45,1	FALSE	FALSE	TRUE	FALSE
76	0,0	FALSE	FALSE	TRUE	TRUE
77	5,0	FALSE	FALSE	TRUE	FALSE
78	37,7	FALSE	FALSE	TRUE	FALSE
79	5,9	FALSE	FALSE	TRUE	FALSE