



# Use Of UAS in a Mining Environment

Brent Godfrey

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# UAS Hardware

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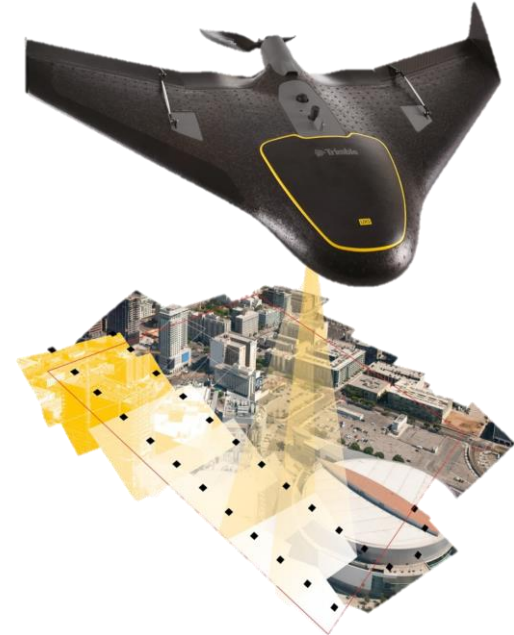
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# Different Solutions for Different Applications

- Fixed Wing Solutions

- Larger open areas
- Horizontal mapping
- Efficient data capture



- VTOL (vertical take-off) Multirotor Solutions

- Smaller obstructed areas
- Horizontal or Vertical
- Visual Inspections



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# Trimble UAS Portfolio



**Trimble UX5**  
Setting the Standard in  
Mapping



**Trimble UX5 HP**  
High Precision Surveying and  
Mapping Solution



**Trimble ZX5**  
Flexible Mapping and  
Inspection Solution

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# Fixed Wing

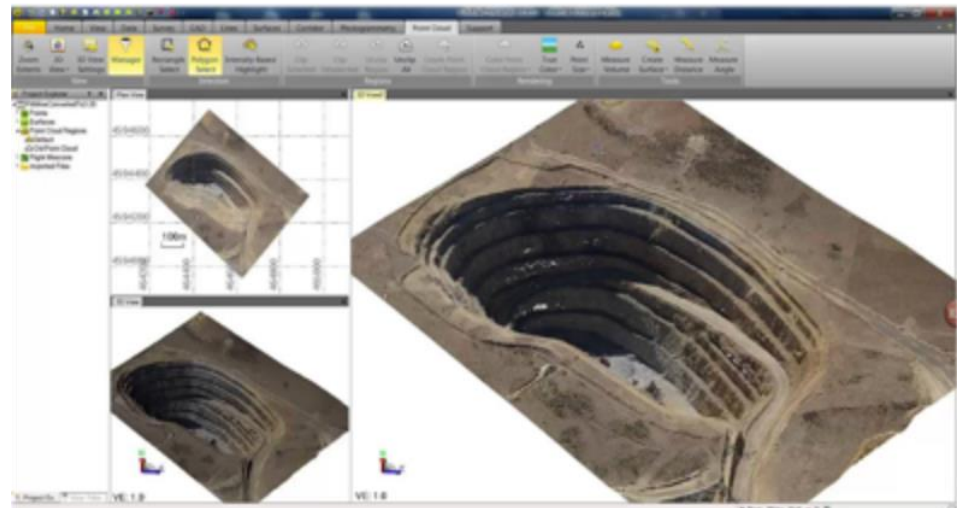


# Trimble UX5 System Overview

- Wing
- Camera system
- eBox - Autopilot
- gBox - GNSS Receiver
- Launcher
- Field software

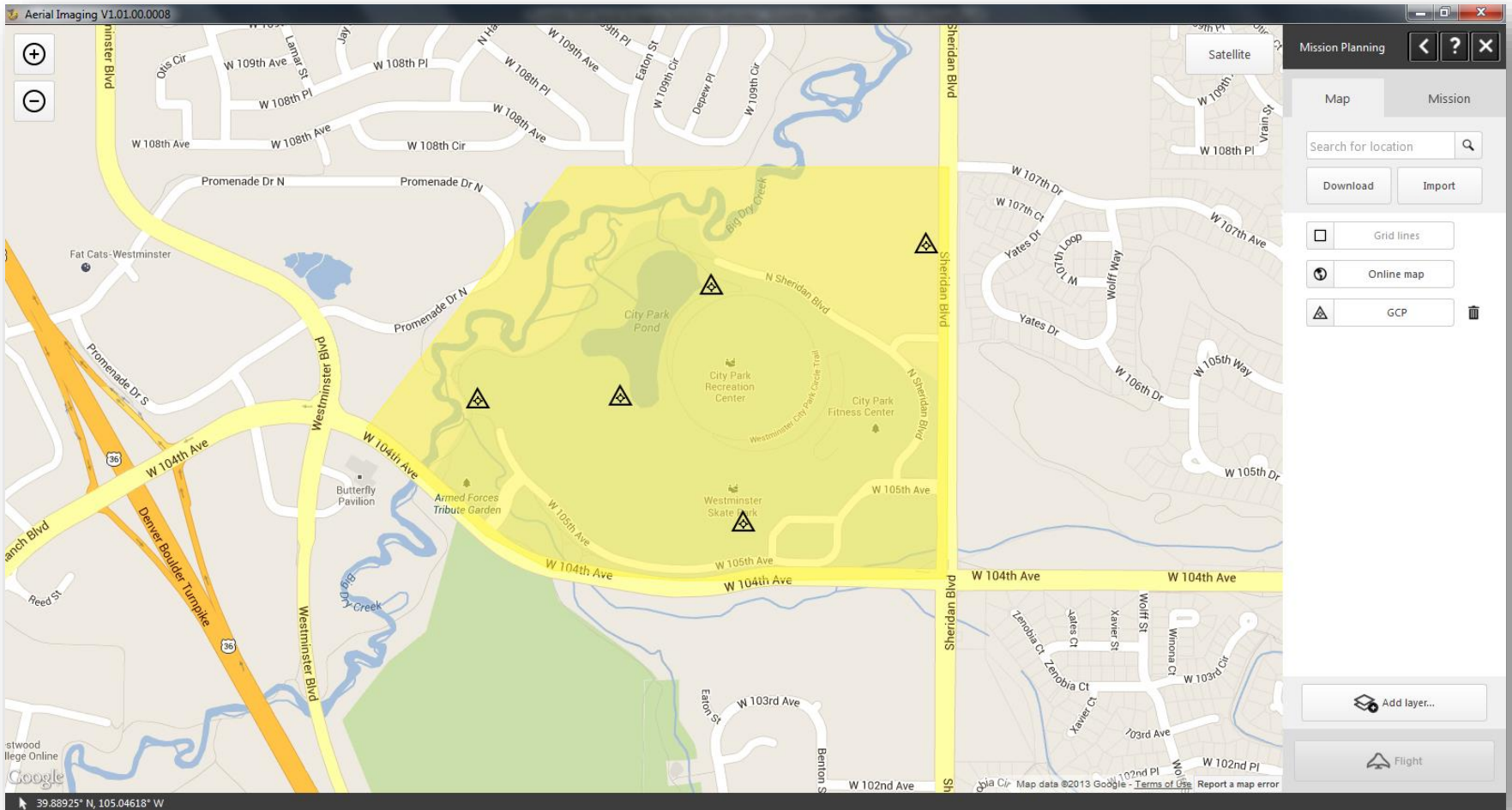


Trimble Business  
Center Office Software



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# Defining the Project Area



# Defining the Flight

Aerial Imaging V1.01.00.0008

Flight Planning

Area Parameters

Duration 34 min

Previous locations

Takeoff 39.88944 °N  
105.05723 °W

Landing 39.88880 °N  
105.05674 °W

First line entry Left Right

Landing entry Left Right

Landing heading [°] 270

Landing zone offset [m] 0

Simulate Checklist

39.89499° N, 105.04873° W

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# Flight Simulation

Aerial Imaging V01.01.00.0007

Simulation Mode

Flight

Satellite

Hide layers

9 85%

Time 01:27 Battery left 42:27

Airspeed (km/h) Throttle 20% Height (m)

125 100 75 50 25

10 10 0 150 100 75 50 25

Land Fly to Hold Here Right FTS

Map data ©2013 Google - Terms of Use Report a map error

39.89223° N, 105.07041° W 39.88968° N, 105.05669° W, ground speed: 81 km/h line 8/23

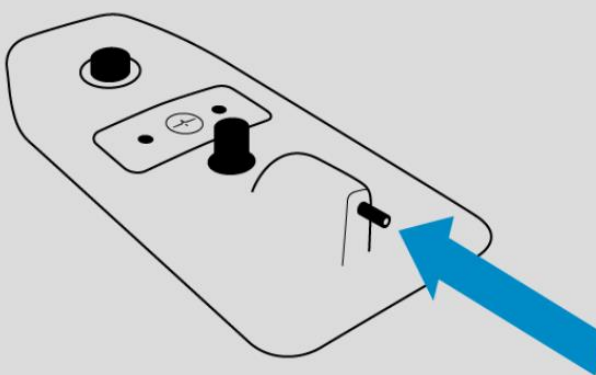
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# Flight Checklist

Aerial Imaging V01.01.00.0007

Pre-flight checklist ?

- GCS connection
- Battery connection
- Prepare camera
- Insert tracker
- Fix top cover
- Cover pitot tube
- Check elevon trim
- Check elevon response
- Put aircraft on launcher
- Transmitting flight plan
- Initializing
- Remove pitot cover
- Check airspeed response
- Position propellers
- Remove safety pin
- Arm system
- Launch



Check airspeed response

Press on the pitot tube (no more than 5 seconds). Check if the current airspeed indication changes. It should be high enough before proceeding to the next step.

39.88799° N, 105.04554° W

# Flight Monitoring

**Aerial Imaging V01.01.00.0007**

**Simulation Mode**

Map data ©2013 Google - [Terms of Use](#) Report a map error

39.89223° N, 105.07041° W 39.88968° N, 105.05669° W, ground speed: 81 km/h line 8/23

**Flight**

Satellite  
Hide layers

9 85%

Time 01:27 Battery left 42:27

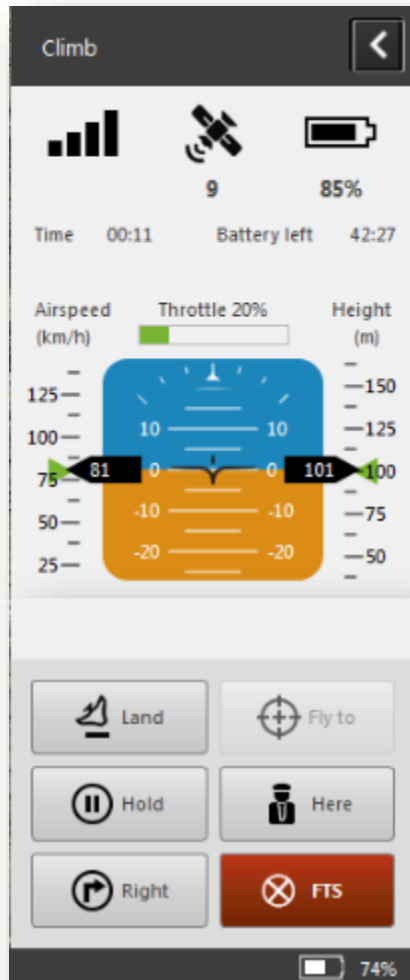
Airspeed (km/h) Throttle 20% Height (m)

125	10	10	200
100	81	0	175
75	-10	-10	150
50	-20	-20	125
25			100

Land Fly to Hold Here Right FTS

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# Safety Maneuvers



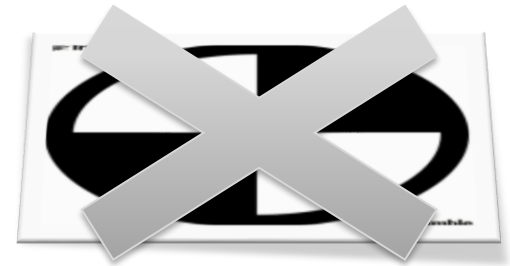
- Land
  - Instruct aircraft to follow land circuit before flight path is finished
- Fly To
  - Fly to a user-specified location on map and circle
- Hold
  - Circle at current position
- Here
  - Fly to location of pilot/GCS and circle
- Right
  - Fly 300 m to the right of current heading and circle
- FTS (Flight Termination System) or (F\*#%& This S%^\$!)
  - Abort flight immediately and spiral downward
- Up (not shown)
  - Instruct UA to increase altitude by 10 m
  - Available once a flight maneuver is enacted
- Down (not shown)
  - Instruct UA to decrease altitude by 10 m
  - Available once a flight maneuver is enacted

# How accurate is it?

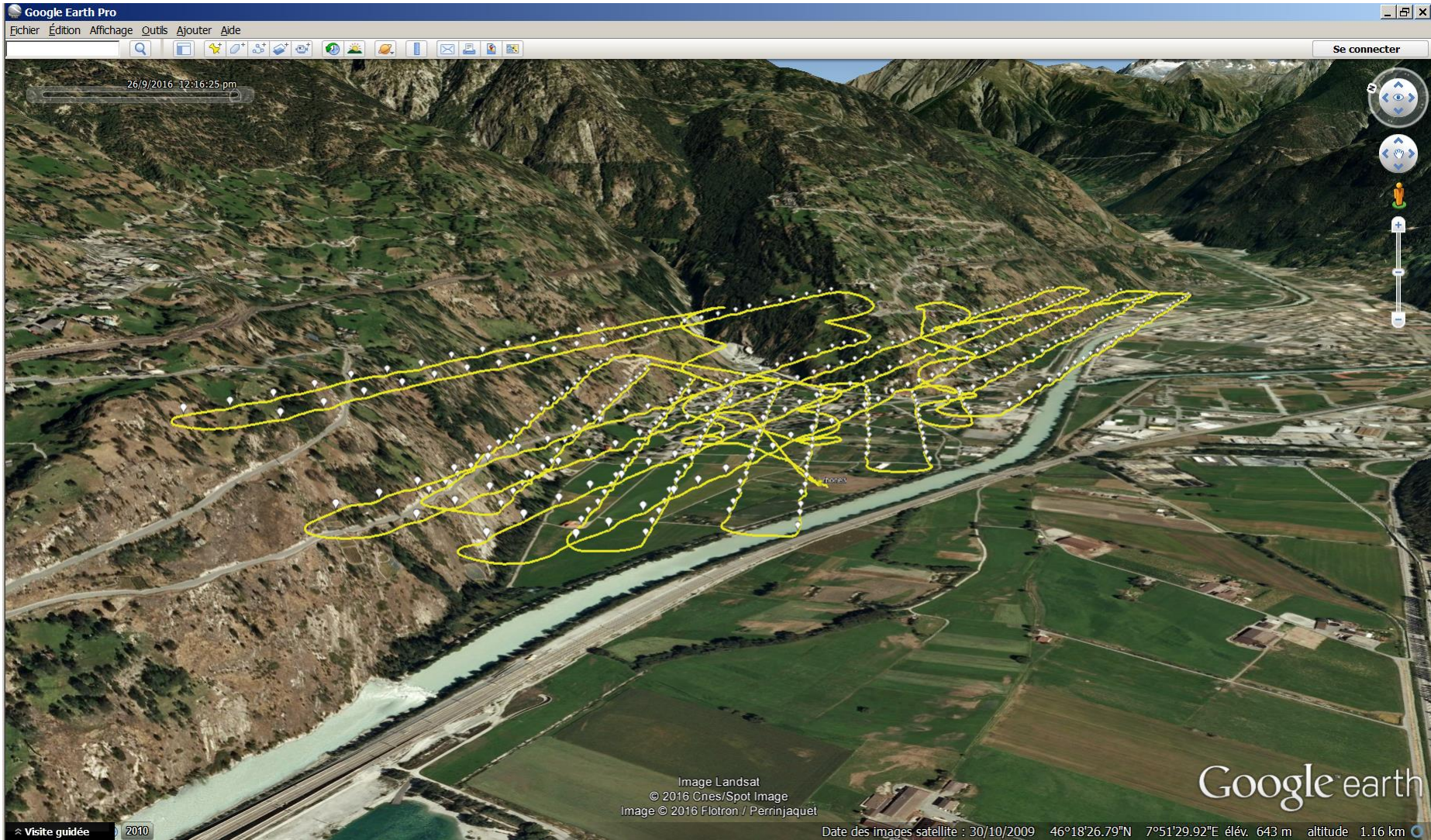
	UX5 (GCP's)	UX5 HP (GNSS)
<b>Min GSD</b>	2cm	1cm
<b>RMSE (XY / Z)</b>	1 GSD	down to 2-5 cm
<b>Max Points / m<sup>2</sup></b>	~ 200	~ 1000
<b>Images / Flight</b>	Up to 2000 @ 24MP	Up to 2000 @ 36MP
<b>Points / Flight</b>	Up to 200M	Up to 500M

# Workflow Comparison

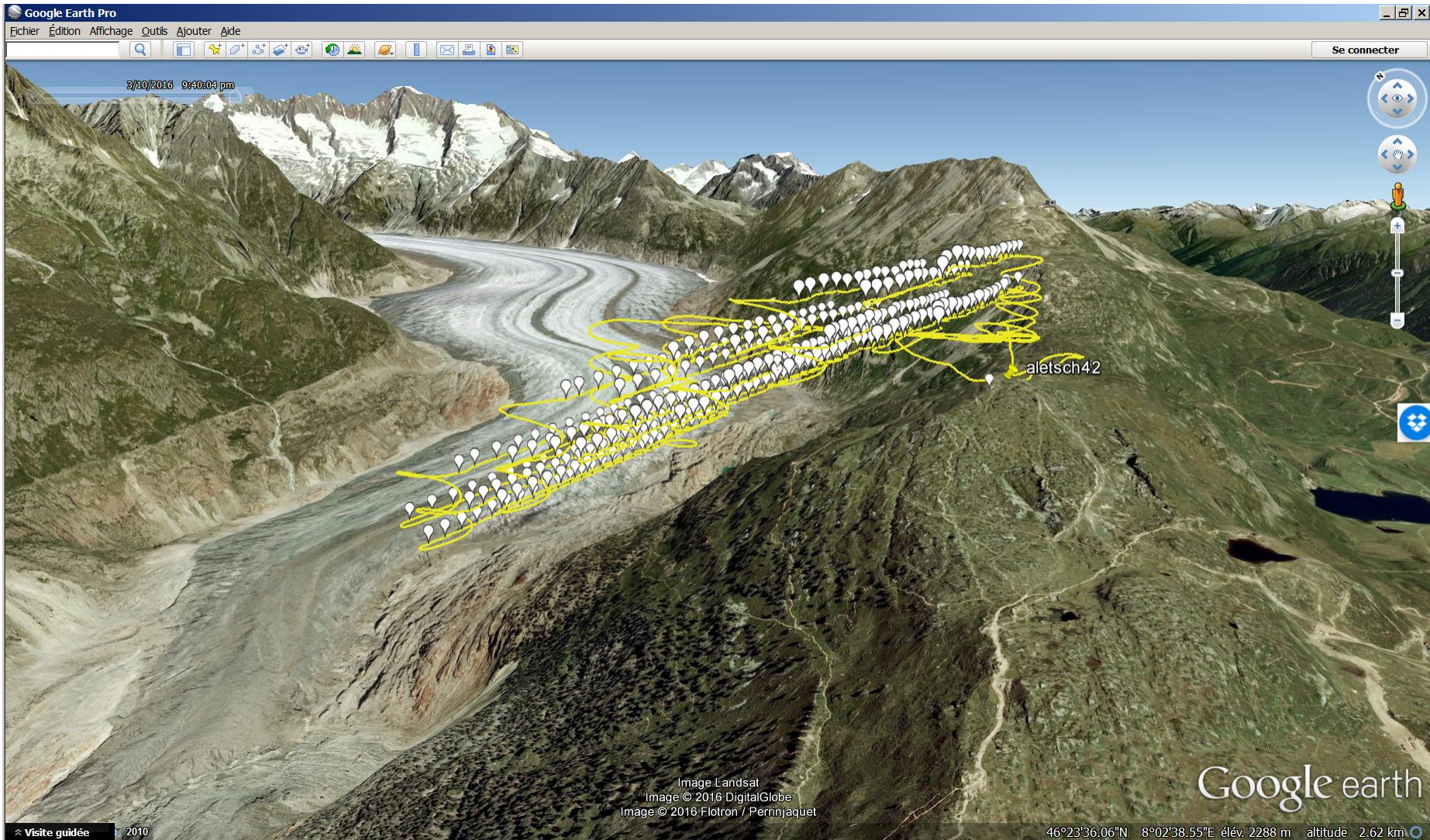
Task	Time	UX5	UX5 HP
Project Plan / Prep.	2 hours	Yes	Yes
Prepare GCPs	1 hour	Yes	⊘
GCP Layout / Field Prep.	2 hours	Yes	⊘
Execute Flight	1 hour	Yes	Yes
Target GCPs	2 hours	Yes	⊘
Process Data	6 - 8 hours	Yes (8)	Yes (6)
Total	16 hours	16 hours	9 hours



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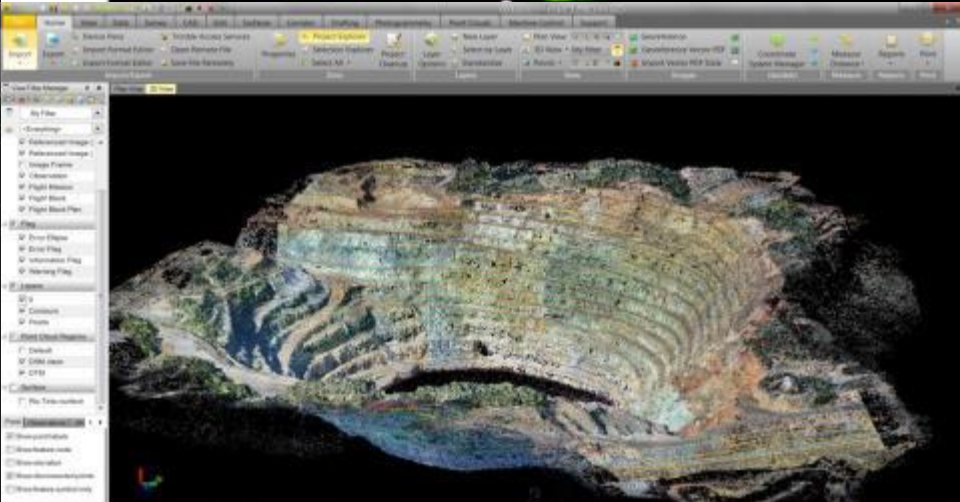
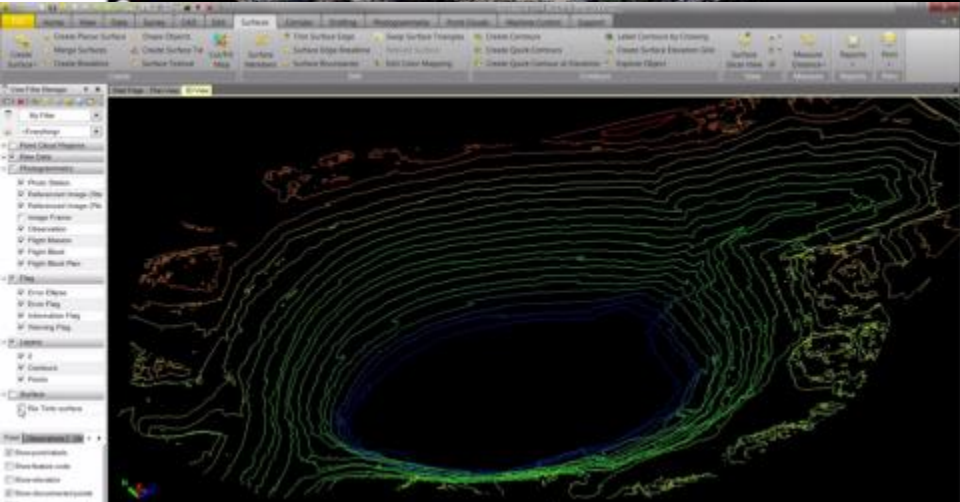
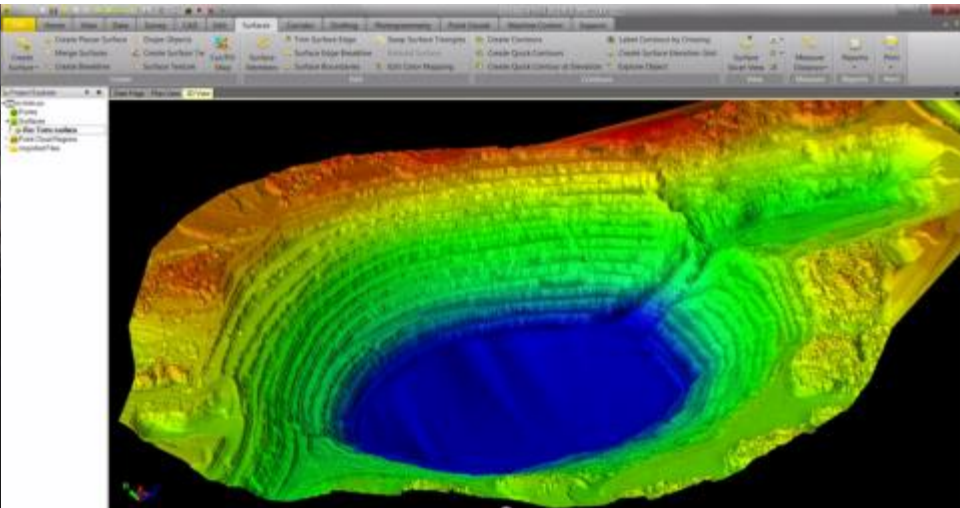
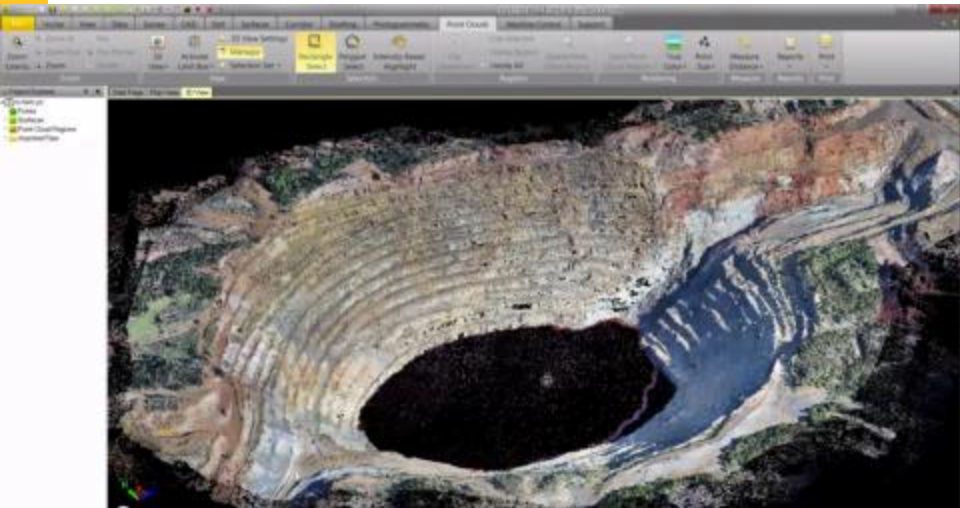
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# Survey Applications of the Deliverable



# Deliverables



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# A local Example

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# Land use Applications of the Deliverable

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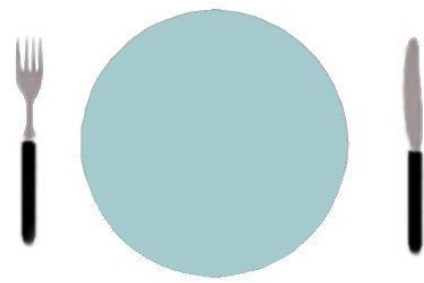
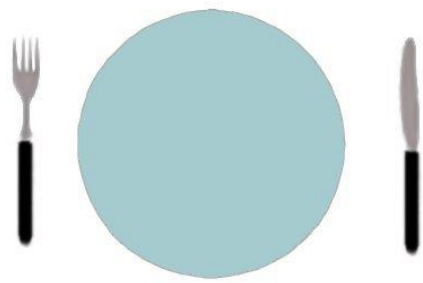


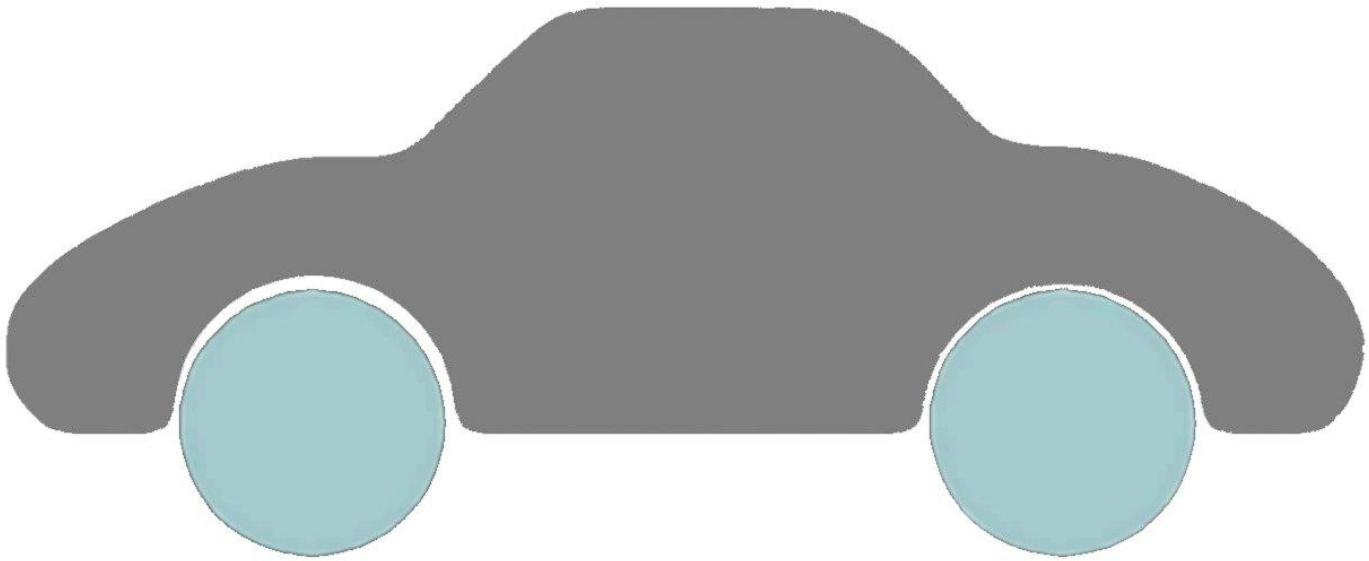
# Trimble eCognition



Can you identify the objects?

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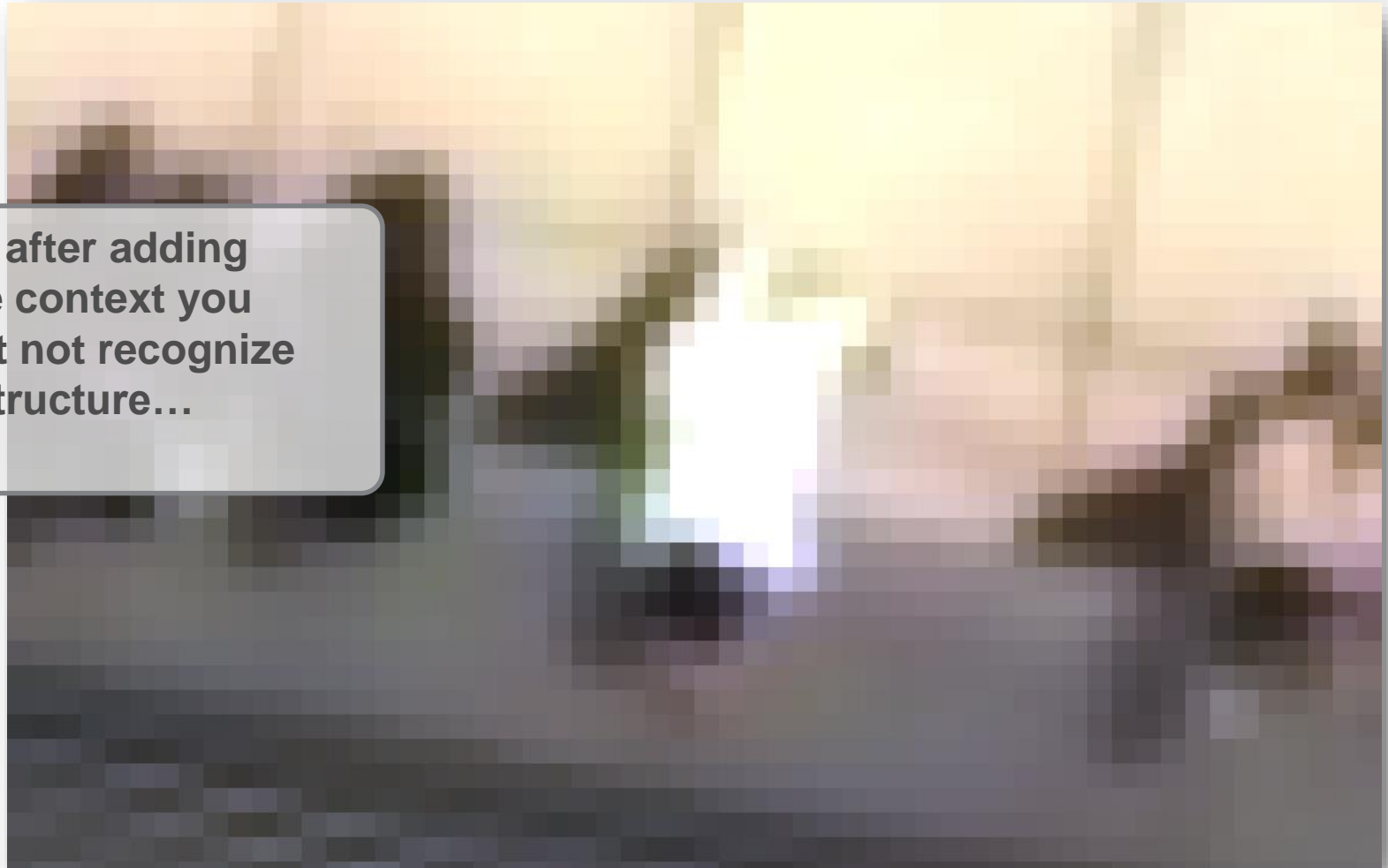
→ Context counts

Which kind of structure  
can be seen here?



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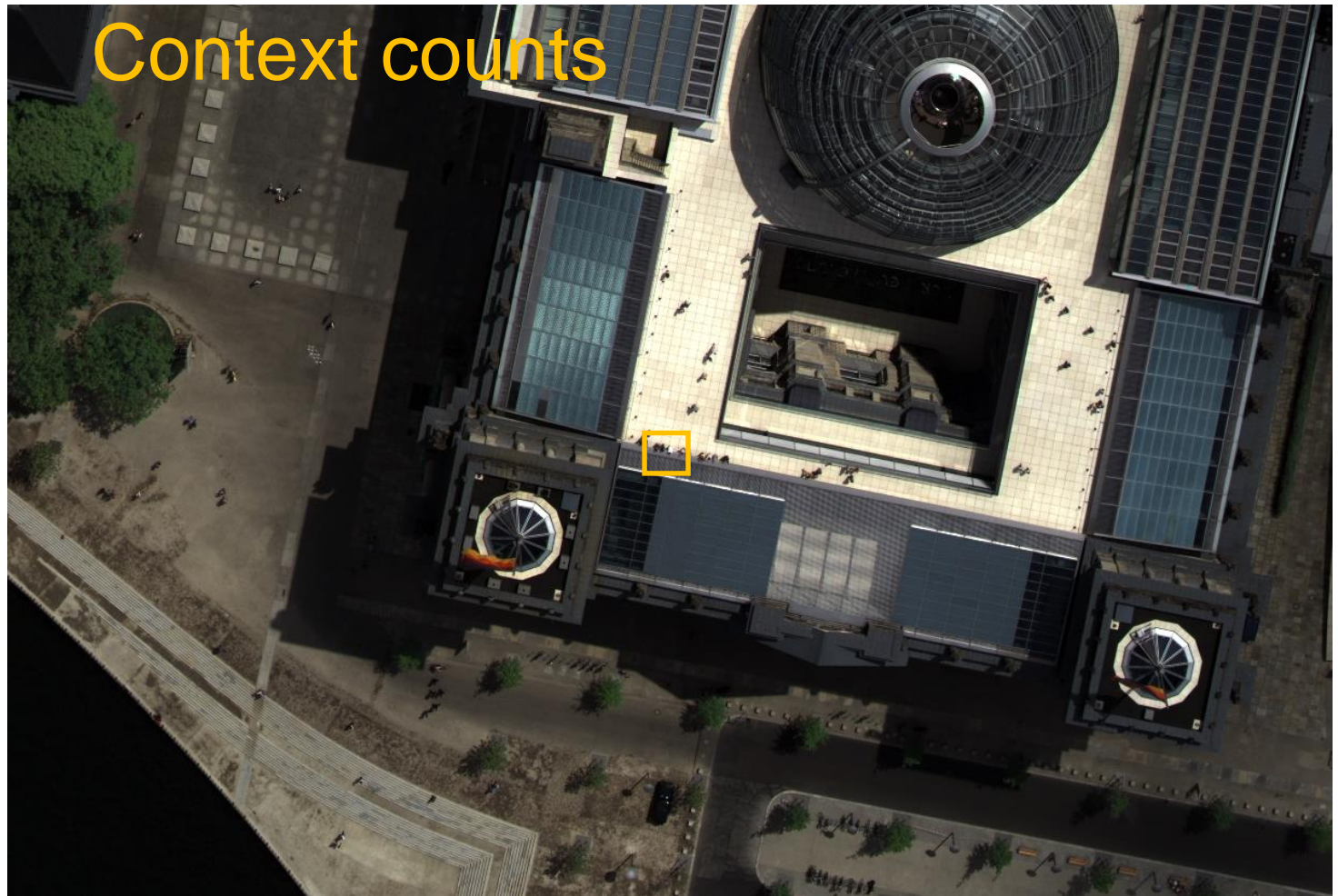
A blurred screenshot of a webpage, likely a social media profile or a similar interface. A white arrow points to a specific element in the center of the page. The background is out of focus, showing various colors and shapes that suggest a complex layout.

Even after adding  
some context you  
might not recognize  
the structure...

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# Context counts



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# Context classification



Input image

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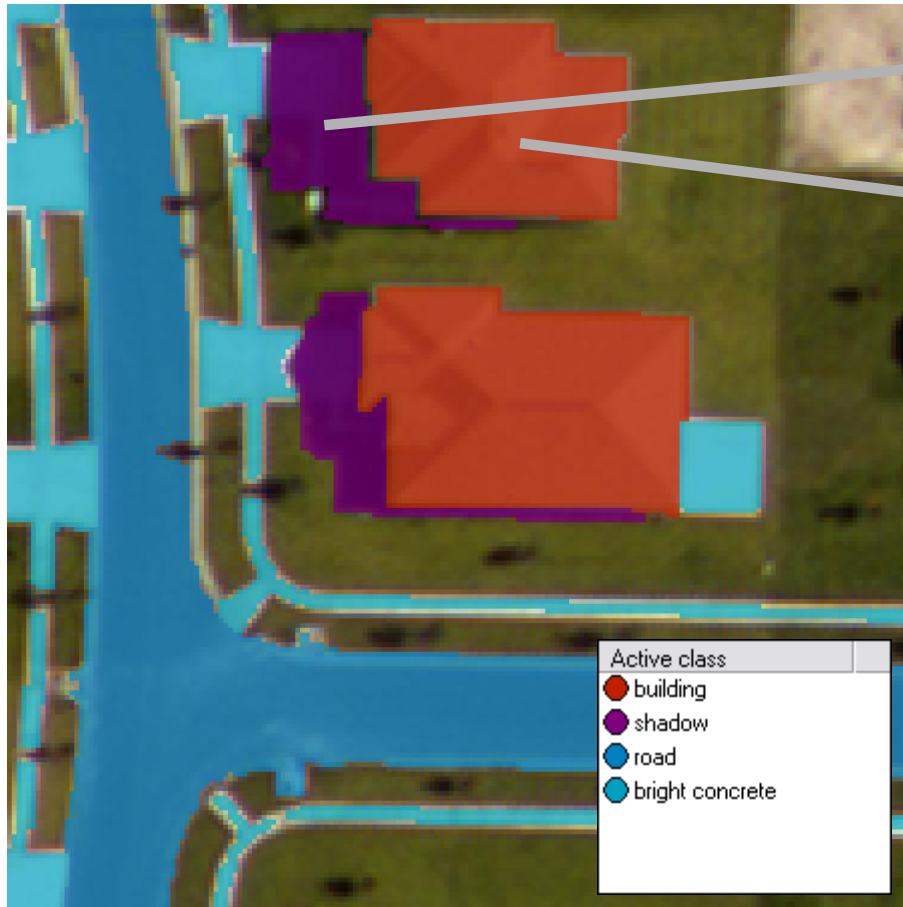
# Context classification



Initial classification  
based on gray values

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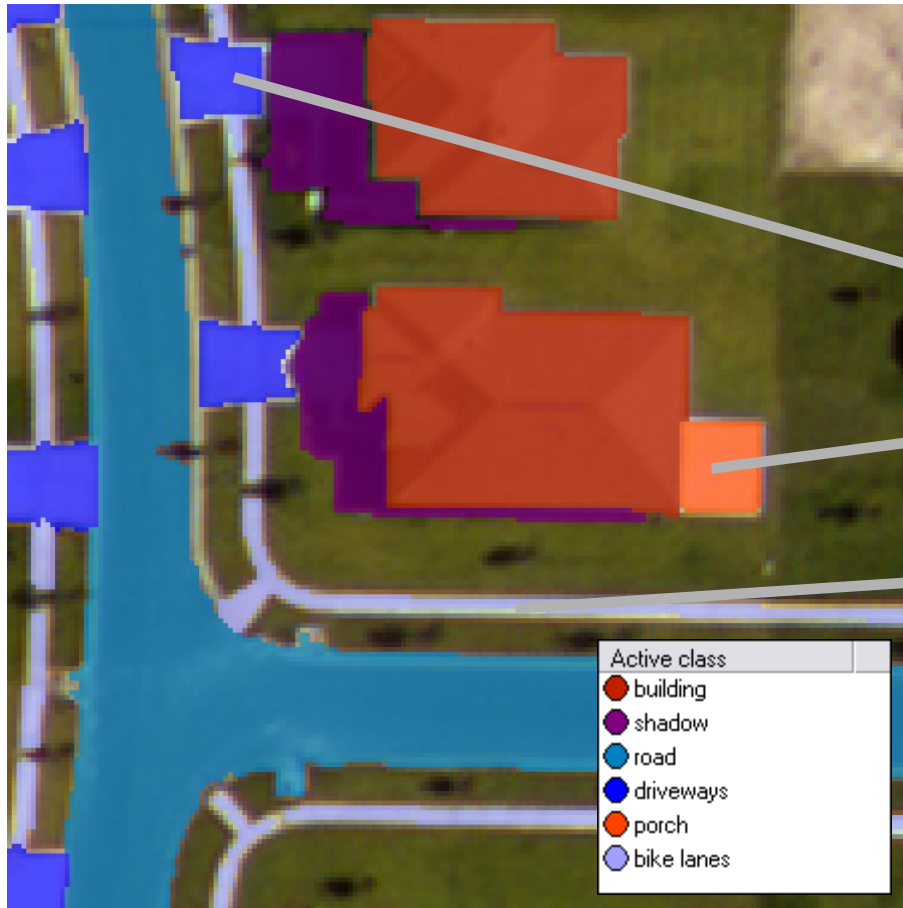
# Context classification



Shadow

Rectangular gray area

# Context classification



Bright concrete between building and road

Bright concrete behind building

Bright concrete linear shape

Used in a mining environment.



# Aerial true-colour spectral



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# Aerial Digital Elevation Model



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# Segmentation



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# Rough Structures Classification



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# Removing small structures



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# Building outlines



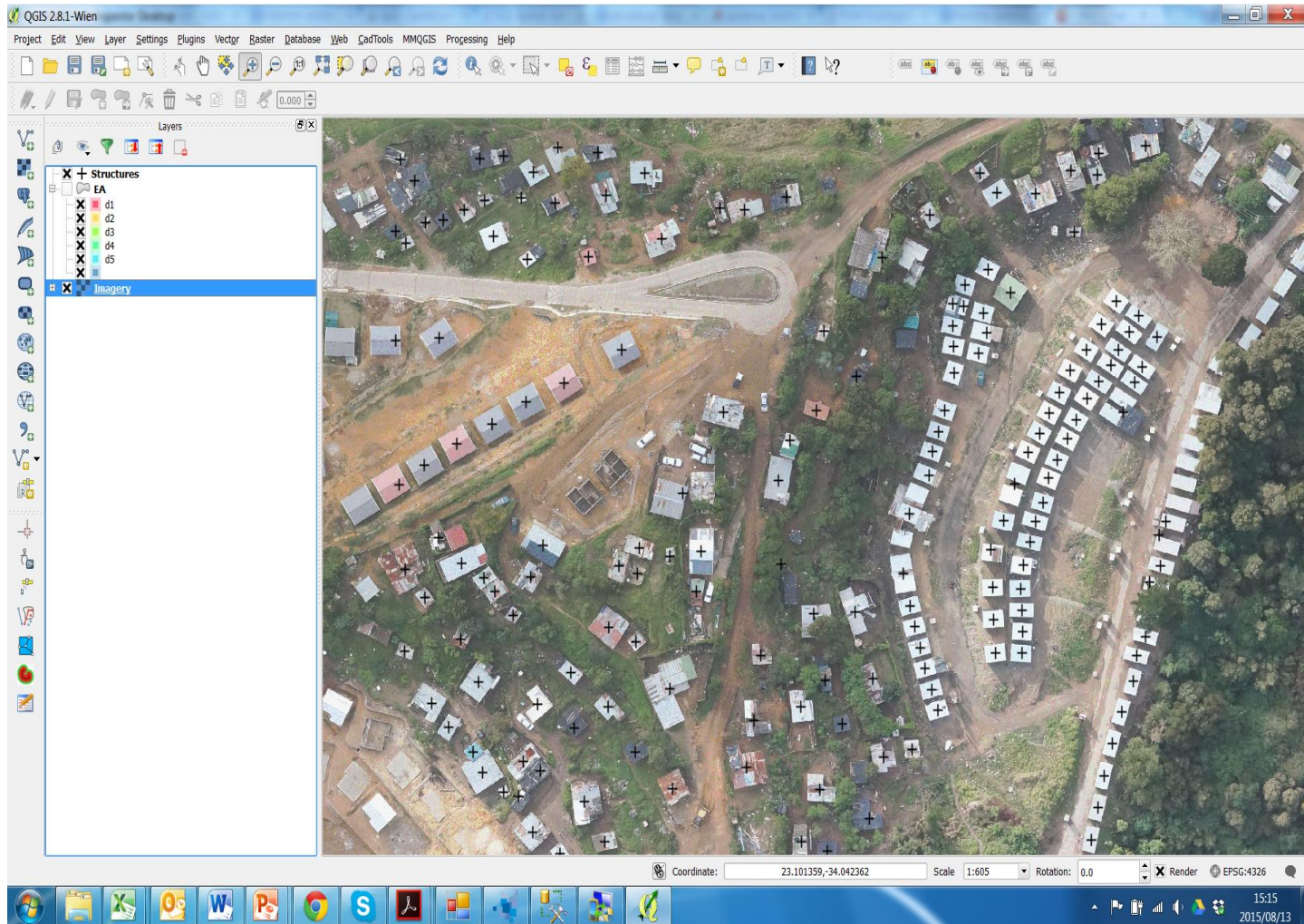
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# Building positions

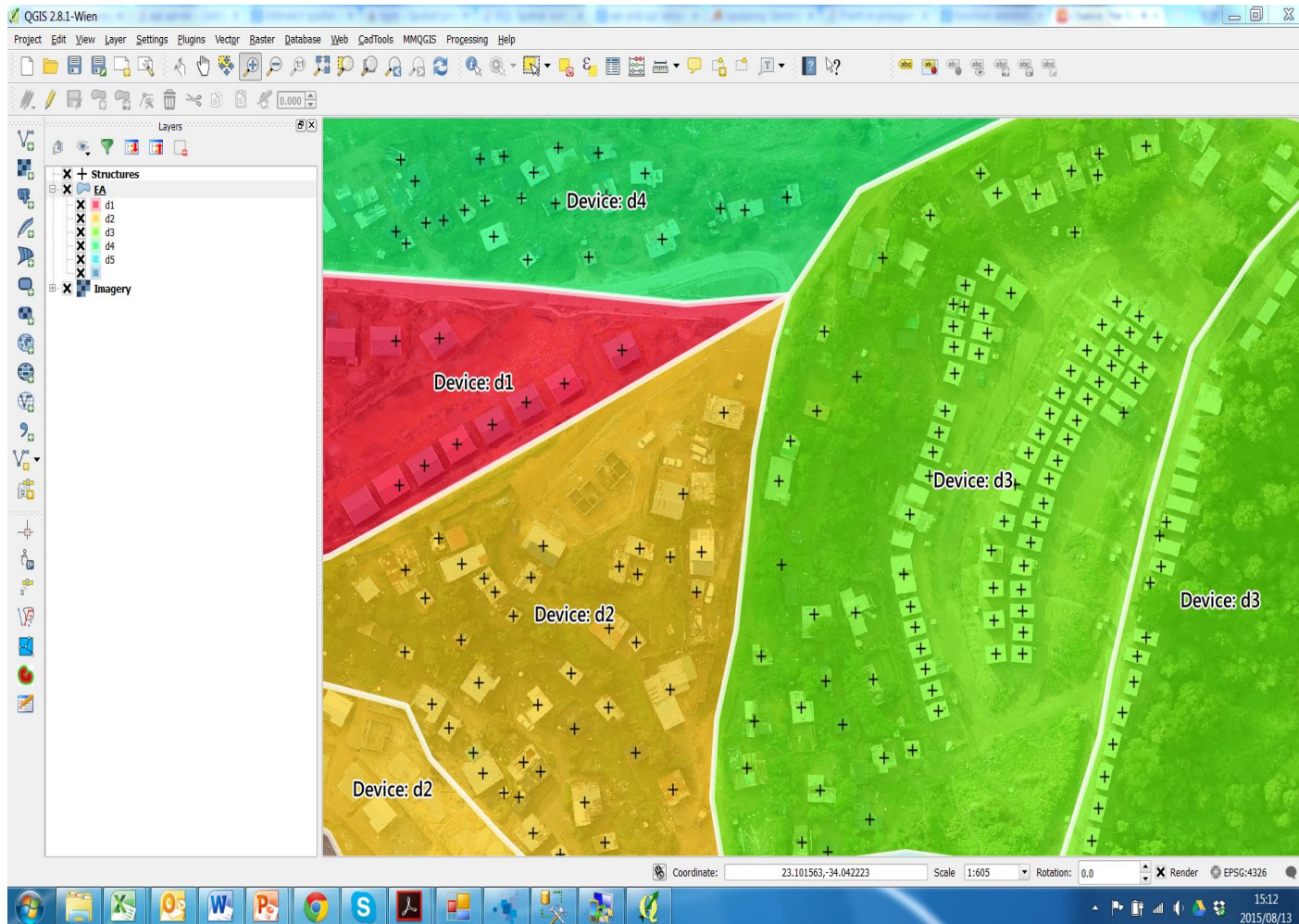


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# Structure Positions in you GIS



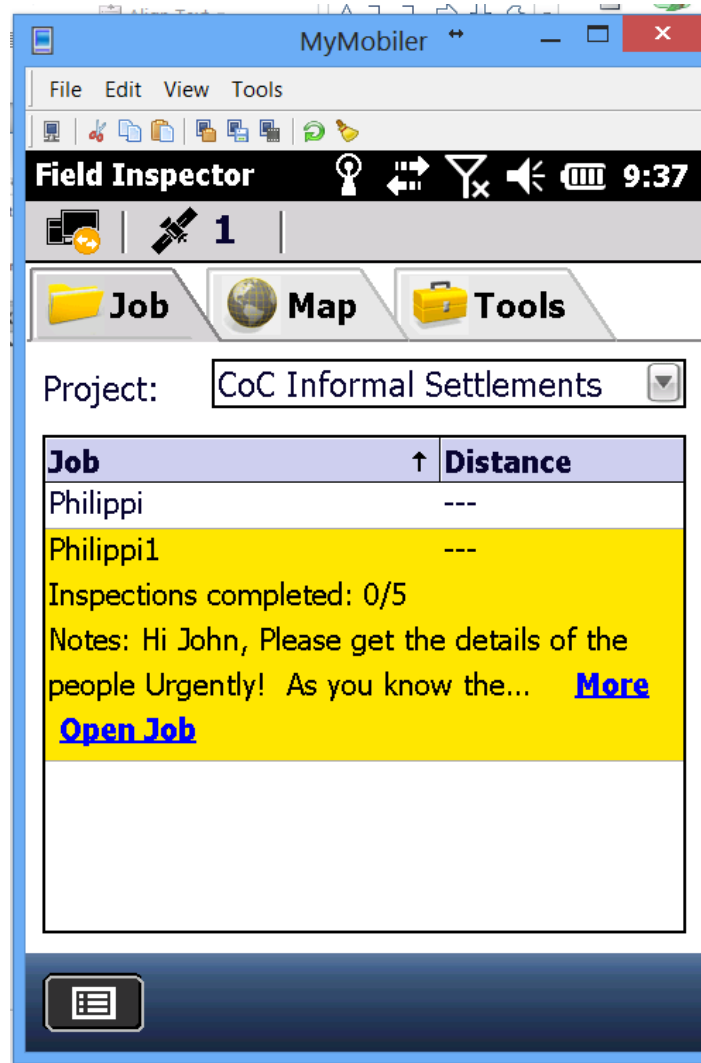
# Structures allocated to data collectors.





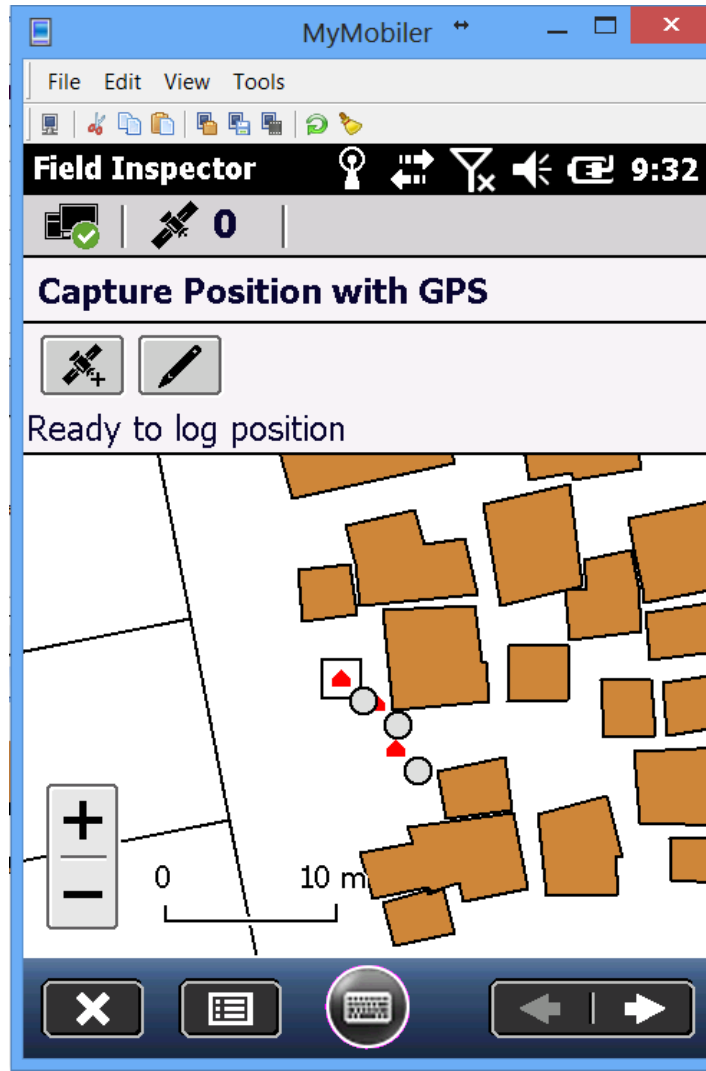
# Hand Held Operation

## Message with Job



# Hand Held Operation

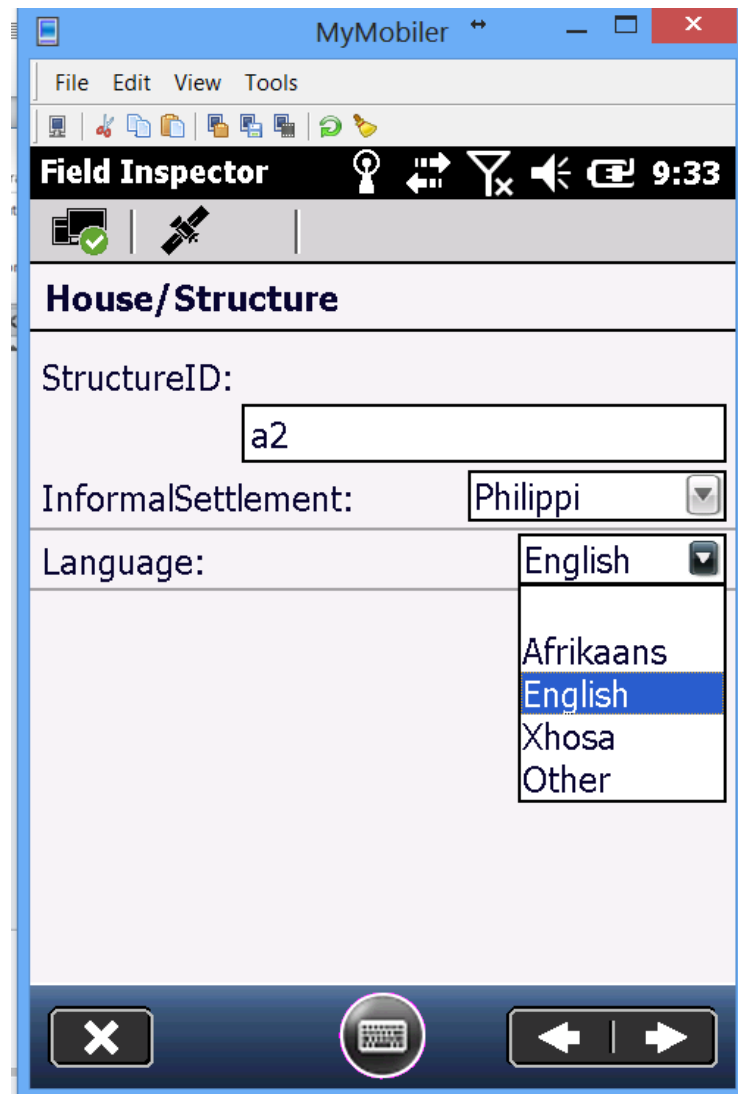
## Background map with navigation



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# Hand Held Operation

## Drop Down multiple select



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# Hand Held Operation

## If-then-else (Married vs Single)

MyMobiler

File Edit View Tools

Field Inspector 9:34

Spouse

MaritalStatus: Married

Surname:

First Names:

Gender: Female

ID Number:

Nationality: South Africa

Navigation icons: Close, Keyboard, Back, Forward

MyMobiler

File Edit View Tools

Field Inspector 9:34

Spouse

MaritalStatus: Single

Navigation icons: Close, Keyboard, Back, Forward

# Hand Held Operation

## Check Boxes

The screenshot shows the 'MyMobiler' application window. At the top, there is a menu bar with 'File', 'Edit', 'View', and 'Tools'. Below the menu bar is a toolbar with various icons. The main interface is titled 'Field Inspector' and includes a status bar with icons for location, signal strength, and time (9:34). Below the status bar, there is a section for 'Housing' with the following questions and input fields:

Have you been granted a housing subsidy:

Do you own property elsewhere in SA:

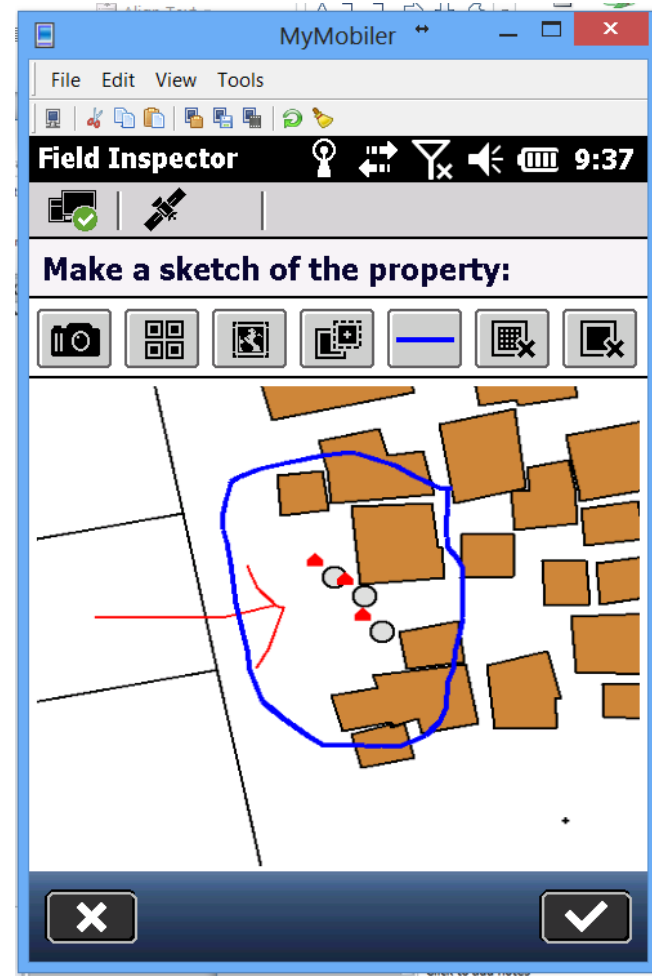
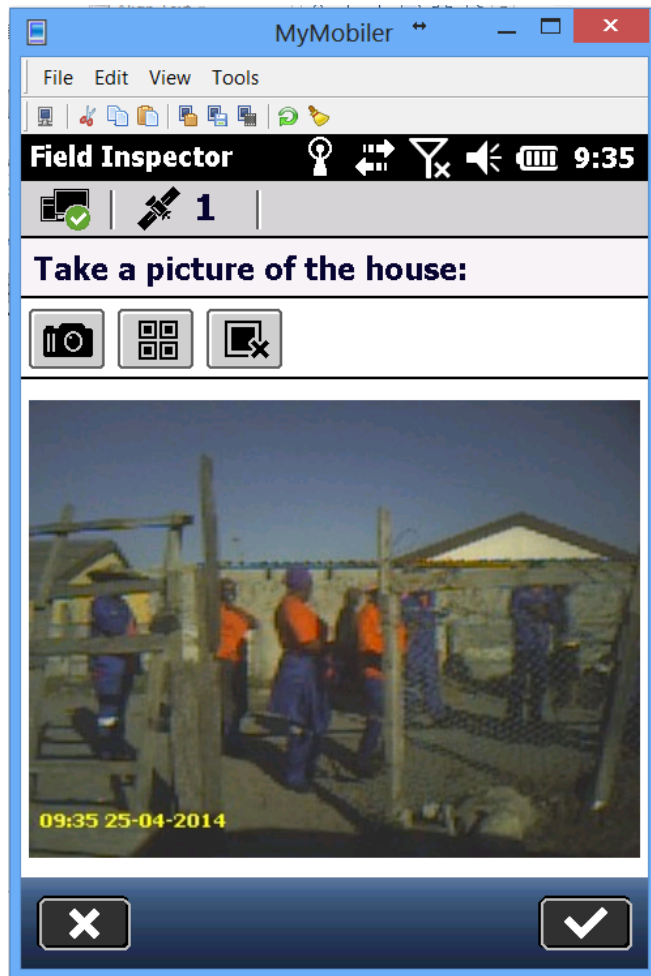
Where did you come from:

Since when did you live here:

At the bottom of the screen, there is a navigation bar with a close button (X), a keyboard icon, and left/right arrow buttons.

# Hand Held Operation

## Photos and redlining



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# Results in GIS

## Query collected data

The screenshot displays the QGIS 2.2.0-Valmiera interface. The 'Identify Results' window is open, showing a list of attributes and their corresponding values for a selected feature. The attributes include household information, child information, and a capture date. The background map shows a settlement area with green buildings and a pink hatched background.

Feature	Value
0	dbo.V_SettlementInspection
HH_Surname	kota
(Actions)	
(Derived)	
Backyarder1Age	
Backyarder1DoB	
Backyarder1Gender	
Backyarder1ID	
Backyarder1Name	
Backyarder1Relation	
Backyarder2Age	
Backyarder2DoB	
Backyarder2Gender	
Backyarder2ID	
Backyarder2Name	
Backyarder2Relation	
Backyarder3Age	
Backyarder3DoB	
Backyarder3Gender	
Backyarder3ID	
Backyarder3Name	
Backyarder3Relation	
Capturedate	2014-04-25T09:59:05
Child1Age	
Child1DoB	
Child1Gender	Male
Child1ID	
Child1Name	qhamani
Child2Age	
Child2DoB	
Child2Gender	
Child2ID	
Child2Name	
Child3Age	

Microsoft SQL Server Management Studio

File Edit View Query Debug Tools Window Community Help

New Query

master

Execute

Object Explorer

- System Databases
- adventureworks
- andre
- Census
- COCT
- FL\_Schema
- Field\_Inspector\_2\_4\_1
- FieldInspector2\_3
- gANDy
- images
- InFlo
- LogTrack
- MPL
- PetroSA\_Applications
- QM
- QM\_TF
- TFI24\_systemDB
- UmpHEME
- UmpTest
- UrbanManagement
  - Database Diagrams
  - Tables
  - Views
    - System Views
    - dbo.jobs
  - Synonyms
  - Programmability
  - Service Broker
  - Storage
  - Security
- Security
- Server Objects
- Replication

SQLQuery8.sql - OPT-LAP-094...e (55) | SQLQuery4.sql - not connected | SQLQuery3.sql - not connected\* | SQLQuery1.sql - not connected

```

/***** Script for SelectTopNRows command from SSMS *****/
SELECT TOP 1000 [id]
, [Area Pxl]
, [Class name]
, [geom]
, [SE ID]
, [Device]
, [E Aid]
FROM [UrbanManagement].[dbo].[jobs]

```

Results

id	geom	Device	E Aid
1	0xE6100000010C03F424D1581A3740550CBAF75D0541C0	d4	1
2	0xE6100000010C861FD879201A37408DEC09E8680541C0	d4	1
3	0xE6100000010C8FF2B48D3D1A374044E0EF766A0541C0	d3	4
4	0xE6100000010C5E2B6970421A3740803462B47C0541C0	d3	4
5	0xE6100000010C2B96B8ECCD193740C368C8627E0541C0	d2	3
6	0xE6100000010C51C8872CFD193740AF61BF5F8E0541C0	d2	3
7	0xE6100000010C9CC9E76C321A37403B7B6662900541C0	d3	4
8	0xE6100000010CA90D0162F1A37404872AF0D940541C0	d3	4
9	0xE6100000010CC1F8A18A221A3740C8AE12FF970541C0	d5	5
10	0xE6100000010C33856A23611A37401967DB1F980541C0	d3	7
11	0xE6100000010CD09C291F401A374038967BF3960541C0	d5	5
12	0xE6100000010CF4A1515F651A3740D95F525F8F0541C0	d3	7
13	0xE6100000010CF1AECF032F1A374054E14E7B8A0541C0	d3	4
14	0xE6100000010CE13841A8561A3740F6D41CA6860541C0	d3	4
15	0xE6100000010CD4F4F668331A3740B368D999880541C0	d3	4
16	0xE6100000010C3BE945BD271A374011B623D4860541C0	d3	4
17	0xE6100000010CACDDFCE561A374086515718850541C0	d3	4
18	0xE6100000010C482FFAA2561A37404A493095830541C0	d3	4
19	0xE6100000010C047172E62D1A374099C64D21980541C0	d5	5
20	0xE6100000010C2A53C646481A3740A31869EB970541C0	d5	5
21	0xE6100000010CA2195E4D4C1A3740682B17A0970541C0	d5	5
22	0xF6100000010C12A5464A341A3740C48E34FE960541C0	d5	5

Query executed successfully. OPT-LAP-094\SQLEXPRESS (10... OPTRON\awise (55) master 00:00:00 189 rows

Output

Properties

Current connection parameters

Aggregate Status

Connection failures

Elapsed time 00:00:00.382

Finish time 2015/08/13 14:56:30

Name OPT-LAP-094\SQLEXPRES:

Rows returned 189

Start time 2015/08/13 14:56:29

State Open

Connection

Connection name OPT-LAP-094\SQLEXPRES:

Connection Details

Connection elapsed 00:00:00.382

Connection finish tin 2015/08/13 14:56:30

Connection rows reti 189

Connection start tim 2015/08/13 14:56:29

Connection state Open

Display name OPT-LAP-094\SQLEXPRES:

Login name OPTRON\awise

Server name OPT-LAP-094\SQLEXPRES:

Server version 10.50.4000

Session Tracing ID

SPID 55

Name

The name of the connection.

Ready

Ln 1

Col 6

# OPTRON



**Thank You**

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