cyclomedia

POC Surface Types

Versie 1
September 2021

Content

1.Shared Goal

During the Covid pandemic, the Netherlands experienced a rapid increase in the need for bandwidth. This is mostly due to fact that people had to start working from home. However, the Netherlands was not yet digital enough to make this happen. To make this digitalisation possible, several CSP's and contractors are working together to upgrade the network throughout the Netherlands.

For example, KPN has the goal to have 80% of households on fiber in 2026 and Vodafone plans to expands it gigabit connection to 6 million in the next 2 years.

These are big ambitions that come with huge investments in operations and infrastructure. New and innovative technologies must be used to make this digital transition possible. Especially in the rollout of new build plans and reconstructions. Therefore, CSP's are continuously looking for ways to improve their workflows and to reduce costs.

Data and AI are two technologies that could positively impact operations. They can be used to automate processes, save time and reduce operational expenses. However, this only works when the quality of the data is high and consistent over all areas where CSPs have their operation.

Currently, this is not the case. Therefore, KPN, Vodafone, VWT, Allinq and Cyclomedia want to work together to develop a universal product or data layer that provides information on the type of surface. This product could provide transparency throughout the value chain and standardize definitions of surface types. Our expectation is that with this new data layer CSP's should be able to reduce manual effort, interaction, and operational expenses.

To see if such a product is possible, we will jointly engage in a proof of concept for which we have set the following goals:

- Is it technically feasible to create a surface type data layer according to the requirements set by KPN, Vodafone, VWT, and Allinq?
- How does the product fit in the current operational processes of KPN, Vodafone, VWT, and Allinq?
- What value doe CSP's gain from this product and how should it be priced in a fair way for all parties?

Next to the processes between CSP's and contractors, efforts will also be done to see how this data layer can be used a proof towards municipalities. However, these efforts are only made when the surface types can indeed be extracted from the Cyclomedia imagery and lidar data with an algorithm.

2. Requirements for solution

Several requirements are discussed during the workshop on the 20th of July. The requirements are listed in data requirements and user requirements. The list is not fully complete yet. During the co-creation session on the 9th of September, we want to finalize the requirements. You can find a more extensive description of the requirements in the Appendix.

Data requirements

- 5 types of surfaces
  - Tiles
  - Clinkers
  - Mozaïk
  - Asphalt
  - Unpaved
- Accuracy of surface type of attribution
  - 90% to 95% accurate classification of surface type class.
- Level of detail the surface types and placement accuracy of polygon edges along the surface borders.
  - Placement accuracy of polygon is 10cm
  - Placement accuracy requirement of polygon edges along the surface is 10cm
  - Lines are not required to be straight
- Minimum acceptable square meters of surface type where a surface type is defined for
  - Small Greeneries such as Tree boxes are a nice to have → not priority/ not needed
  - Mozaïk often comes in smaller areas -→ priority / needed
- National wide availability
  - Urban areas such as
    - Cities
    - Villages

User requirements

- Data delivery
  - WFS layer
- Instant availability of data layer
  - Use case 'fiber rollout' → possibility to wait 2 days
  - Use case 'client requests' → off the shelf, meaning 1 min loading time

3. Proposed solution

3.1 Considerations

The product management, sales, and R&D team from Cyclomedia looked togetherto the problems that need to be solved. Also, under which requirements these problems need to be solved to be able to add value in the processes of the partners. Together we found that the most important problems are:

- Reduce 'surprises' during engineering / rollout of FTTH and COAX projects
- Reduce engineering time during high AND low level design
- Create overview through the value chain of CSP's to reduce discussion with partners or for example with municipalities

We set that the most important requirements are the following.

- Accuracy of surface type of attribution
  - 90% to 95% accurate classification of surface type class.
- Instant availability of data layer
  - Use case 'fiber rollout' -> possibility to wait 2 days
- 5 types of surfaces
  - Tiles
  - Clinkers
  - Mozaïk
  - Asphalt
  - Unpaved

Internally, we discussed several options that could solve the problems of the partners. Hereby a short summary of the most important considerations: (more information can be found in the next paragraph 3.2)

- Surface types are ranging from 'simple' patterns like asphalt to complex patterns such as mosaic. Also it's cheaper to put fiber under simple surface type patterns than under complex surface type patterns, with the exception of asphalt.
- A Simple Geometry Pass and Surface Complexity Maps algorithm takes only 2 to 3 months to develop and has a classification accuracy of 90% - 95%. This is in line with the data requirement.
- A Simple Geomery Pass and Surface Complexity Maps algorithm is a 'light' algorithm which makes it possible to process villages / cities within a couple of days. This is in line with the user requirement.

Based on these consideration. We propose to develop a Simple Geometry Pass and Surface Complexity Maps Algorithm. We explain this in more detail in the next section.

3.2 Proposed solution

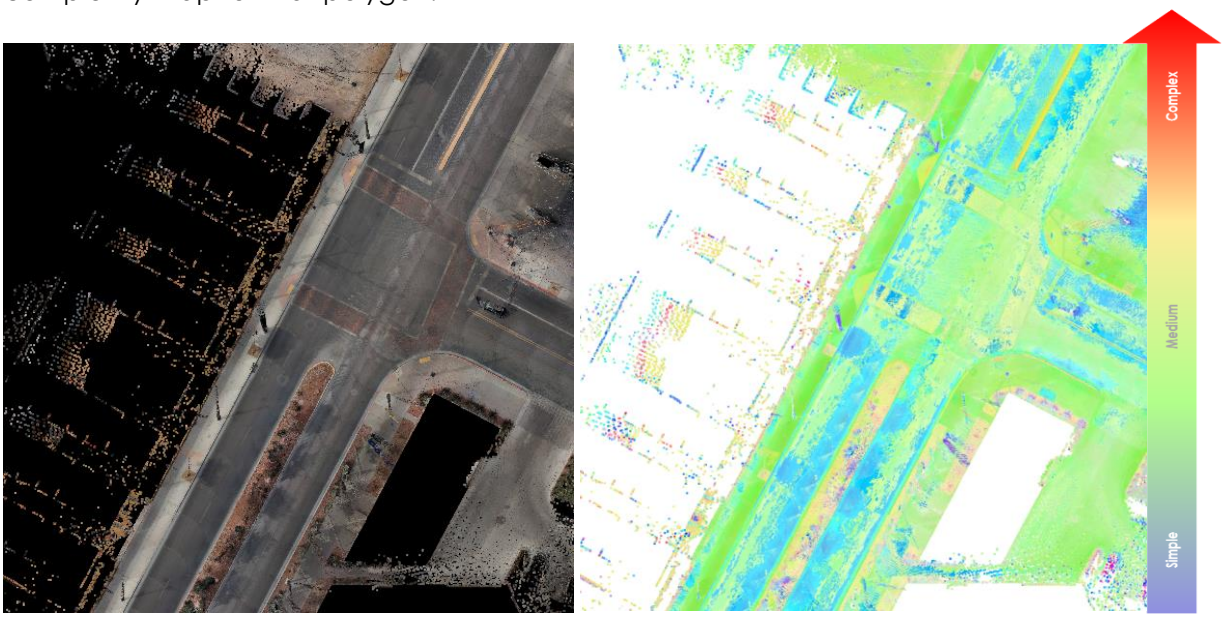
The Simple Geometry Pass and Surface Complexity Maps algorithm has two different elements that combined solve the problem of the partner. The elements are as followed:

1. A pre-existing polygon layer or manually extracted simple polygon layer by surface function (road surface, sidewalk, terrain, driveway),
2. On top, complexity maps are created (either tiled or per polygon layer) that provide a surface classification (tiles, clinkers, mozaïk, asphalt, unpaved)

The model has the characteristics:

- *Processing time: light (few days) Estimated Development Time: 12 Dev weeks. (3 months)*
- *Estimated Accuracy: 90%*
- *Level of Detail: +/- 10cm*

By either starting with a pre-existing polygon layer or manually extracted simple polygon layer by surface function (road surface, sidewalk, terrain, driveway), we can create surface complexity maps (either tiled or per polygon layer) that can provide a basic surface classification (asphalt, Tile, Terrain) as well as a respective complexity map associated with each polygon. The complexity map would be visualized as a heatmap denoting areas with simple to no patterns across a spectrum to areas with very complex and ornate patterns such as mosaic tiling. Terrain meshes would not receive a complexity map, that means that terrain polygons will just be classified as unpaved. The advantage with this approach is that the initial polygon layer is greatly simplified. Changes in the tiling on the sidewalk do not need to be reflected in the polygon geometry. Those changes should be reflected in the attached complexity map for that polygon.



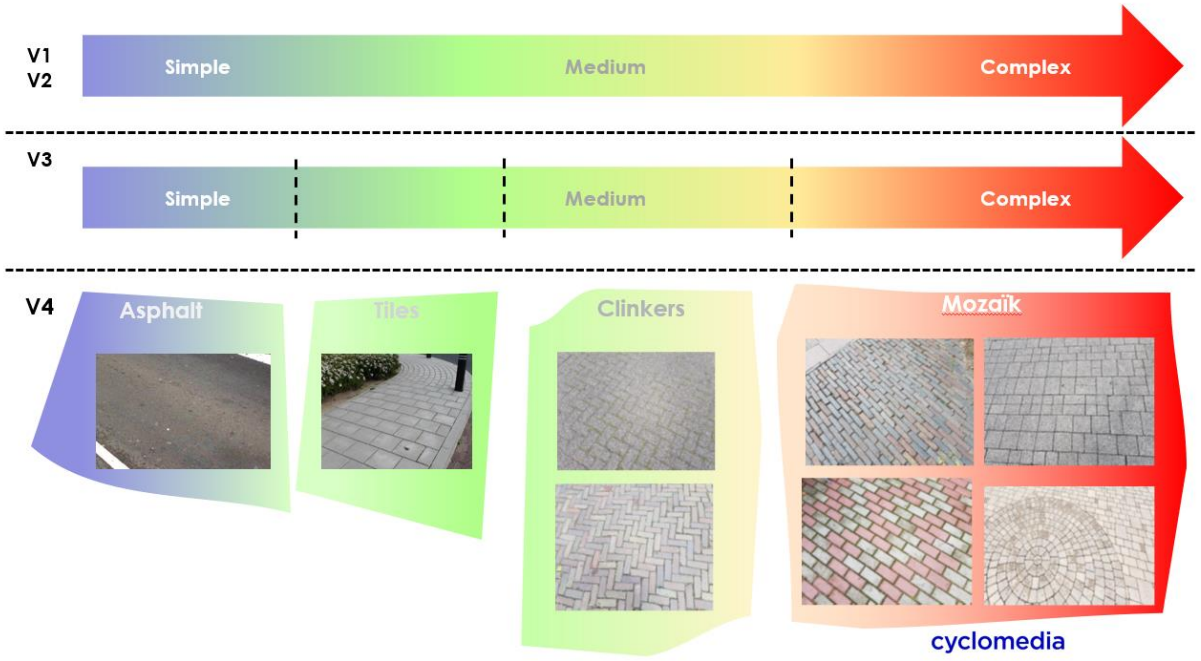
The images above show a representation of what the complexity maps may look like. The left image is an RGB surface tile. The right image is a quick kernel built to look at local complexity within the image to create a heatmap where Green is the least complex, Red is the most complex. The plan is to build a semantic mask model that would provide a single 0-1.0 output

per pixel based upon the local complexity within the image. This model will be trained to ignore shadowing and other lighting effects or artifacts on the roadway to minimize the variation. Therefore reducing the chance of giving a wrong classification to the polygon. Cyclomedia will focus on getting a clean graduation of complexity based upon larger feature patterns in the area as opposed to smaller noise patterns.

3.3 Roadmap

The roadmap for this product would of four versions. This is also shown in the picture below.

- v1 – Tiled Complexity Heat Maps corresponding to existing polygon layer areas.
- v2 – Improvements to complexity classification results based upon client needs and feedback.
- v3 – Simplify the complexity graduation to be discrete intervals.
- v4 – Generate 3D polygons for SHP representation of the complexity graduation.



V1 – Tiled Complexity Heat Maps corresponding to existing polygon layer areas.

V2 – Improvements to complexity classification
V1 is about developing the initial complexity maps. In version one the heatmaps are continuous 0-1.0 ranges. V2 is about changes and tweaks to the v1 algorithm based upon client feedback. The output of V1 and V2 are GEO-TIFS

V3 – Simplify the complexity graduation to be discrete intervals.
In version 3, we will work with the partners to come up with an accepted complexity graduation, say 4 or 5 buckets from low to high complexity.

V4 – Generate 3D polygons for SHP representation of the complexity graduation.

Once those discrete intervals are determined, we can then proceed to step 4 of generating these polygon layers automatically from the complexity maps that represent each discrete complexity interval. The polygons are based upon the discrete intervals we decide in v3 with the clients. The actual border of those polygons will derive the same positional accuracy as the heatmaps themselves in v1. But how segments cluster together will be entirely dependent on the number of discrete classes we decide to end up with. 3 classes (low, med, high) will have a very different result than 10 classes (complexity 1-10).

4. Scope

4.1 Product PoC scope

The goal of this PoC is to confirm that it is technically feasible to create a surface type data layer according to the requirements set by KPN, Vodafone, VWT, and Allinq. This data layer should also fit in to the processes of the PoC partners. Cyclomedia believes that the development of version 1 to 3 of the complexity model does provide answer to these questions. Therefore, we propose that we the scope of the PoC is the development of version 1, 2 and 3 of the model.

4.2 PoC test areas

To verify the model works as expected we propose three representative test areas. The test areas range from urban city centers to suburban and villages:

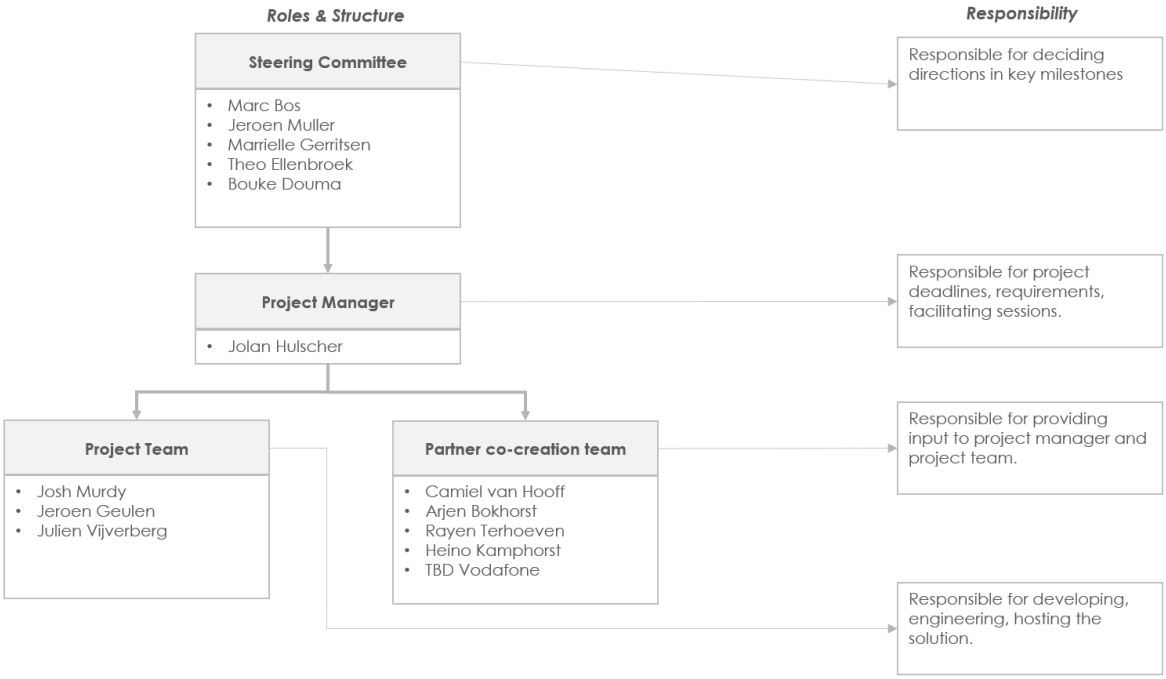
- Doorn – Entire village
- Leiden – City center and suburban area.
- Utrecht – City Center

5. Collaboration

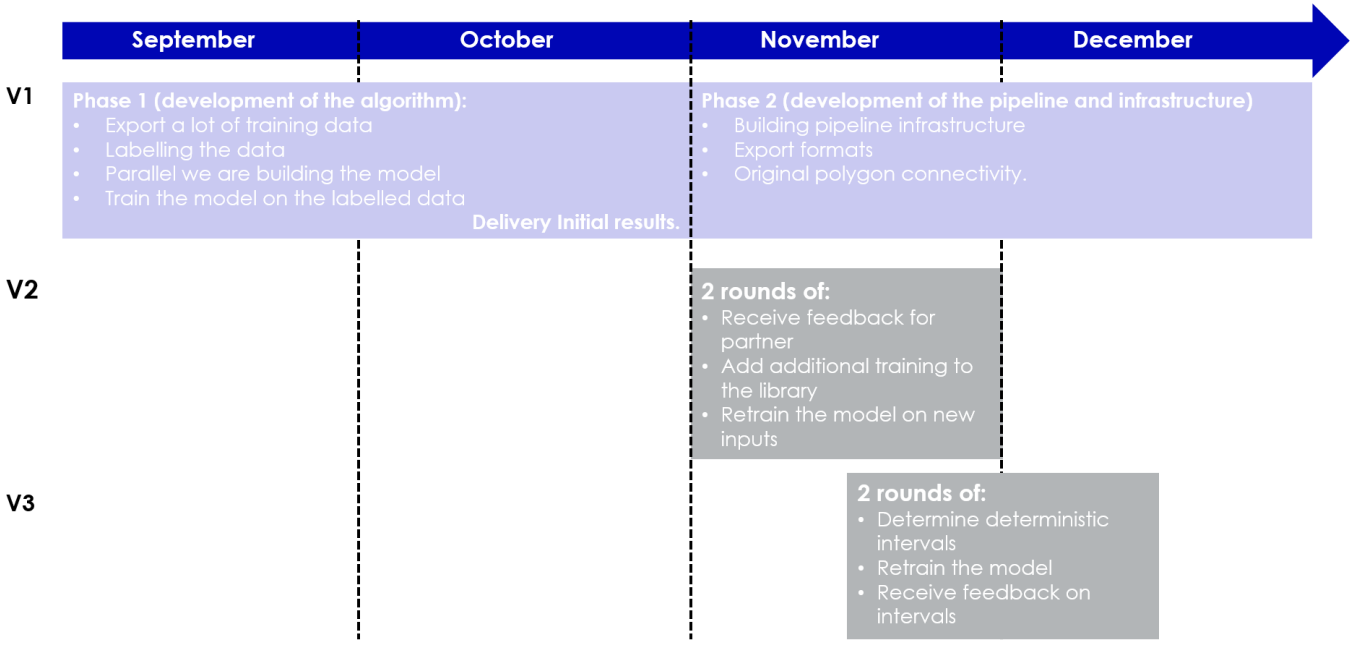
For the POC, we suggest the roles and structure illustrated in the picture below. The steering committee, consisting of the managers of each participating party, is responsible to track progress of the project and make key decisions at the end of each development sprint.

Jolan Hulscher (Cyclomedia) will be responsible to manage the POC, meaning that he set the meetings, deadlines, and facilities collaboration between the project team and client co-creation team.

The project team consists of data scientists, data engineers, and software developers of Cyclomedia. They are responsible to develop the POC according to the requirements. Last, the Partner (co creation team consists of fibre / coax engineers. They are the end user of the data layer. We will host two sessions with them. One at the start of the POC and one at the middle of the POC. Next to that, it's important that they can swiftly answer questions of the project team.



6. Timeline



Partner co-creation team sessions:

- 13th of September: Kick off & input session
- End of October: Review of initial results
- Mid of November: Review of retrained model results & start determining deterministic intervals
- Start December: Review of final model results & 2nd round deterministic intervals
- Mid December: Review of final round deterministic intervals

Steering group sessions:

- End of October: Review of initial results
- End of November: Review of final model results
- Mid December: Review of model and deterministic intervals

7.Investment

7.1 PoC investment

Internally we checked investment to be made to develop the PoC. This resulted in the following expenses:

Version	Type of expense	Expense
V1		
	Development hours	20k euro
	Data labeling	2k euro
	GPU / Cloud	10k euro
V2		
	Development hours	8k euro
	Data labeling	2k euro
	GPU / Cloud	Incorporated in v1
V3		
	Development hours	8k euro
	GPU / Cloud	Incorporated in v1
	Total:	**50k euro**

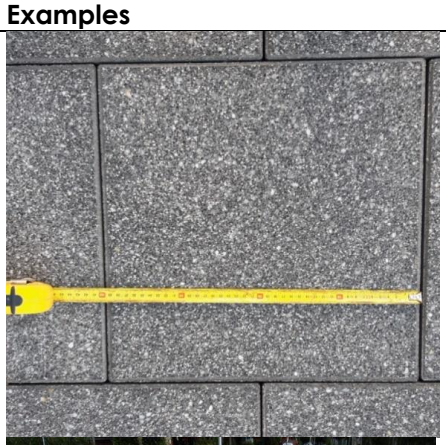
We will share these expenses equally among the PoC partners. That means that KPN, Vodafone, Allinq, VWT, and Cyclomedia each will put in 10k euro.

7.2 Indicative price commercial product

We send you and email with the indicative price for your organization.

8. Appendix

8.1 Surface type classification

Surface type	Definition	Examples
Tiles (Tegels)	**Confirmed** • Tile Paving Consisting of Normal Rectangular Format • Maximum length and/or width up to 30 cm and tile height up to 7 cm. **Not Confirmed** • IF tile height > 7 cm THEN mozaïk • Tiles according to the laying techniques: stretcher, diamond or longitudinal technique. Otherwise techniques -> set at mozaïk.	 

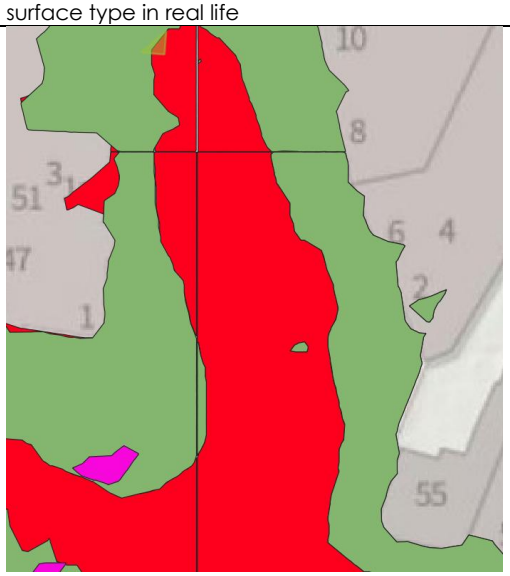
Clinkers (Klinkers)	**Confirmed** • Clinkers consisting of normal rectangular format and laid in the same color. • Maximum 80 pieces/m2. IF Clinkers >80 pieces/m2 THEN Mozaïk. **Not Confirmed** • Maximum height of Clinker is 8 cm. IF >8 cm THEN Mozaïk. • The Clinkers are laid in stretcher, ribbon, twill, elbow, block or diagonal technique and without patterns, with the exception of simple markings such as parking spaces. • The Clinkers can be in the sidewalk as well as in the road section.	 Clinkers without pattern -> Clinkers  <80 pieces per /m2 -> Clinkers  <80 pieces /m2 -> Clinkers

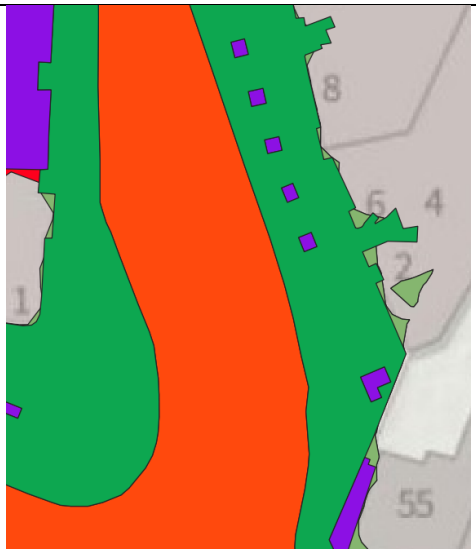
		 <80 pieces /m2 -> Clinkers
Mozaïk (Sierbestrating)	**Confirmed** • H-Format Clinker, Double Clinker, Clinkers in driveway, speed inhibitors, or parking spaces. • Clinkers >80 pieces/m2. • Tiles in different sizes • Clinkers is different colors **Not Confirmed** • IF tile height > 7 cm THEN mozaïk • IF Tiles are NOT according to the laying techniques: stretcher, diamond or longitudinal technique THEN mozaïk. • Maximum height of Clinker is 8 cm. IF >8 cm THEN Mozaïk.	 H shaped clinker -> Mozaïk  >80 pieces /m2 -> Mozaïk  Tiles in multiple shapes -> Mozaïk

		 Clinkers is complex color pattern -> Mozaïk  Clinkers in complex shapes -> Mozaïk
Asphalt (asfalt)	**Confirmed** • Surface type made of asphalt	 
Unpaved (berm)	**Confirmed** • Surface with no appreciable cover other than greenery. **Not confirmed** • IF verge/lawn THEN unknown • IF gravel THEN Unknown	

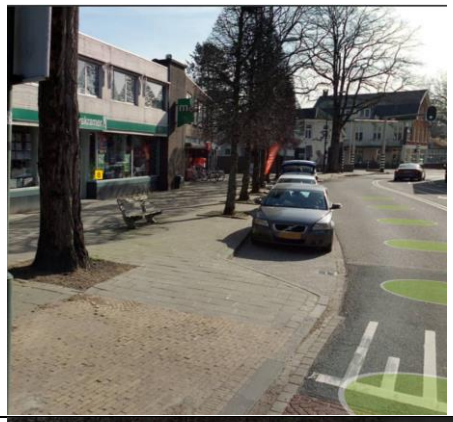
		

8.2 Level of detail

Requirement	Explanation	example
Placement accuracy of polygon is 10 cm	The surface type in the data layer can deviate max 10 cm from the real world surface type.	 Tiles can be 10 cm off the real place of where they are in real life
Placement accuracy requirement of polygon edges along the surface is 10cm	The line between two surface types can be maximum 10 cm off with regards to the real life situation	 Tiles are allowed to be 10 cm in the mozaïk surface type in real life
Lines are not required to be straight	Top picture is the current automated pipeline. Middle picture is the manual product of Cyient. Bottom picture is the Dutch open dataset (BGT). We discussed that the don't have to be as straight as the manual data layers (Cyient and BGT). But should be more straight as the current automated pipeline. Here, we should meet somewhere in the middle. However, we could also use the opendata set to draw the straight lines.	

		 8 6 4 2 1 55  10 8 51 3 1a 6 4 47 2 1 55

8.3 Minimum acceptable square meters

Requirement	Explanation	Example
Small Greeneries such as Tree boxes are a nice to have -> not priority/ not needed	As shown on the right, greeneries where trees are placed are not needed since there already is a data layer available for trees. Comment from telco's: If it doesn't cost more, then do. Otherwise, don't.	 
Mozaïk often comes in smalles areas -> priority / needed	The circle is a relatively small area. However, this is the mozaïk that the telco's want to avoid.	

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