



The implementation of high-quality cycle path (Fietsroute Plus) along the Hoofdstraat in Midwolde and Lettelbert of Municipality Leek

Final Thesis

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372170

International Civil Engineering Management



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Preface and Acknowledgement

Being in Groningen for about nine months, I found the joy of cycling around the city daily with my small bicycle, or the so-called *fietsje* in Dutch. That is why I was really excited to be able to design Fietsroute Plus Groningen-Leek as my final thesis. The project was given by Provincie Groningen through Mr. Fokke Woudstra. From the project, I can learn a lot about things related to bicycle infrastructure. During the process, I also enjoyed cycling to different places in the city of Groningen, Municipality Haren, and also the Hoofdstraat Midwolde and Leek to take some photos for the final thesis. It was killing two birds with one stone.

Throughout this process, I would like to thank Mr. Fokke Woudstra from Provincie Groningen as my company supervisor and Mr. Dirk Ernten as my supervisor from Hanzehogeschool for their guidance. Then, my thanks also go to Mrs. Greet Luursema and Mr. Hans Buis from Provincie Groningen for their inputs that I can use for my final thesis. Furthermore, I am thankful for the ideas that were gathered by the related stakeholders during the expert session Fietsroute team.

I am so grateful and blessed for being able to end my bachelor's degree program with this final thesis. Finally, I wish you a pleasant reading.

Groningen, 28 May 2018

Irene Sitohang

I can do all this through him who gives me strength.
(Phillipians 4:13 NIV)

Summary

The Provincie Groningen wants to connect people from Municipality Leek and Groningen better with a high-quality cycle path, namely Fietsroute Plus. In the exploration phase, a route was decided and it will pass through the Hoofdstraat in Midwolde and Lettelbert, which are two villages in Municipality Leek. This is a problem for the construction of Fietsroute Plus because there is not enough land to construct a separate cycle path along Hoofdstraat. Therefore, the route will be located on the Hoofdstraat. This creates another problem since the road is not completely free for cyclists and therefore it is not safe for them.

The purpose of this final thesis is to find a solution of the problem, that is why a main question was formulated as follows: “Which is the most suitable solution in terms of safety in traffic for the implementation of Fietsroute Plus along the Hoofdstraat in Midwolde and Lettelbert of Municipality Leek?”. Five sub-questions were formulated as well.

At first, the information related to safety in traffic and the project was collected. Afterwards, a state of requirements which contains ten requirements of three stakeholders of the project was formulated. Then, three designs were presented, namely Design 1, Design 2, and Design 2b. They were made in presentation design level. Bicycle street (*fietsstraat*) and shared space were the main inspirations of all designs. Although all designs have their own characteristics, there are some things that are applied the same for all, since they are suitable and logical for all designs.

All designs were then assessed with Multi Criteria Analysis. The requirements in the state of requirements got an important role in the assessment, as the designs were assessed based on them. Each requirement got its own weigh according to its importance to safety in terms of traffic. The designs were then evaluated and were given a score for each requirement. It was known afterwards that design 2 is the best design of all.

In design 2, a bicycle street with rabat strip in the middle is applied inside the built-up area, and a road with suggestion strip is applied outside the built-up area. Moreover, there are two shared spaces which are located in Lettelbert.

The final step was to develop design 2 into provisional design. Cross sections were presented as well. In addition to that, some pictures of impression were made. At the end of the final thesis report, conclusion and some recommendations for the project are given.

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Chapter 1: Introduction

1. Introduction

This chapter contains background information, the location of the project, problem, and goal of the final thesis. Then, a reading guide is given at the end of this chapter.

1.1. Background information

The Provincie Groningen, which is the public administration of the province of Groningen, is currently working on the implementation of high-quality cycle paths (herein is called Fietsroute Plus). The Fietsroute Plus is a wider and more comfortable cycle path that connects Groningen and nearby municipalities. It is hoped that with Fietsroute Plus, more people commute with their bicycles from one municipality to the other. This is one of the concrete plan to implement the Bicycle Strategy 2016-2025 (*Fietsstrategie 2016-2025*) in the province of Groningen.

A work is in progress for the Fietsroute Plus Groningen-Leek. In the exploration phase of the project, a route along the highway A7 was chosen. The next phase, which is the plan development phase, is to see some design possibilities for the route before it is being constructed. A certain part of the whole Fietsroute Plus will use the Hoofdstraat¹ in Midwolde and Lettelbert in Municipality Leek (hereinafter referred to as the Hoofdstraat). The total length of the route in Hoofdstraat is 3.5 km. This final thesis is related to Fietsroute Plus Groningen-Leek in Hoofdstraat.

1.2. The location of the project

The province of Groningen is one of twelve provinces in the Netherlands which is situated on the north side of the country. It neighbors two provinces: Friesland on the west side and Drenthe on the south side. Furthermore, it borders Lower Saxony, a state in Germany, on the east side. The city of Groningen serves as the capital city of the province.

The Municipality Leek is one of twenty municipalities in the province of Groningen, which is located on the west side of the city of Groningen. Midwolde and Lettelbert are two of villages within the municipality. Both villages are connected with the Hoofdstraat. It is the main road for the both villages as well. Figure 1 shows the location of Hoofdstraat. The figure shows two important roads located near the Hoofdstraat as well, namely road A7 and road N372. The roles for these roads are explained in sub-chapter 4.1.

¹ The word '*straat*' means street in English.

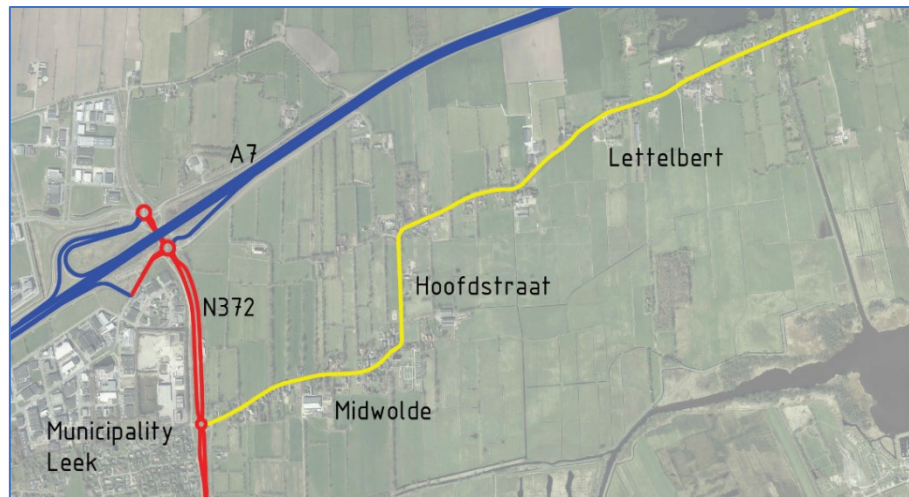


Figure 1: Location of Hoofdstraat

1.3. Problem

The Provincie Groningen made its own guideline for the Fietsroute Plus in the province. The guideline is meant for an ideal situation, where a separated cycle path² can be constructed. It is not possible to construct a separated cycle path along the Hoofdstraat, because there is a lack of space for that. For that reason, the Fietsroute Plus will be implemented on the existing road and the road should be available for the vehicles as well. However, there are some points from the guideline that can be applied even with this condition. The problem with mixed use road is related to safety in terms of traffic of the cyclists. Moreover, there are several speed limits along the road which cause the road to be not safe for the cyclists.

According to a bicycle survey to the residents in Leek by Provincie Groningen through Royal Haskoning DHV (2014), 105 respondents gave good scores for the road flatness, delay, and vehicles nuisance. Respondents gave average score for traffic safety, and bad scores for car lighting and wind.

1.4. Goal

The outcome of the final thesis is the most suitable solution in terms of safety in traffic, which was tested with Multi Criteria Analysis (MCA). The MCA was based on the stakeholders' wishes, which are listed on state of requirements. The result of this final thesis serves as the recommendation for the Provincie Groningen for the implementation of the part of Fietsroute Plus Groningen-Leek in Midwolde and Lettelbert, Municipality Leek. In the future, it will bring benefits for the residents in Leek to use bicycle as a transportation mode to Groningen with Fietsroute Plus more frequently.

² Separated cycle path: A cycle path which is separated from a road by, for example, berm.

1.5. Reading guide

This final thesis is divided into 8 chapters. Research method is explained in Chapter 2. Chapter 3 and Chapter 4 respectively contain information about Fietsroute Plus and the Hoofdstraat and its situation. Next, Chapter 5 contains the state of requirements. Then, Chapter 6 contains brief explanation of the design alternatives, which complements the appendixes. After that, Chapter 7 contains the assessment and solution of the problem. Finally, Chapter 8 contains conclusion and recommendation.



Chapter 2: Research method

2. Research method

In order to obtain the goal of the final thesis, a main question and five sub-questions were formulated. This chapter contains the questions, alongside the research workflow and boundaries.

2.1. Research questions

Main question

Which is the most suitable solution in terms of safety in traffic for the implementation of Fietsroute Plus along the Hoofdstraat in Midwolde and Lettelbert of Municipality Leek?

Sub-questions

1: What is the Fietsroute Plus and how does it differ from the regular cycle paths?

Literature study was done to answer sub-question 1. The Provincie Groningen published *Verbinden met de fiets: Fietsstrategie 2016-2025 Provincie Groningen* which includes the guideline for the Fietsroute Plus. This publication was the point of reference to compare the Fietsroute Plus with the regular cycle paths.

2: What is the problem at the location of the research, which is related to safety in traffic?

Sub-question 2 was formulated to know more about the Hoofdstraat and its current situation related to safety in traffic. The result of the sub-question was used for formulating the state of requirements and designing the alternatives. Secondary data from Provincie Groningen was used.

3: What are the requirements of the involved stakeholders to solve the problem?

The outcome of sub-question 3 is a state of requirements, which is the following action of collecting data from sub-question 2. The stakeholders' wishes were put to consideration for the solution of the problem.

4: What are the alternatives to solve the problem and how are they assessed?

The design alternatives were created in presentation design level. Afterwards, they were assessed with Multi Criteria Analysis. The criteria were based on the state of requirements. Sources which are related to road and bicycle infrastructure design were important during this phase.

5: How does the design of the most suitable solution in terms of traffic safety look like?

After the assessment, the best design was improved to the provisional design level with the cross section. The sources which are related to road and bicycle infrastructure design were important during this phase as well. Then, some impressions of the design were also made.

2.2. Research approach

The final thesis was done by following the PODOE method. With this method, the research was done systematically by identifying problem (*Probleem*), finding causes (*Oorzaak*), formulating objectives (*Doel*), designing and implementing solutions (*Oplossingen*), and finally doing evaluation (*Evaluatie*). Evaluation is meant to be done after the implementation or construction of the Fietsroute Plus, therefore it was not possible to do the evaluation in this final thesis.

2.3. Workflow

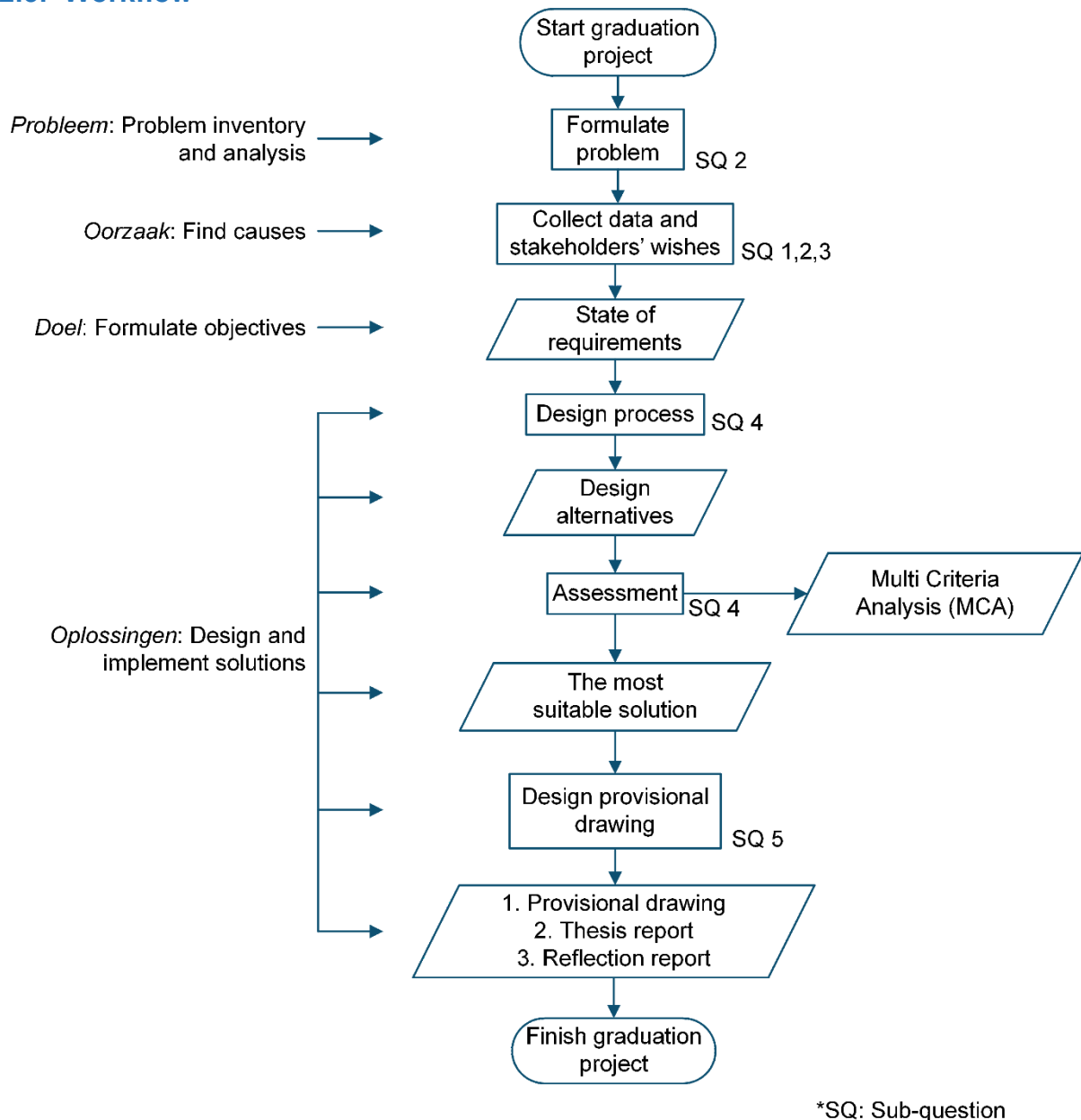


Figure 2: Research workflow

2.4. Research boundaries

- a. The final thesis focused on safety in traffic, which was divided into objective and subjective safety. Crime safety was not included.
- b. The location of the project is at Hoofdstraat in Midwolde and Lettelbert of municipality Leek.
- c. The designs and the assessment with Multi Criteria Analysis were made according to the State of Requirements.



Chapter 3: Fietsroute plus

3. Fietsroute plus

Chapter 3 answered sub-question 1. It contains the situation of bicycle infrastructure in the Netherlands, including the Fietsroute Plus. A table of comparison between Fietsroute Plus and regular cycle path is given at the end of this chapter.

3.1. Cycling in the Netherlands

The bicycle is an important thing for the life of the people in the Netherlands. It is used as a mode of transportation alongside car and other type of vehicles. People like cycling because it is healthy and faster, while cycling in the city. The Netherlands has 22 million bicycles in the country, that is 1.2 bicycles per resident (Statistics Netherlands, 2016).

The country has extensive bicycle infrastructures to accommodate the cyclists. Almost 35000 km bicycle infrastructures were constructed in 2016 (Statistics Netherlands, 2016). Figures 3 show the bicycle infrastructures in the form of separated cycle path (Figure 3a) and cycle lane on the road which is separated by road markings and most of the time with red asphalt (Figure 3b). If there is a lack of space for a cycle infrastructure or other possible reasons, a road is used to accommodate both vehicles and bicycles (Figure 3c). The most distinguished characteristic of a cycle path is the use of red asphalt as pavement, and sometimes red bricks are also used.



Figures 3: Cyclists on the roads

Cycling is not only popular to be done within a city or a municipality, but also inter-city or inter-municipality. Especially in the province of Groningen, the Provincie Groningen is expanding its bicycle network between Groningen and surrounding municipalities. The bicycle network is composed of numbers of Fietsroute Plus and other cycling infrastructures (see Figure 4).

Figure 4: Cycling network in the Province of Groningen³
(Provincie Groningen, 2017)

The Fietsroute Plus, or is translated in English as high-quality cycle path, connects the city of Groningen and nearby municipalities within the distance of 15 km. It is designed in such a way that the cyclists have a pleasant and save travel so more people consider bicycle as a transportation with such distance to the city instead of using cars. The Fietsroute Plus will not only accommodate the 'normal' bicycle, but also other types of bicycle, for example e-bike and pedelec. E-bike and pedelec have maximum speed of 25 km/h and 45 km/h respectively, while normal bicycle has an average speed of 15 km/h. However, the pedelec cannot be ridden more than 30 km/h as the Fietsroute Plus is designed for speed of 30 km/h.

³ Thick yellow and thick blue lines indicated the Fietsroute Plus. The Fietsroute Plus in blue line means it is already realised or will be realised soon, while the one in yellow line means that it is a potential Fietsroute Plus.

Table 1: Differences between Fietsroute Plus and regular cycle path

No	Aspect	Fietsroute Plus	Regular Cycle Path
1.	Width	Ranging from 2.5–4 m (one direction) and 4–5 m (two directions), depending on the cyclists' intensity	Minimum 1.7 m, preferred 2.2 - 2.5 m (one direction)
2.	Protection against wind and car headlight	Yes, suited to the surrounding	No
3.	Distance from the (provincial) road (berm width)	Preferred 6 m, minimum 3 m (at intersection 6 m)	Customized
4.	Minimum number of intersection with other traffic	Yes	No
5.	Obstacle free zone	1.5 m	Not applicable
6.	Detour factor	Preferred 1.1, maximum 1.2	Not applicable
7.	Waiting time at traffic light	Maximum 60 seconds	As short as possible



Chapter 4: The Hoofdstraat and its situation

4. The Hoofdstraat and its situation

Chapter 4 contains information about the Hoofdstraat and its situation in relation to safety in terms of traffic, except for sub-chapter 4.6 (*Natuur Netwerk Nederland*). By this chapter, sub-question 2 was answered.

4.1. Roads in the Netherlands

The sustainable safety vision⁴ divides roads in the Netherlands into three types (see Table 2). The roads in the Netherlands are also distinguished whether they are inside the built-up area or outside the built-up area. Due to this differentiation, the speed limit of the road can be different.

Table 2: Type of roads in the Netherlands according to Sustainable Safety Vision

No	Type of road	Function	Example*
1.	Through road (<i>stroomweg</i>)	<ul style="list-style-type: none">- Connect places with high speed- No conflict both on the road and at intersections	Road A7
2.	Distributor road (<i>gebiedsontsluitingsweg</i>)	<ul style="list-style-type: none">- Connect through road and access road- No conflict on the road but there are conflicts at intersections	Road N372
3.	Access road (<i>erftoegangsweg</i>)	<ul style="list-style-type: none">- Connects distributor road and resident's area- Conflict both on the road and at intersections	Hoofdstraat

* The location of the roads is shown in Figure 1

(SWOV, 2012)

Other types of roads are parallel road (*parallelweg*) and side road (*zijweg*). Parallel road is a road for slower traffic and usually can be found alongside a through road or a distributor road, while side road is a road that connects access road and a place of residence.

4.2. The Hoofdstraat

According to Sustainable Safety vision, the Hoofdstraat is classified as an access road. Inside the villages Midwolde and Lettelbert, the road is classified as inside the built-up area, and the road in between the villages is classified as outside the built-up area. There is no parallel road alongside Hoofdstraat, but there are many side roads which are connected to the road.

⁴ Further explanation about Sustainable Safety vision:
https://www.swov.nl/sites/default/files/publicaties/gearchiverde-factsheet/uk/fs_sustainable_safety_background_archived.pdf

The road is paved with grey asphalt (closed pavement) and the intersections are differentiated by applying red asphalt. In average, the width of the road is 5.5 m. There is no special lane for cyclists inside the built-up area, but there is suggestion lane with suggestion strips outside the built-up area. Suggestion strips are road markings which indicate that cyclists are suggested to cycle inside the suggestion strips (in other words, it is a suggested lane for the cyclists). When two cars pass through one another in different directions, the drivers may use the suggested lane.

Along the road, there are many residential buildings and some commercial buildings. Mostly, they are located inside the built-up area. Open spaces are seen more outside the built-up area. The properties are closely located near the Hoofdstraat.

Vehicles such as cars, buses, and agricultural vehicles are also driven along the road. Due to its location which is near the road A7, many drivers use the Hoofdstraat as an alternative route when road A7 is busy during the peak hours. In fact, the road N372 serves as the alternative route for road A7. Many drivers drive at high speed on the Hoofdstraat and this is not good for the cyclists in terms of safety in traffic.

4.3. Cycling on the Hoofdstraat

Based on the Bicycle Survey (Royal HaskoningDHV, 2014), the respondents cycle mostly from Municipality Leek to the city of Groningen, with the distance of around 15 km. 63% respondents cycle at least four days per week. 47% respondents include Hoofdstraat as their route while cycling between Groningen and Leek.

There are around 350 cyclists who use Hoofdstraat in the working day. Moreover, another 350 cyclists from different route converge with the initial 350 cyclists before the bridge crossing Lettelberterdiep (a canal) in Lettelbert (direction to Groningen), thus making that part of the route busy with 700 cyclists.

4.4. Road accidents

In 2014-2017, there were a total of seven accidents which were happened and recorded at Hoofdstraat (Provincie Groningen, 2018). An accident between cyclist and car driver occurred in 2014 in Lettelbert. The cyclist was injured in the accident. The other accidents were between cars and cars, street light, and trees. Figure 5 shows that the accidents were in three different locations inside the built-up area.

Despite the number of accidents at Hoofdstraat, the road is still considered safe. De Poffert, a hamlet which is located around 7 km from Midwolde and around 4.5 km from Lettelbert, had more accidents and more locations of accident in 2014-2017 (Provincie Groningen, 2018). Even so, the

Hoofdstraat should be designed so that the road users can safely use the road and the number of accidents goes down. The locations of accident should receive more attention since they are the dangerous parts of the route.

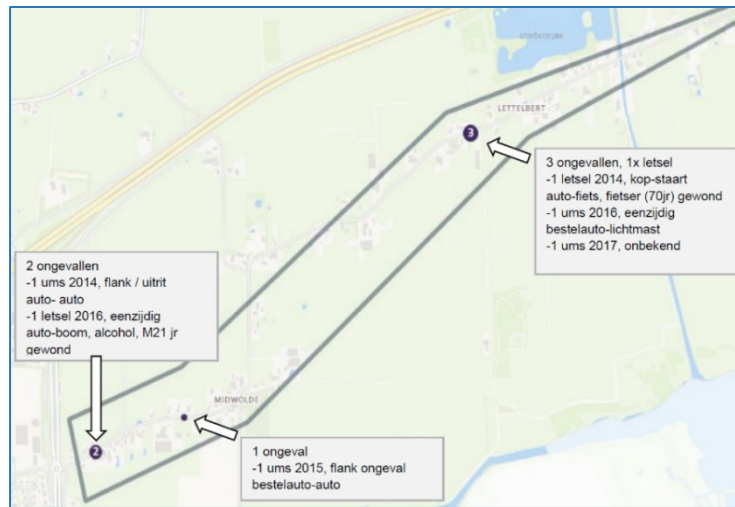


Figure 5: Road accident map along the Hoofdstraat (Provincie Groningen, 2018)

4.5. Speed limit

A road has a certain speed limit according to its classification and its location against the built-up area. On the road, speed limit border is usually shown with traffic sign and markings. Table 3 shows the speed limit on general access roads and on the Hoofdstraat. Appendix 1 shows the speed limit on the Hoofdstraat. As the owner of the Hoofdstraat, Municipality Leek is responsible for the road and has a right to make policies for its roads, including the policies which are related to the speed limit.

As shown on Table 3 and Appendix 1, the Hoofdstraat has three types of speed limit. For cyclists, cycling is not safe alongside traffic with the speed of more than 30 km/h. This is worsened with the fact that there is no dedicated cycle path or cycle lane along the road.

The Fietsroute Plus Groningen – Leek might, or might not, affect the current speed limit, by applying several traffic calming measures, moving the built-up area border (which means moving the speed border as well), or even changing the speed limit. The adjustments should not only be beneficial to the cyclists, but to the other road users as well.

Table 3: Speed limit of general access roads and the Hoofdstraat

Location	General access roads (km/h)*	Hoofdstraat (km/h)
Inside built-up area	30	50
Outside built-up area	40/60	60
Intersection outside built-up area	30 (with slow traffic), 50 (without slow traffic)	30
Intersection inside built-up area	30	30

*source: (CROW, 2013)

4.6. Public transport

Bus line 88 runs through the Hoofdstraat once an hour every day. Along the Hoofdstraat, there are 6 pairs of bus stops, in which the bus stops near the Church of Midwolde have platforms. The Hoofdstraat should be designed so that the bus can pass through the road. It means that the road cannot be too narrow for the bus of 2.55 m wide. When the bus can pass through the road, the road will be accessible for the smaller vehicles (ex: personal cars) as well.

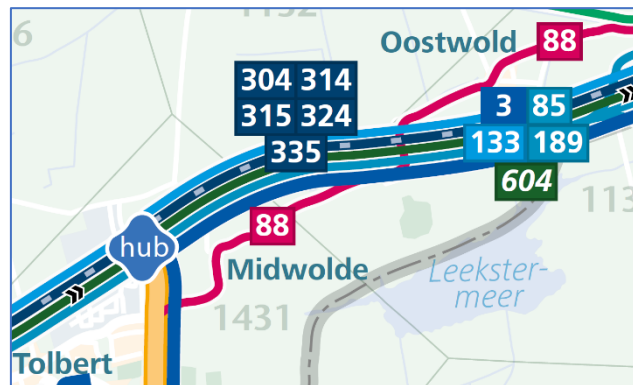


Figure 6: Bus network on the Hoofdstraat and surroundings (Qbuzz, 2017)

4.7. Natuur Network Nederland (NNN)

Figure 7 shows the areas near the Hoofdstraat which are determined as *Natuurnetwerk Nederland* (NNN, translated in English as the Nature Network Netherlands). NNN is a way of the government to preserve the nature and keep it from extinction. There are some parts of the road in Midwolde which are situated next to NNN area. Although NNN is not related to safety in terms of traffic, it is important to have a solution for the Hoofdstraat which doesn't harm the protected area.

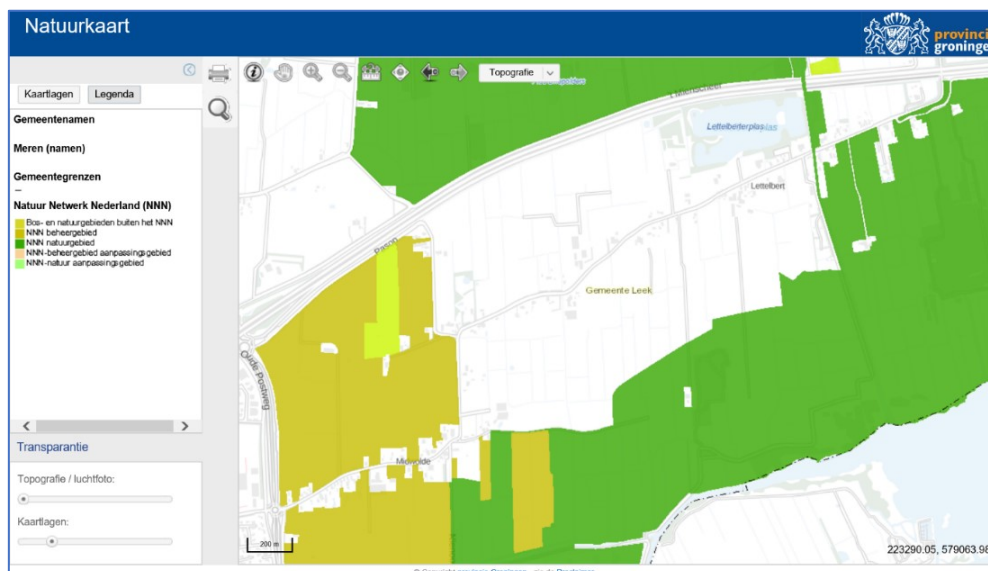


Figure 7: NNN map of the Hoofdstraat and surroundings (Provincie Groningen, 2018)



Chapter 5: State of requirements

5. State of requirements

For the final thesis, a state of requirements was made (see Table 4). The state of requirements answered sub-question 3. It has in total ten requirements from three stakeholders in which were going to be used during the design and assessment processes in the following phase of the final thesis.

Provincie Groningen, Municipality Leek and the community are considered as stakeholders. The community is generally the road users of the Hoofdstraat, including the residents along the road. The requirements were discussed together with the Provincie Groningen for all stakeholders. As the requirements of the Cyclists' Union (Fietzersbond) are likely to be the same with the ones from the community, it was decided that community also represented the requirements of the Cyclists' Union.

The requirements were based on safety in traffic. Safety is divided into two types: objective safety and subjective safety. Objective safety can be measured, for example the number of accident. A road should be designed as safely as possible so that the parameter of objective safety can be fulfilled. In Hoofdstraat, objective safety is related to the number of accident on the road. Meanwhile, subjective safety is related to the feeling of safety of the road users. For cyclists of Hoofdstraat, the road is not really safe because the cars sometimes are driven fast. This is a problem for them as the road is accessible for all road users, so they can feel unsafe when they cycle with a relatively slower speed than the car's speed. Moreover, the cyclists are afraid of cycling at night as there might be a possibility of crime. However, the safety which is related to crime is not considered in the state of requirements.

Table 4: State of requirements

No	Stakeholders	Role	Requirements	Remarks*
1.	Provincie Groningen	1. Responsible for the Fietsroute Plus Groningen - Leek Project 2. Responsible for the nature in the province of Groningen	1. There is clarity in material and dimension	OS
			2. The route has some attracting points: protected against wind and or rain, trees planted along the route, or other approach while considering the natural landscape	SS
			3. Road markings are applied for the whole route	OS
			4. The important intersections along the road are recognizable: intersection between Hoofdstraat and Nienoord (Midwolde), Pasop (outside built-up area), Lettelberterplas (2 intersections in Lettelbert), Watersportcentrum Lettelbert, Hooilanden (Lettelbert)	OS
			5. Obstacle-free zone of 1.5 m for the whole route	SS
			6. Use closed pavement, such as asphalt and concrete	OS
2.	Municipality Leek	The owner of the Hoofdstraat	7. The design is appropriate for the speed limit	OS
			8. Important objects or buildings along the road are emphasized: -Churches -Lettelbert bridge -Watersportcentrum Lettelbert -Lettelberterplas	SS
3.	Community	1. Bicycle users 2. Residents who live along the Hoofdstraat 3. Other road users	9. The route is wide and comfortable for cyclists, with width of the road for one direction is as much as possible the same width for the ideal Fietsroute Plus width (2.5 m)	OS
			10. There is a solution for the locations of accidents along the Hoofdstraat	OS

*OS: Objective safety

SS: Subjective safety



Chapter 6: Alternative designs

6. Alternative designs

In this chapter, three designs (namely Design 1, Design 2, and Design 2b) are explained. Prior to the designs explanation, information about bicycle street and shared space, which are the sources of inspiration for the designs, are presented. Then, the things which are applied the same for all designs are informed following it. The explanations for the designs come afterwards. These designs are made in presentation design level and can be found in Appendixes 4, 5, and 6.

6.1. Bicycle street (*fietsstraat*)

A bicycle street allows the cyclists to get priority over the vehicle drivers. The vehicles are expected to be driven more slowly as they are the guests of the road. Some examples of bicycle street in the province of Groningen are Bessemoerstraat in the city of Groningen and Jachtlaan in Municipality Haren. The main similarity of these examples is the application of red asphalt for the street. It is used because it is highly associated with bicycle path in the Netherlands. The bicycle street has rabat strip (*rabatstrook*) along the street. The rabat strip is a strip along the road which has different material and color than the street itself. The materials which are used for the strip are, for example, bricks and StreetPrint (asphalt which is printed with brick patterns).



Figure 8: Bicycle streets at a) Bessemoerstraat, Groningen and b) Jachtlaan, Haren

6.2. Shared space

In some places in the Netherlands, a shared space is implemented. A shared space, which was firstly initiated by a Dutch traffic engineer Hans Monderman, facilitates all road users: vehicle drivers, cyclists, and pedestrians, on one road. The interesting thing about shared space is that there are limited or even no road features: traffic signs, road markings, or traffic lights. The goal of that manner is to cause confusion for the road users as it is unclear who has the priority. Then, all road users need to be

careful and have to do an eye-communication with each other in order to move (Toth, 2009). In other words, all road users are equal on the shared space.

6.3. Workshop expert session fietsroute team

On 9th April 2018, a workshop was done to discuss about the possibilities for the Fietsroute Plus Groningen Leek in the Hoofdstraat and also the part in Roderwolderdijk (see Appendix 3 for the Factsheet). The stakeholders, who are related to the project as well as two advisors who also gave their inputs for the topic of discussions, were present. From the workshop, ideas were gathered and for Hoofdstraat, the ideas are listed as follows.

- a. The built-up area borders between inside and outside built-up area are recognizable.
- b. The nature or environment is emphasized at 30 km/h zone.
- c. Ideas for plants in the design: less gap for the plants inside the built-up area and more gap / more open for the plants outside the built-up area.
- d. Shared space can be applied near the churches and other important locations along the route.
- e. The route should be understandable so that cyclists know their position while cycling by applying strips with enough width.
- f. The design as much as possible discourage drivers to use the route and to use another route instead.

6.4. The same things for all designs

There are some changes for the whole route which are made the same for all designs because they are suitable to be applied on all designs and are logical as well.

Inside the built-up area in Midwolde:

- a. The intersection between road N372 and the Hoofdstraat is designed smaller than the current situation. This is done so that the drivers understand that the Hoofdstraat is not wide and they are expected to drive slower.
- b. Three speed bumpers in different places are applied in order to have the drivers drive slower. Two places are located near the accident locations. The speed bumper which will be used should be appropriate with the speed limit of the road.
- c. The intersection of the Hoofdstraat with Nienoord uses the priority to the right system with speed bumpers. This system requires all road users to be careful while passing through the intersections and to pay attention of the traffic from all directions.

Outside the built-up area:

- a. The intersection of the Hoofdstraat with Pasop uses the priority to the right system with speed bumpers. This system requires all road users to be careful while passing through the intersections and to pay attention of the traffic from all directions.
- b. In the designs, the speed border or the built-up area border in Lettelbert is moved nearer to the Church of Lettelbert, where there are more houses in that area.
- c. The intersection between Hoofdstraat and Pasop has the speed limit of 30 km/h and it will not be changed. A calculation to determine the speed limit based on the radius of the intersection has been done. It is known that the horizontal radius is 55.54 m, thus the appropriate speed limit is 32 km/h. Such number is not usual for a speed limit, that is why it is decided to be 30 km/h. The calculation can be seen in Appendix 9.

Inside the built-up area in Lettelbert:

- a. Two shared spaces near the church of Lettelbert and Watersportcentrum Lettelbert are applied in order to give more attention to the public places. StreetPrint are used for the shared space. For Design 2b, the road in between the shared spaces are also designed to be a shared space, thus making it one long shared space. Figure 10d shows the top view of shared space.
- b. The bridge in Lettelbert which is crossing the Lettelberterdiep is improved by applying StreetPrint with contrast colors, street lights, and name sign for the bridge. In the current situation, the bridge is not distinguishable from the road, so the road users are not aware of the bridge.
- c. From Hoofdstraat in Lettelbert, the red asphalt is continued to Hooilanden in order to guide the cyclists to use Hooilanden afterwards.
- d. In the design, the speed border in Lettelbert near Hooilanden is moved. In the current situation, it is located before the intersection with Hooilanden, but it is then designed to be located after the intersection. It is done so that it is logical to use red asphalt continuously from Lettelbert to Hooilanden.

The whole route:

- a. A speed bumper is placed at every built-up area border. The design is similar with the bumpers in Tolbert (a village which is also located in Municipality Leek) so that the borders in Municipality Leek have a uniform style (in terms of colors and material).
- b. Overall, the route is not changed significantly. It means that there will be no problem for bus line 88 to pass through the Hoofdstraat as in the current situation, there is no problem as well.

6.5. Design 1

In Design 1, the Hoofdstraat is a two-direction road with the total width of 5.5 m for both inside and outside built-up area (see Appendix 4). There is no different in dimension for both parts of the road because it costs more when the road is widened, although later, cost is not considered for the assessment. The following are the descriptions for the road inside and outside the built-up area:

- a. **Inside the built-up area (Midwolde and Lettelbert):** The speed limit is set to 30 km/h, because it is more practical especially in Midwolde to have the same speed limit along the road. Moreover, the road in both villages is safer if the speed limit is lower. The bicycle street is applied with rabat strip at both edges of the road (see Figure 10a). When there is no strip or marking that separate the road, the road users from both directions are not sure how wide is the road that they should use, therefore they will go slower. The intersection between the Hoofdstraat in Lettelbert and Hooilanden has a *punaise* (circle junction – see Figure 9) as a speed bumper.



Figure 9: A *punaise* at an intersection in Jachtlaan, Haren

- b. **Outside the built-up area:** The speed limit is set the same as the current situation, which is 60 km/h, except for the intersection with Pasop. The bicycle street is applied with rabat strip in the middle of the road (see Figure 10b) in order to guide the road users to use their own lane while going with a faster speed limit.

6.6. Design 2

The design can be found in Appendix 5. The following are the descriptions for the parts of the road inside and outside the built-up area in Design 2:

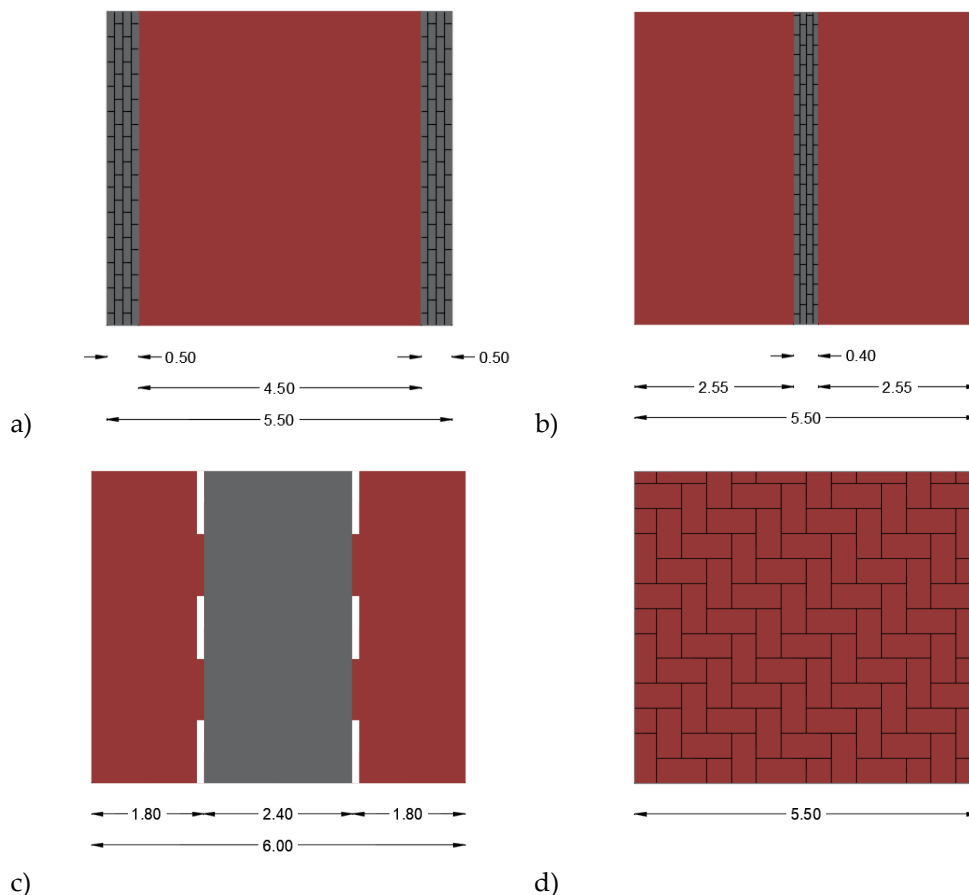
- a. **Inside the built-up area (Midwolde and Lettelbert):** The road is designed with the width of 5.5 m, and the speed limit is kept the same as the current situation (50 km/h). Here, a bicycle street with rabat strip in the middle is applied (see Figure 10b). This type of road is suitable to be applied in 50 km/h zone because there is a clear separation of road for both directions, thus making it safer for the road users when they go fast. The rabat strip is continued to Hooilanden from the

Hoofdstraat in Lettelbert. The bumpers along the road in Midwolde is used for the speed limit of 50 km/h according to CROW. The speed limit of the intersection between the Hoofdstraat and Nienoord is 30 km/h. The speed borders are without speed bumpers because they are located near the intersection, which has already speed bumpers there.

- b. **Outside the built-up area:** The road is designed with the width of 6 m, and the speed limit is 60 km/h, except for the intersection with Pasop. There are suggestion strips along the road and red asphalt is used on the outer part of the road, while (grey) asphalt is for the middle part of the road (see Figure 10c). The road is wider because it is too narrow when the road with suggestion lanes are applied on the road of 5.5 m wide.

6.7. Design 2b

Design 2b is a variation of design 2. The different is that in Design 2b, two shared spaces are merged into one long shared space. By doing so, there are some things that can be added, in which it is more suitable with the fact that the road is a shared space. Next to the entrance of Lettelberterplas, there is a space for people to park their bicycle. Then, a pair of bus platforms with shelter are applied in the middle of the shared space. The bus stops currently have no platform nor shelter.



Figures 10: Top view road pavements for the designs



Chapter 7: Solution

7. Solution

So that the best design is obtained, an assessment was done with Multi Criteria Analysis. The criteria were based on the state of requirements which has been listed before. Following the assessment, the best design was developed into provisional design and road impressions were made as well. Together with chapter 6, chapter 7 answered sub-question 4. Chapter 7 also answered sub-question 5.

7.1. Multi Criteria Analysis

Three designs were assessed with Multi Criteria Analysis and stakeholder's wishes, which are listed in the state of requirements, were used as criteria. For the assessment, a weight was given for each requirement. Every requirement got 10 worth weights as a start. For example, Provincie Groningen had 60 weights as a start because it has 6 requirements. In total, the requirements weighed 100 points. A requirement might be more important than another to each stakeholder, so it got a higher weigh, and vice versa. There were some considerations in giving weigh for each requirement:

- a. The weigh was decided based on its significance to safety in terms of traffic.
- b. The requirement got a low weight if it is not really significance for the road users since they are frequent travelers on the route, although it is significant to the safety.
- c. Some requirements are intended for the ideal Fietsroute Plus. Some of those requirements might work well with the condition in Hoofdstraat, but some of them might not (too ideal, not really realistic). The requirements which might work well got higher weigh.

After deciding the weighs, the three designs were given scores according to the requirements. The best design for each requirement got 3 points, then the 2nd and the 3rd ranks got 2 points and 1 point respectively. When there were two designs with the same qualities, they were given 2 points whereas the best design gets 3 points.

7.2. Assessment

Table 5 shows the result of the assessment with Multi Criteria Analysis for the designs. The explanation for the assessment is given in sub-chapter 7.3. Based on the assessment, Design 2 scored the highest with total score of 2.65. Therefore, Design 2 is the best design.

Table 5: Assessment for each design

Stakeholders	Criteria	Design			Weight
		1	2	2b	
Provincie Groningen	1. There is clarity in material and dimension	3	2	2	7
	2. The route has some attracting points: protected against wind and or rain, trees planted along the route, or other approach while considering the natural landscape	2	2	3	10
	3. Road markings are applied for the whole route	2	3	3	7
	4. The important intersections along the road are recognizable: intersection between Hoofdstraat and Nienoord (Midwolde), Pasop (outside built-up area), Lettelberterplas (2 intersections in Lettelbert), Watersportcentrum Lettelbert, Hooilanden (Lettelbert)	3	3	3	10
	5. Obstacle-free zone of 1.5 m for the whole route	3	2	2	13
	6. Use closed pavement, such as asphalt and concrete	2	3	1	13
Municipality Leek	7. The design is appropriate for the speed limit	2	3	2	13
	8. Important objects or buildings along the road are emphasized: -Churches -Lettelbert bridge -Watersportcentrum Lettelbert -Lettelberterplas	3	3	3	7
	9. The route is wide and comfortable for cyclists, with width of the road for one direction is as much as possible the same width for the ideal Fietsroute Plus width (2.5 m)	3	2	2	7
Community	10. There is a solution for the locations of accidents along the Hoofdstraat	3	3	3	13
Total					100

7.3. Explanation of the assessment

1: There is clarity in material and dimension

Design 1 scored 3 points because the whole route has the width of 5.5 m, while for Design 2 and 2b, they scored 2 points because the width of the road outside the built-up area is 6 m and inside the built-up area is 5.5 m. It is less clear for the road in Design 2 and 2b with the road user's eyes to see the change of the width than in design 1.

2: The route has some attracting points: protected against wind and or rain, trees planted along the route, or other approach while considering the natural landscape

Design 2b scored the highest due to one long shared space in Lettelbert from the Church of Lettelbert to Watersportcentrum Lettelbert. Design 1 and 2 have the same score because the same manner is applied the same for both designs.

3: Road marking are applied for the whole route

The score for this requirement was based on the total length of the marking for each design. The design which has the longest road markings got the highest score. The total length of road markings and its percentage against the whole route for each design are shown as follow:

Design 1: 32,38 m (0,93%)

Design 2: 1188,65 m (33.09%)

Design 2b: 1188,65 m (33.09%)

Thus, Design 2 and 2b scored 3 points while Design 1 scored 2 points. In Design 2 and 2b, road markings are found outside the built-up area (road markings for the suggestion strips) and at the intersection between the Hoofdstraat and Midwolderweg (a side road next to road N372). Meanwhile, road markings are applied only at the intersection between the Hoofdstraat and Midwolderweg. Although road markings are also applied on Hooilanden for Design 1, it was not counted since it is not located on Hoofdstraat. Moreover, the road design at Hooilanden is not complete since it only gives impression of what Hooilanden should look like in when the Fietsroute Plus is being realized with Design 1.

4: The important intersections along the road are recognizable: intersection between Hoofdstraat and Nienoord (Midwolde), Pasop (outside built-up area), Lettelberterplas (2 intersections in Lettelbert), Watersportcentrum Lettelbert, Hooilanden (Lettelbert)

All design scored the same (3 points) because the intersections are designed the same for all designs, except for the intersection between Hoofdstraat and Hooilanden. In Design 1, a *punaise* is applied, then in Design 2 and 2b the rabat strip from the Hoofdstraat is discontinued at the intersection. It is then continued at Hooilanden. The intersections between Hoofdstraat and Nienoord and also Pasop are recognizable with speed bumps at all directions and the discontinued rabat strip. The small part of two side roads leading to Lettelberterplas are paved with StreetPrint with the same pattern and color as the shared space to give more attention to the side roads. The intersection between Hoofdstraat and Watersportcentrum Lettelbert is given the same manner as with Lettelberterplas, with adding a *punaise* to give more attention.

5: Obstacle-free zone of 1.5 m for the whole route

The highest score for this requirement was given to the design which has the biggest percentage of obstacle-free zone of 1.5 m of the whole route. If one side of the pavement does not have 1.5 m of the zone, then it is not calculated.

Design 1: 2087,52 m (59,87%)

Design 2: 1903.48 m (54.59%)

Design 2b: 1903.48 m (54.59%)

Thus, Design 1 got 3 points and both Design 2 and 2b got 2 points.

6: Use closed pavement, such as asphalt and concrete

A closed pavement ensures cyclists to have a convenient cycling experience because the surface of the pavement is flat (thus less hindrance from the pavement itself). Although asphalt is also used for StreetPrint, but due to the pattern, it is more inconvenience for the cyclists. The whole route of Hoofdstraat is paved with asphalt, so the way to assess this requirement was by calculating the area of StreetPrint at each design. The StreetPrint which is used for shared space, bridge, *punaise*, and speed borders were calculated. The StreetPrint on rabat strip was not calculated because it is rarely used by the cyclists as they cycle. They likely use asphalt more. Only when there is a big vehicle, they might cycle on the rabat strip to give room for the vehicle. The design with the least area of StreetPrint got the highest score. The assessment is shown as follows:

Design 1: 3756.95 m²

Design 2: 1763.47 m²

Design 2b: 5286.54 m²

Thus, Design 2, Design 1, and Design 2b got 3 points, 2 points and 1 points respectively.

7: The design is appropriate for the speed limit

For this requirement, design 2 scored 3 points because bicycle street is applied inside the built-up area in Midwolde and Lettelbert with speed limit of 50 km/h, then road with suggestion strips is applied outside the built-up area with speed limit of 60 km/h. The design of the road thus appropriate for the speed limit. Design 1 scored 2 points because the road outside the built-up area with bicycle street indicates the speed should be lowered whereas it is allowed to drive 60 km/h there. Although it is good for the cyclists, it is not that appropriate with such speed limit. Then, Design 2b also scored 2 points because in Lettelbert, the road is 50 km/h but there is a long shared space. A shared space indicates the road to be driven slower, but with such speed limit, it might draw confusion for the drivers especially while driving there.

8: Important objects or buildings along the road are emphasized: churches, Lettelbert bridge, Watersportcentrum Lettelbert, and Lettelberterplas

All designs scored 3 points because the same manner is applied for all designs. The Church of Midwolde is next to an intersection, so road users will pay more attention to the area. The Church of

Lettelbert, Watersportcentrum Lettelbert, and Lettelberterplas are within the shared space area, thus they are recognizable. Then, as mentioned in sub-chapter 6.2., the Lettelbert bridge is improved so that it is more recognizable as well.

9: The route is wide and comfortable for cyclists, with width of the road for one direction is as much as possible the same width for the ideal Fietsroute Plus width (2.5 m)

Design 1 scored 3 points because for each direction, the road for cyclists is 2.55 m wide. Meanwhile, Design 2 and 2b scored 2 points because outside the built-up area, the width of each suggested lane for cyclists is 1.8 m.

10: There is a solution for the locations of accidents along the Hoofdstraat

All designs got 3 points since the same manner is applied for all designs. As shown in Figure 5 sub-chapter 4.3., there are three locations of accident along the Hoofdstraat. For two accident locations in Midwolde, speed bumpers are applied near the location. Then, in Lettelbert, a shared space is applied.

7.4. Provisional design and road impressions

Previously, Design 2 was chosen as the best design. The following step was to develop the design into provisional design level from presentation design level. Table 6 shows the difference between presentation design and provisional design. Design 1, Design 2, and Design 2b were all made in presentation design level, therefore side pavement, indicative material use, water way, and indicative green area are present on the designs. Meanwhile, the aspects of provisional design, which are shown in Table 6, are present on provisional designs of Design 2. The design can be seen in Appendix 7.

Some road impressions were made to complement the provisional designs of Design 2. They can be seen in Appendix 8. The appendix contains four pairs of photos of the current situation and the road impressions.

Table 6: The differences between presentation design and provisional design

No.	Components	Presentation design	Provisional design
1.	Side pavement	X	X
2.	Horizontal axis (without annotation)		X
3.	Indicative material use	X	X
4.	Indicative dimension		X
5.	Indicative markings		X
6.	Brief description at some parts of the road		X
7.	Water way	X	X
8.	Indicative green area	X	X
9.	Cross section		X

(Antea Group)



Chapter 8: Conclusion and recommendation

8. Conclusion and recommendation

The final chapter of this final thesis contains conclusion of the final thesis. Then, it is followed by recommendations for Provincie Groningen in regard to Fietsroute Plus Groningen – Leek project.

8.1. Conclusion

The Provincie Groningen is working on Fietsroute Plus Groningen - Leek in order to have more people cycling between Groningen and Leek. One of the problems of the route is that there is no space for separated cycle path along Hoofdstraat, that is why the cycle route is designed on the road itself.

The route along Hoofdstraat should be safe for the cyclists in terms of objective and subjective safety. That is why the state of requirements was made based on those aspects. There are ten requirements which are obtained.

Following the requirements, there are three alternatives for the route, namely Design 1, Design 2, and Design 2b. They were then assessed with Multi Criteria Analysis. It can be concluded that design 2 is the best solution in terms of safety. In design 2, there is no change in the speed limit with the current situation. Then, a bicycle street with rabat strip in the middle is applied inside the built-up area, while a road with suggestion strip is applied outside the built-up area. In Lettelbert, there are two shared spaces which are located near the Church of Lettelbert and various leisure location in Lettelbert.

8.2. Recommendation

Some recommendations that can be summarised for the Fietsroute Plus Groningen - Leek in Hoofdstraat are listed as follows.

- a. The red asphalt is used for the road. The color might not be suitable for the nature, although it is chosen to emphasize that cyclists are given the priority on the road. Other color options that might be suitable are darker red or brown.
- b. StreetPrint is used for the brick-patterned pavement on all designs because it creates less sound than the bricks. However, bricks can be a possible option based on other considerations, such as the impact for the nature and the residents, attractiveness, or cost.
- c. There is a possibility to discuss the speed limit inside the built-up area further. In Design 1, it is designed for the speed limit of 30 km/h, while it is 50 km/h in Design 2 and Design 2b. However, it is decided based on safety in terms of traffic. Other considerations might or might not change the current situation.
- d. Speed bumpers in Midwolde are applied with cyclists in mind, but they might not be suitable for the bus. It is possible to discuss further about the bumpers and decide the best option for Fietsroute Plus Groningen-Leek and the road users.

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Appendix 9:
Calculation of speed design for the intersection between
Hoofdstraat and Pasop

Calculation of speed design for the intersection between Hoofdstraat and Pasop

Formula:

$$r_h = \frac{\left(\frac{v_o}{3.6}\right)^2}{\left(f_z + \frac{i}{100}\right)g} = \frac{v_o^2}{127\left(f_z + \frac{i}{100}\right)}$$

$$\text{Thus, } v_o = \sqrt{r_h \times \left(127\left(f_z + \frac{i}{100}\right)\right)}$$

r_h : radius of horizontal curve (m)

v_o : speed design (km/h)

g : gravitational acceleration (9.81 m/s²)

f_z : coefficient of side friction

i : cross slope (%)

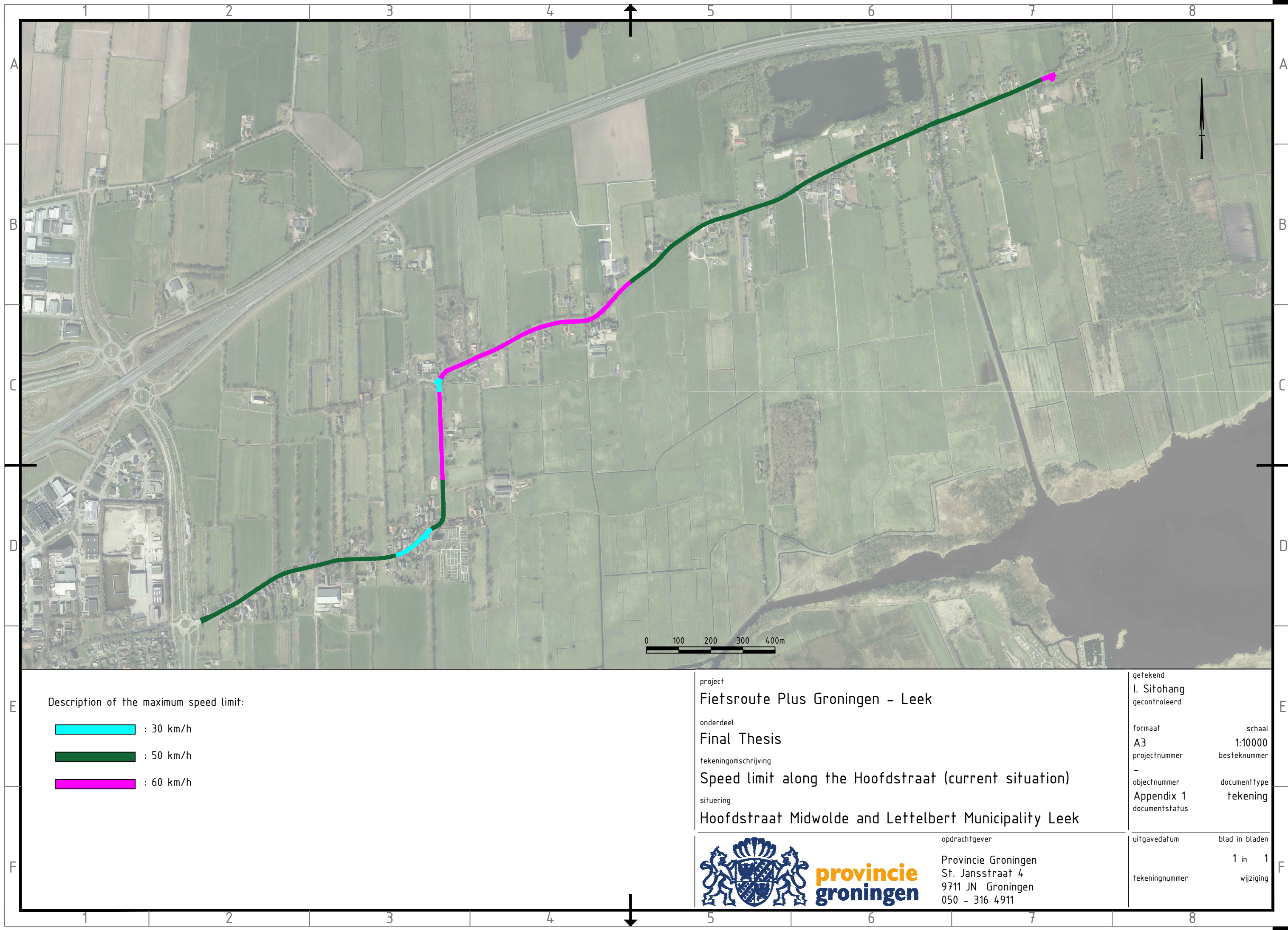
Given the r_h for the intersection is 55.54 m, the f_z is 0.169, and the i is -2%, thus:

$$\begin{aligned} v_o &= \sqrt{r_h \times \left(127\left(f_z + \frac{i}{100}\right)\right)} \\ &= \sqrt{55.54 \times \left(127\left(0.169 + \frac{(-2)}{100}\right)\right)} \\ &= 32 \text{ km/h} \end{aligned}$$

Since the speed limits in the Netherlands are of 30 km/h, 50 km/h and 60 km/h on an access road, so the speed design for the intersection between Hoofdstraat and Pasop is 30 km/h.

Source:

CROW. (2013). Handboek Wegontwerp 2013 - Basiscriteria. Ede: CROW.



Description of the maximum speed limit:

- : 30 km/h
- : 50 km/h
- : 60 km/h

project
Fietsroute Plus Groningen – Leek

onderdeel
Final Thesis

tekeningomschrijving
Speed limit along the Hoofdstraat (current situation)

situering
Hoofdstraat Midwolde and Lettelbert Municipality Leek



opdrachtgever
Provincie Groningen
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050 – 316 4911

getekend
I. Sitohang
gecontroleerd

formaat
A3

projectnummer
-

objectnummer
Appendix 1

documentstatus
documentstatus

schaal
1:10000

besteknummer

documenttype
tekening

uitgavedatum

blad in bladen
1 in 1

tekeningnummer

wijziging



Appendix 2:
Minutes of Discussion Fietsroute Plus Groningen - Leek Designs

Minutes of Discussion Fietsroute Plus Groningen - Leek Designs

Present : Irene Sitohang, Fokke Woudstra, Greet Luursema, Hans Buis
Day, date : Wednesday, 18 April 2018
Time : 11.00 - 12.00
Agenda : Discussion about design 1, 2, 2b

All designs:

1. The intersection between road N372 and the Hoofdstraat should be smaller, and median can be erased
2. Apply intersection with priority to the right for all intersections (every direction has the same hierarchy)
3. Move the border of inside the built-up area in Lettelbert nearer the church of Lettelbert
4. It is not important to provide additional parking place near the church of Lettelbert, because a funeral (the graveyard is behind the church) happens only once in a while, so it is not really a problem for the cyclists generally
5. Shared space:
 - Erase the rabat strip along the shared spaces in Lettelbert to have wider space
 - Ideas for planting of shared space in Lettelbert: with trees or leilindes
6. Put descriptions (including the speed limit on the designs so that it is understood easily
7. Apply attention point to the intersection near church in Midwolde
8. Check the radius of the intersection with Pasop to know the ideal velocity (see CROW)
9. More possibilities with the bridge: wood, changing the railing, street lights

Design 1:

1. The punaise on the intersection with Hooilanden is good to be kept. The cyclists unlikely go to Hooilanden after coming from Oostwold

Design 2 and 2b:

1. Road bubeko is too wide with 6.2 m wide. 5.8 m wide is enough. The road is quiet with less cars and bicycles, and the cyclists rarely use the road at both directions, so if the road is too spacious, the car will be driven faster and this is not good for the cyclists.
2. Bicycle symbols should be erased because the red asphalt lane should also be used by the vehicles

Further discussions:

1. The application of bricks and street print, it depends on the soil foundation. Street print is less noisy
2. The possibilities of brick/street print patterns and general landscape for the shared space
3. Suggestion strip: To be discussed whether it is good to use the suggestion strip for design 2 and 2b, considering that the traffic is not so heavy, and when cyclists are using one side of the road and the other side is empty, then car drivers are likely to drive faster with the remaining width of the road



Appendix 3: Factsheet Expert Session Fietsroute Team (Workshop 9th April 2018)

Factsheet Expertsessie Fietsrouteteam

Groningen: Route Groningen – Leek, maandag 9 april 2018



Aanwezigen	
Provincie Groningen	Fokke Woudstra, Greet Luursema, Frank Zijlstra, Bert Katerborg, Edgar Horneman, Hans Buis, Irene Sitohang, Jan Enno de Jong, Rolf Dijkstra, Hans Praamstra (Sweco)
Gemeente Leek Provincie Drenthe	Theo Vlaming, Peter Jonk, Dirk Brouwer Sjoerd Bijleveld, Gerrit Jansen, Foekje Hellinga
RHDHV Adviseurs	Joost Toxopeus
Loendersloot groep Tridee	Bas Hendriksen Benjamin Schaipp

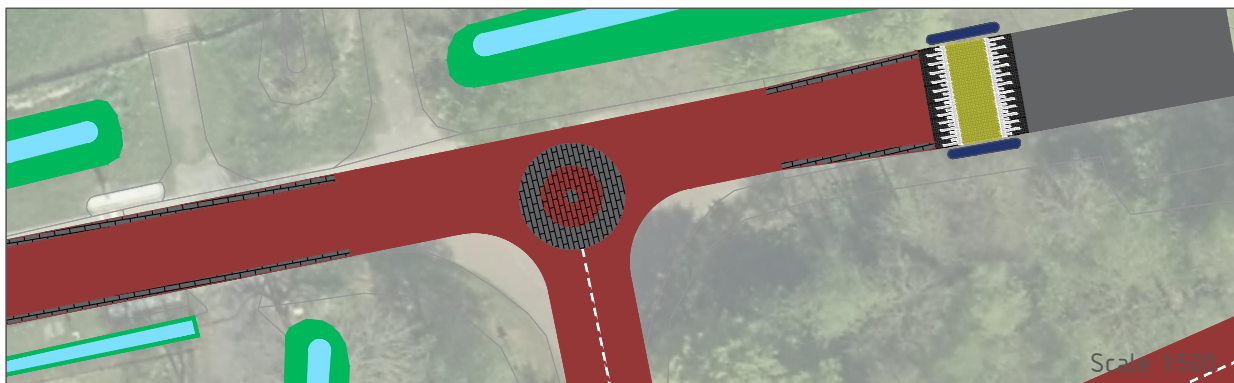
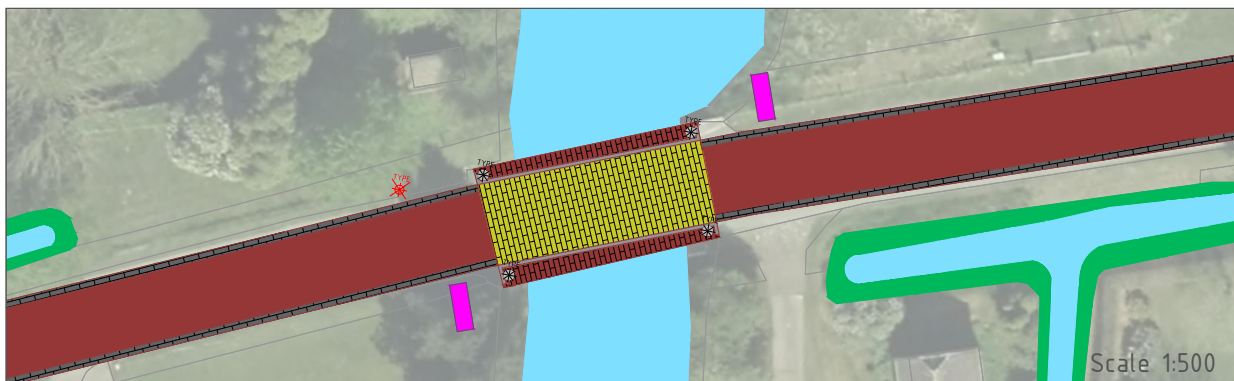
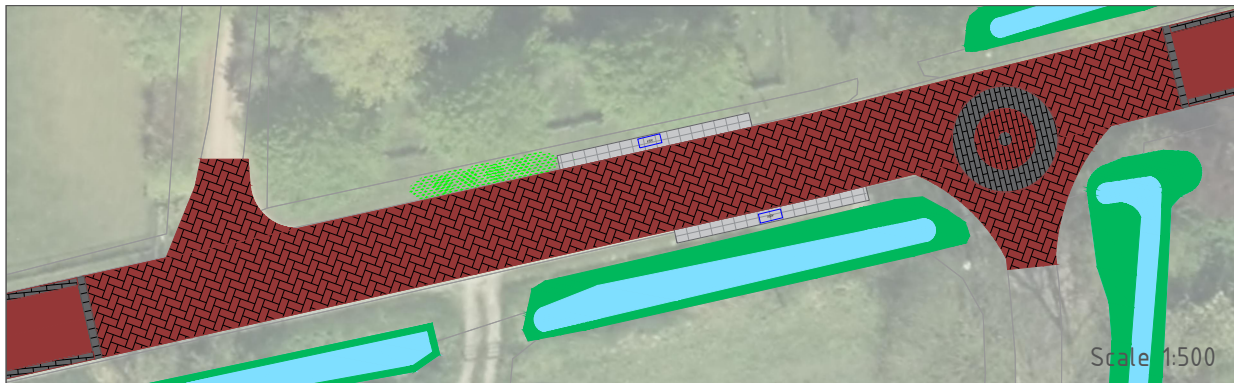
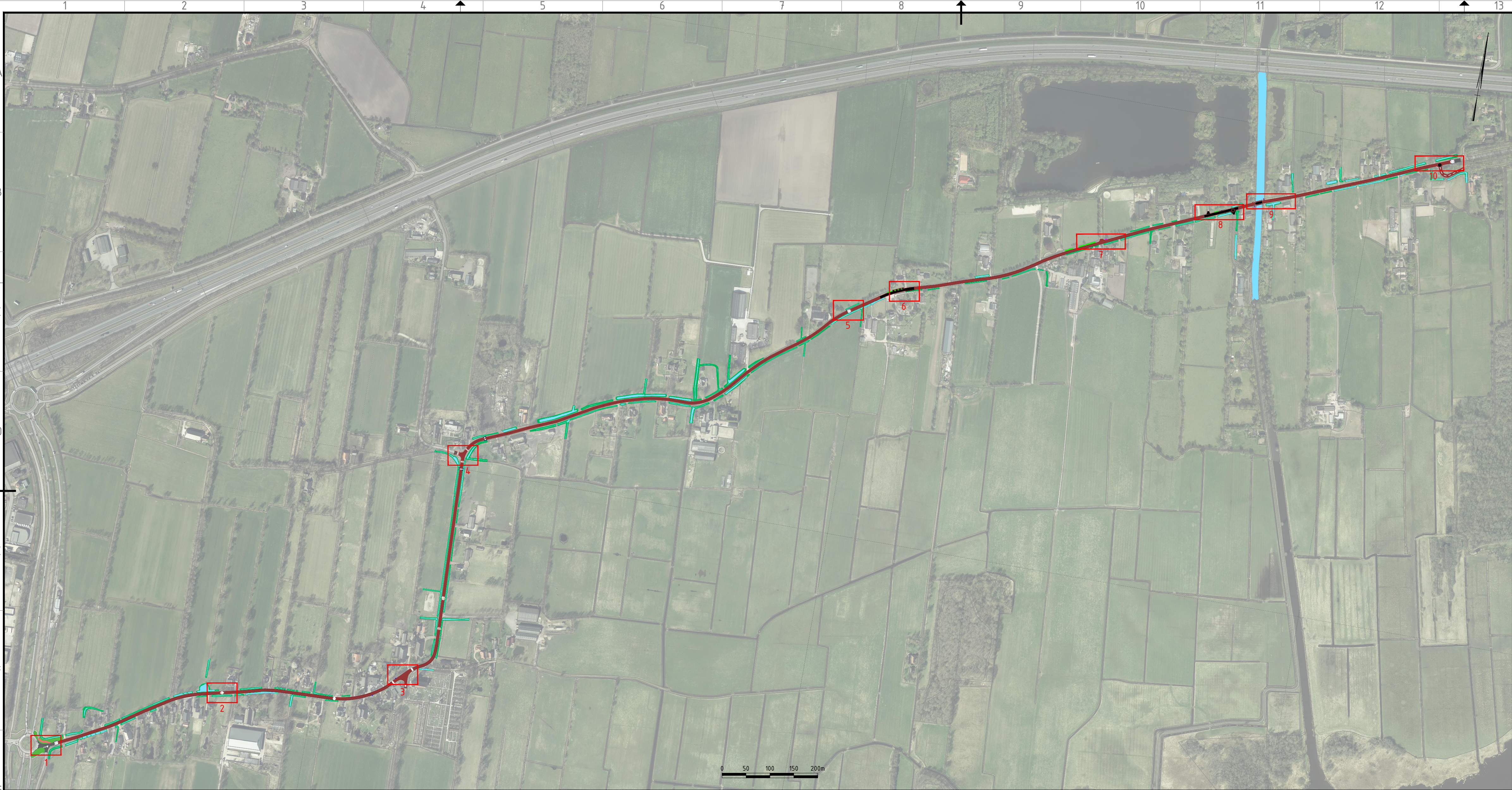
Beschrijving vraagstuk
Er lagen twee opgaven voor. De provincie werkt aan een Fietsroute Plus Groningen - Leek. Op een deel van de route (3,5 km) zit het fietsverkeer op een erftoegangsweg met deels lintbebouwing. Wat is een goed snelheidsregime en indeling van de weg? De tweede opgave betrof een kruising van een fietspad met een 60 km-weg.

Werkwijze
Het programma bestond uit een toelichting op het project (algemeen, specifiek de weg, wat is al eerder geprobeerd, verkeersveiligheid, landschap e.d.). Daarna deelden de adviseurs hun ervaringen elders en gaven hun visie op het project. Vervolgens werd in twee groepen aan de opgaves gewerkt. Dit werd naderhand aan elkaar teruggekoppeld.

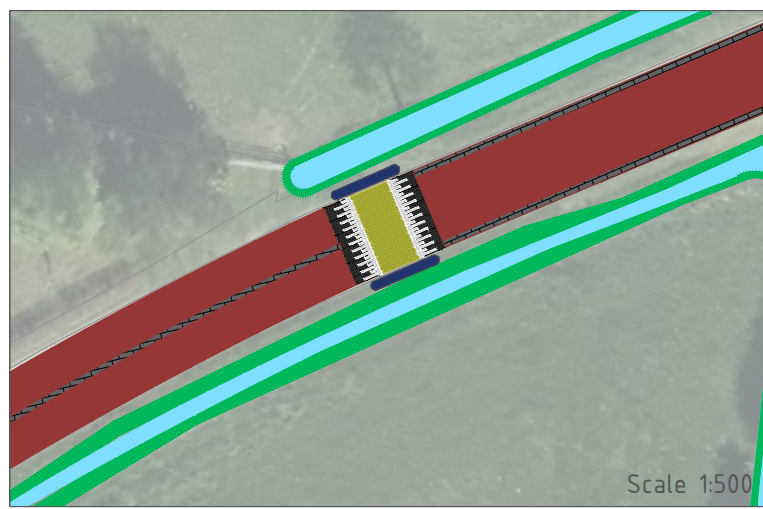
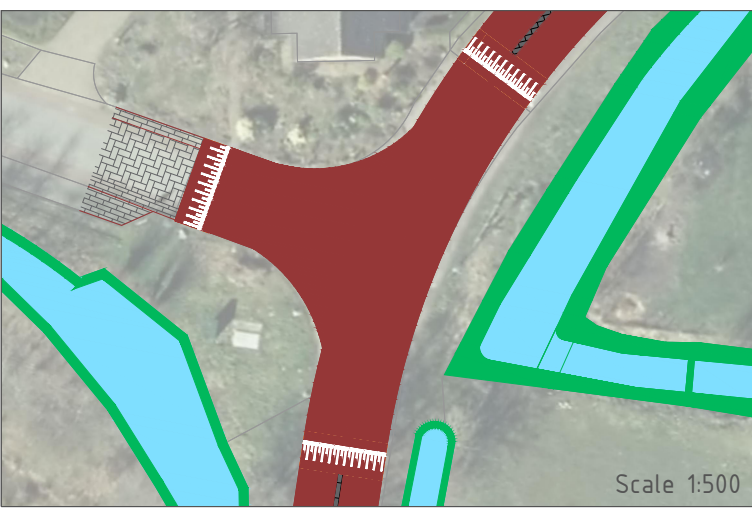
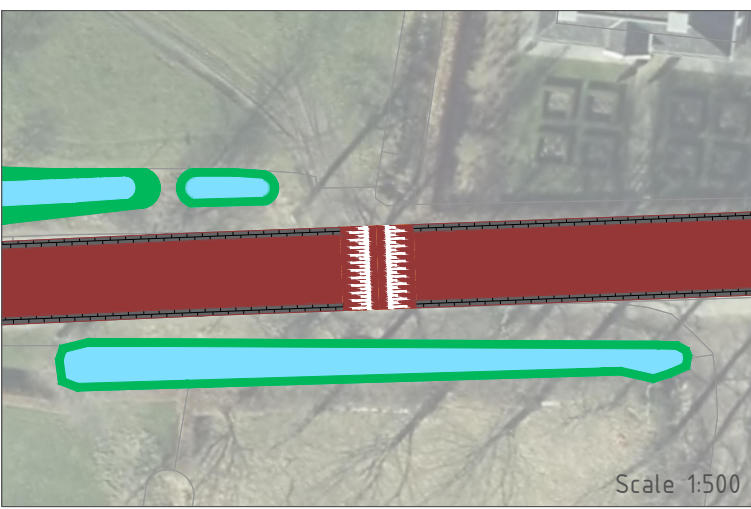
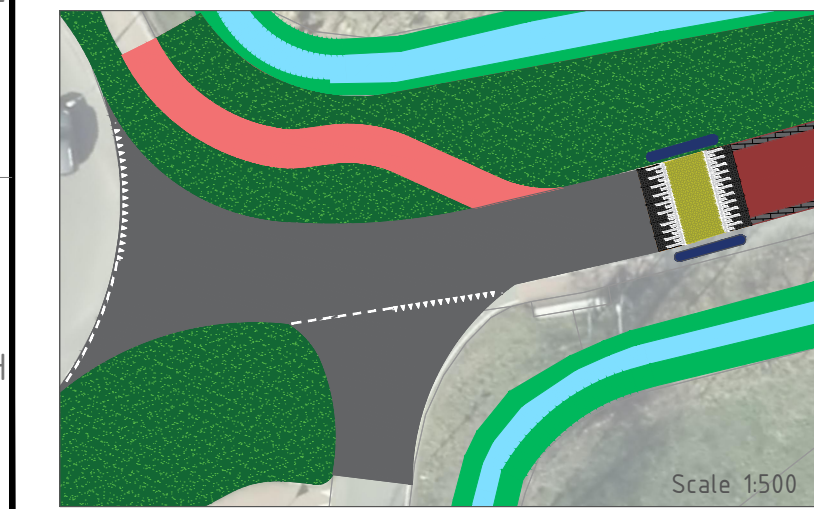
Toelichting op oplossing / uitkomsten
<p>Aanpassingen erftoegangsweg:</p> <ul style="list-style-type: none">• Duidelijke scheiding binnen/buiten de kom: 60/30• Gebruik maken van elementen in omgeving om 30 km-regime op natuurlijke wijze in te passen• Spelen met de beplanting: binnen de kom dicht, buiten de kom opener• Shared space-achtige situaties nabij kerken en andere herkenbare punten in de dorpen• Duidelijke positie voor de fiets: stroken van voldoende breedte• Mogelijkheid verminderen autoverkeer (stimuleren andere route) <p>Kruispunt:</p> <ul style="list-style-type: none">• Uitbuigen van de weg om zo fietsers in de voorrang te zetten• Aanpassing van ontwerp waarbij fietspad ongelijkvloers over de bestaande weg gaat in combinatie met viaduct over de snelweg.

Vervolgstappen
De plannen worden opgenomen in het eindbeeld van totale Fietsroute Plus Groningen - Leek. In het najaar worden de plannen in provinciale Staten besproken. Na vaststelling van het eindbeeld volgt de uitwerking waarbij ook inwoners worden betrokken.

Opschaalbare uitkomsten, die ook elders toepasbaar zijn
<p>De werkvorm pakte goed uit. Eerst kennisoverdracht, daarna in groepen uit elkaar. Daarbij kan iedereen zijn inbreng leveren. De beide adviseurs en ook de collega's uit Drenthe (zij zijn bezig met fietssnelweg Groningen - Assen) zorgden voor een frisse blik op het project.</p> <p>Aandachtspunten:</p> <ul style="list-style-type: none">- Twee onderwerpen op één dag was wel wat veel.- Rol van de adviseur tijdens de workshop (écht als adviseur)



DESCRIPTION	
	Road (red asphalt)
	Road (asphalt)
	Shared space (StreetPrint)
	Rabat strip (StreetPrint)
	Side road (diverse patterns and colors)
	Bus platform with shelter
	Green area
	Ditch
	Cycle path
	Bicycle rack
	Bench
	Tree (new)
	Street light (new)
	Street light (current situation, erase)
	Signboard
	Bush



project

Fietsroute Plus Groningen - Leek

onderdeel

Final Thesis

tekeningomschrijving

Design 1

situering

Hoofdstraat Midwolde and Lettelbert Municipality Leek

opdrachtgever

Provincie Groningen
St. Jansstraat 4
9711 JN Groningen
050 - 316 4911

getekend

I. Sitohang

gecontroleerd

formaat

A2.1

projectnummer

objectnummer

Appendix 4

documentstatus

uitgavedatum

tekeningnummer

schaal

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besteknummer

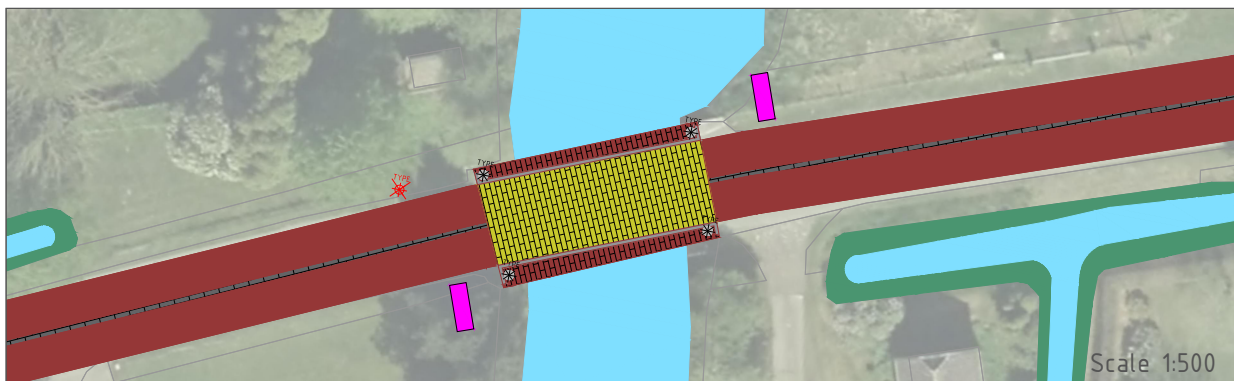
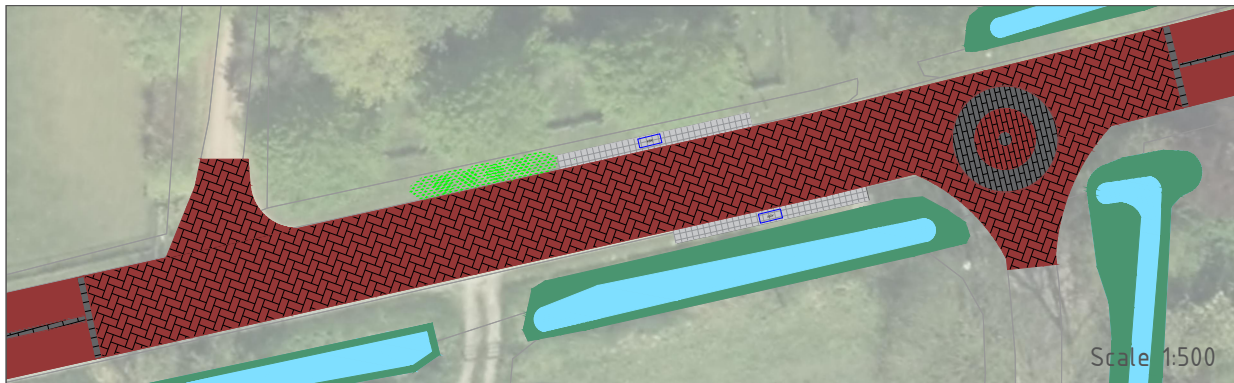
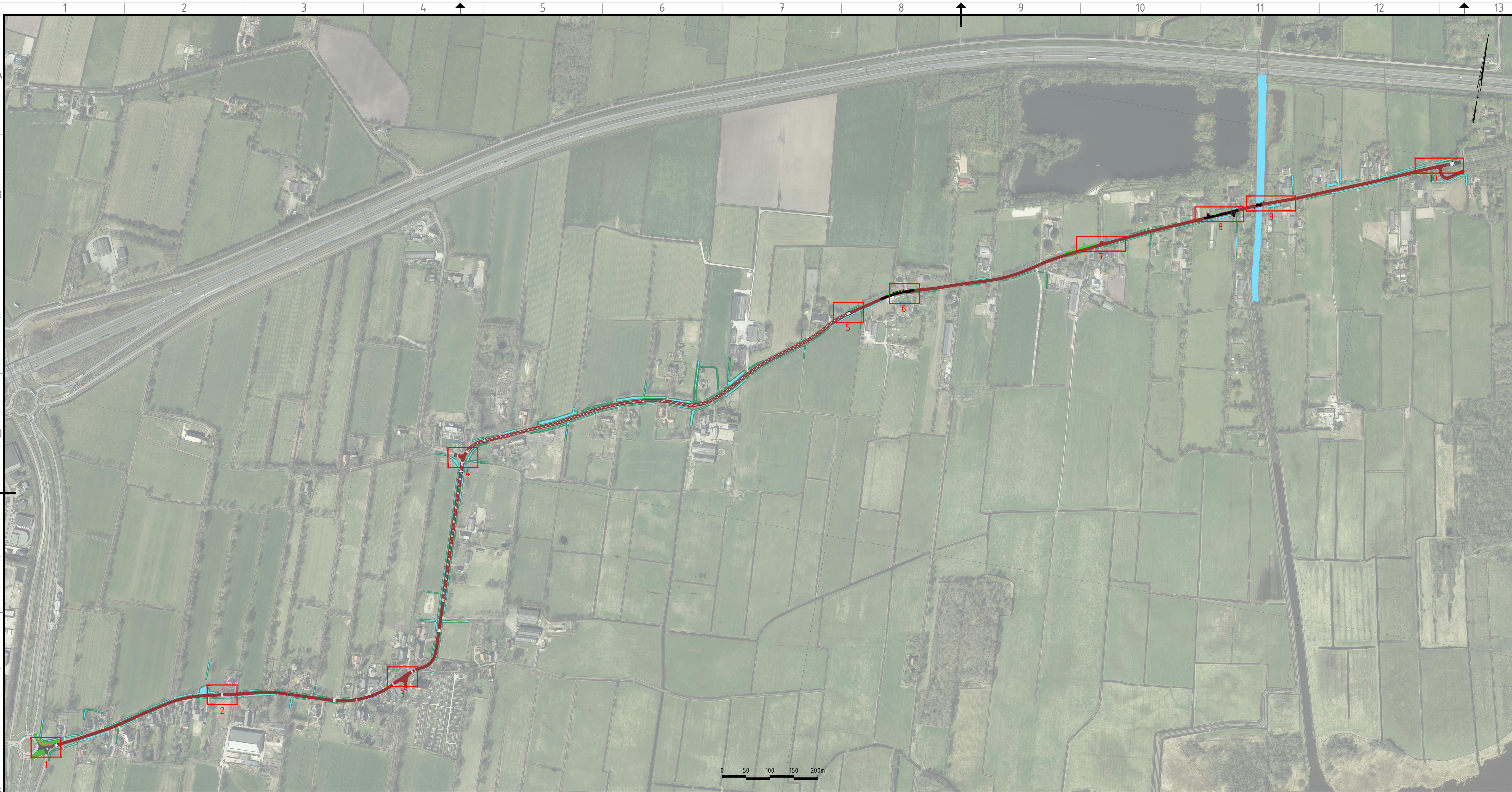
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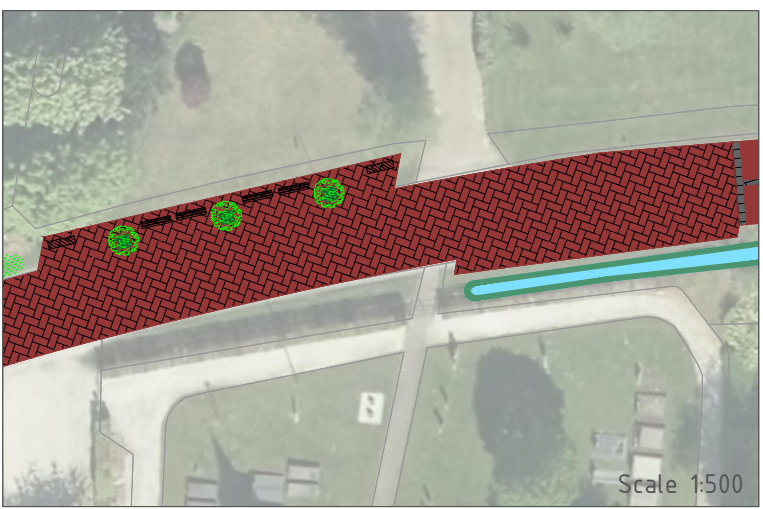
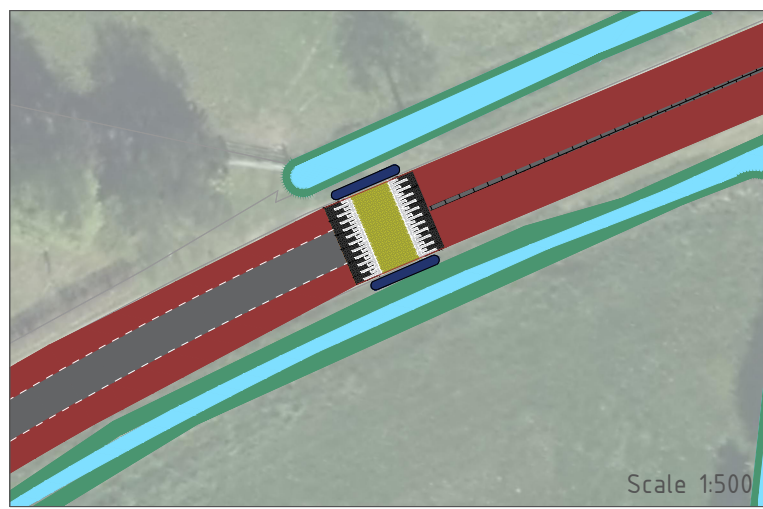
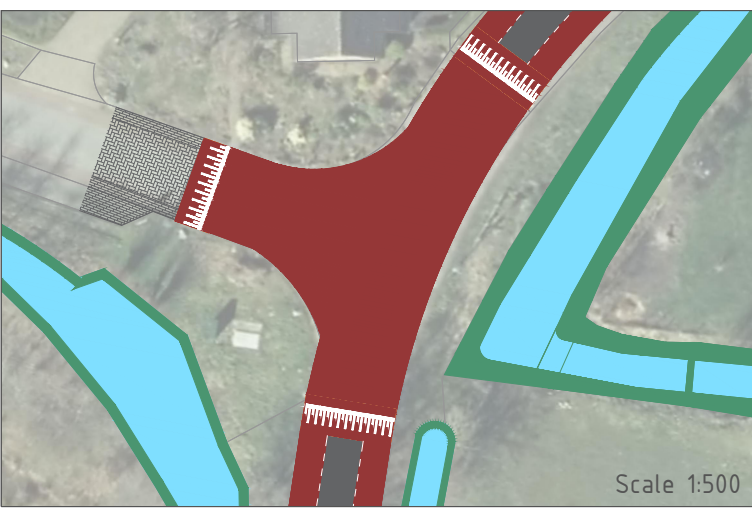
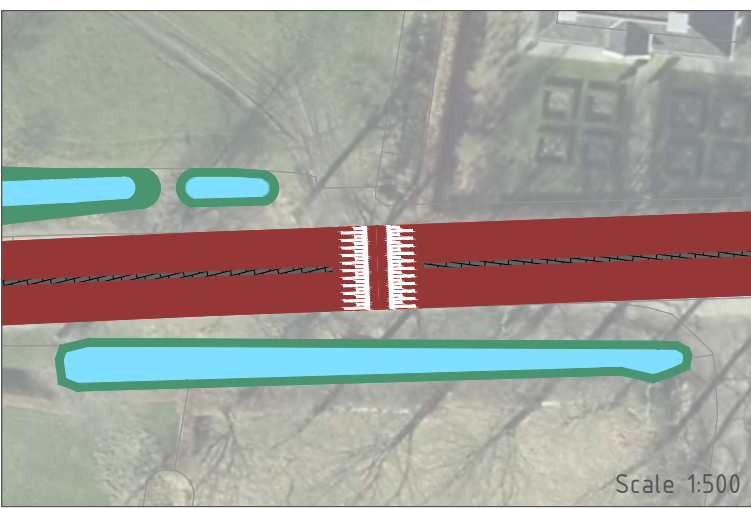
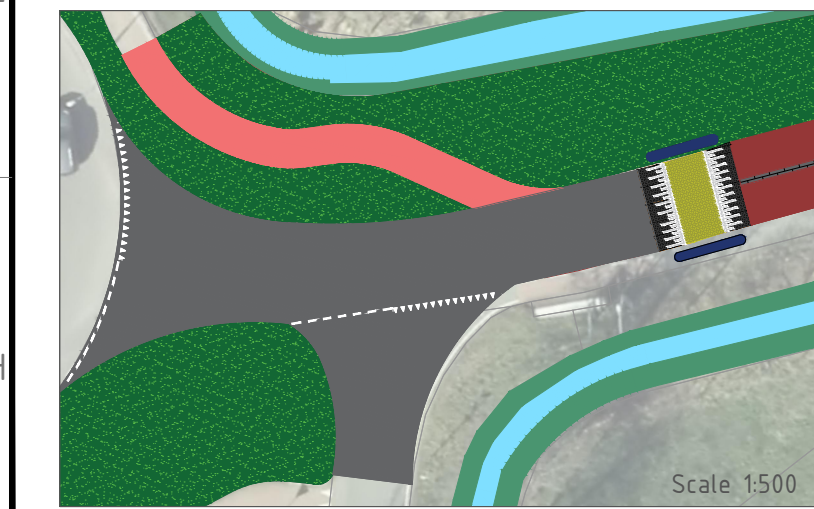
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1 in 3

wijziging



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	Shared space (StreetPrint)
	Rabat strip (StreetPrint)
	Side road (diverse patterns and colors)
	Bus platform with shelter
	Green area
	Ditch
	Cycle path
	Bicycle rack
	Bench
	Tree (new)
	Street light (new)
	Street light (current situation, erase)
	Signboard
	Bush



project

Fietsroute Plus Groningen - Leek

onderdeel

Final Thesis

tekeningomschrijving

Design 2

situering

Hoofdstraat Midwolde and Lettelbert Municipality Leek

opdrachtgever

Provincie Groningen
St. Jansstraat 4
9711 JN Groningen
050 - 316 4911

getekend

I. Sitohang

gecontroleerd

formaat

A2.1

projectnummer

objectnummer

Appendix 5

documentstatus

documenttype

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uitgavedatum

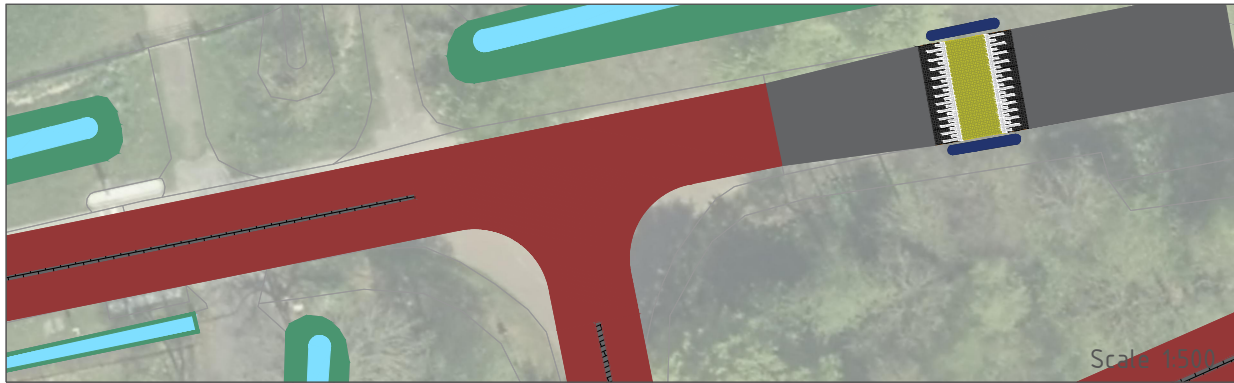
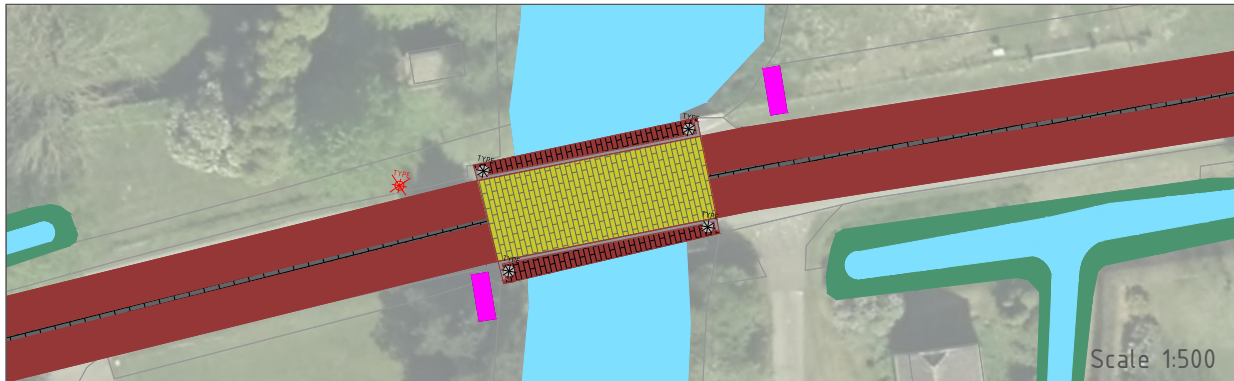
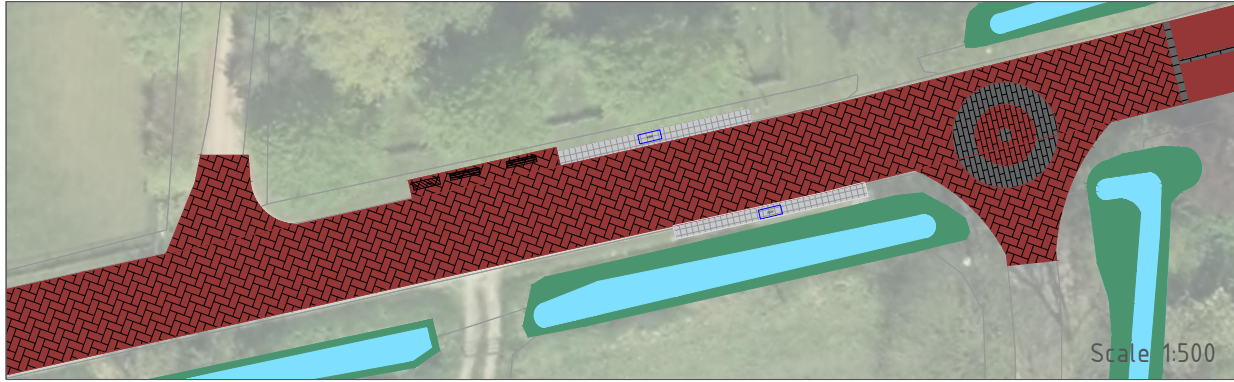
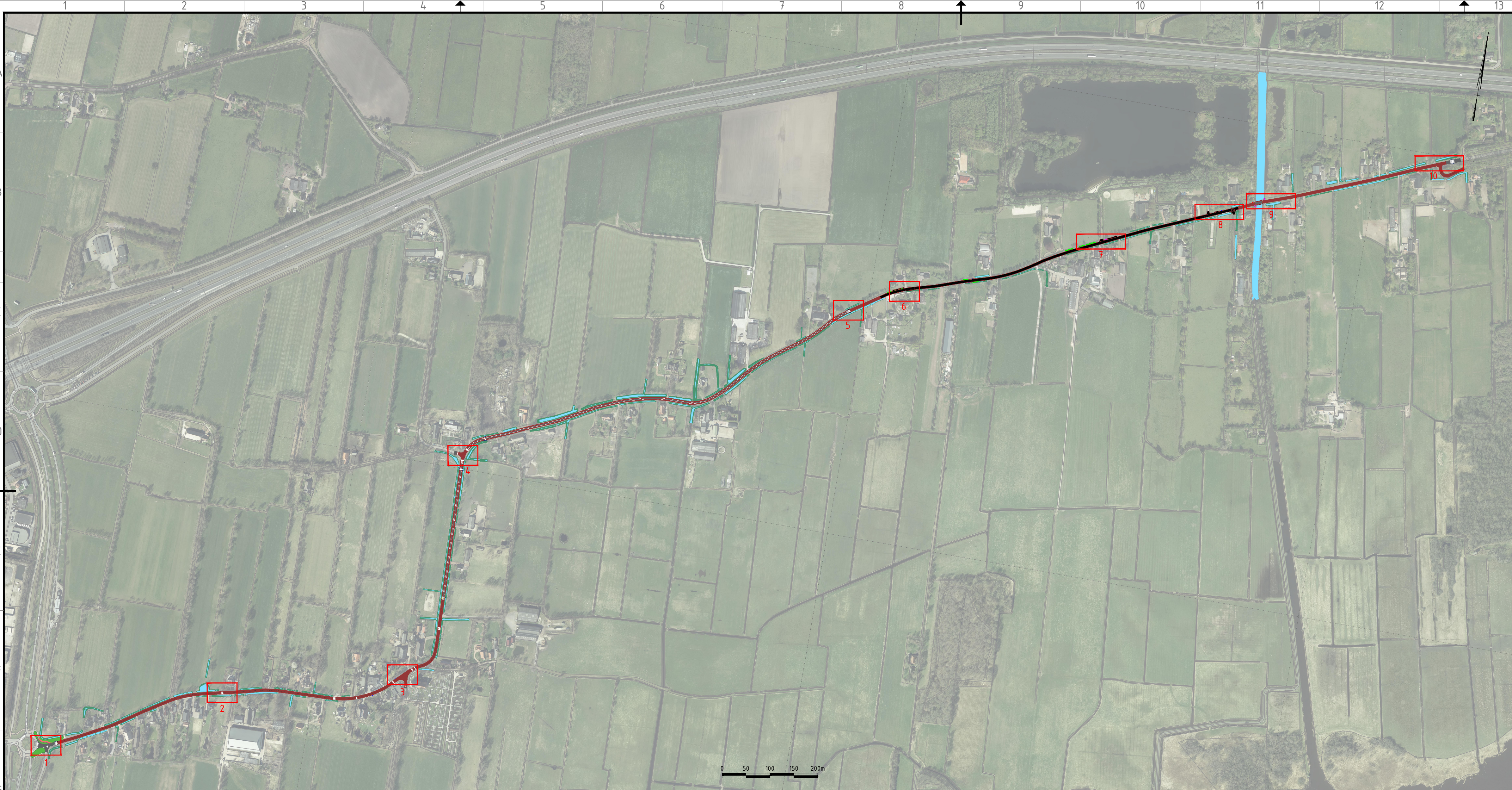
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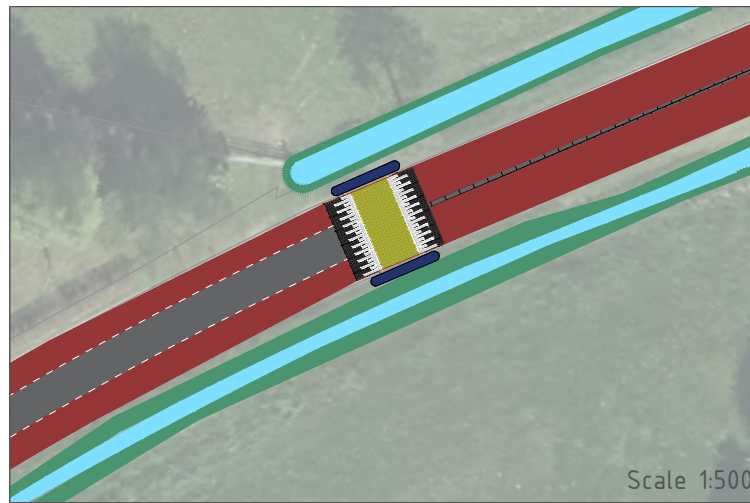
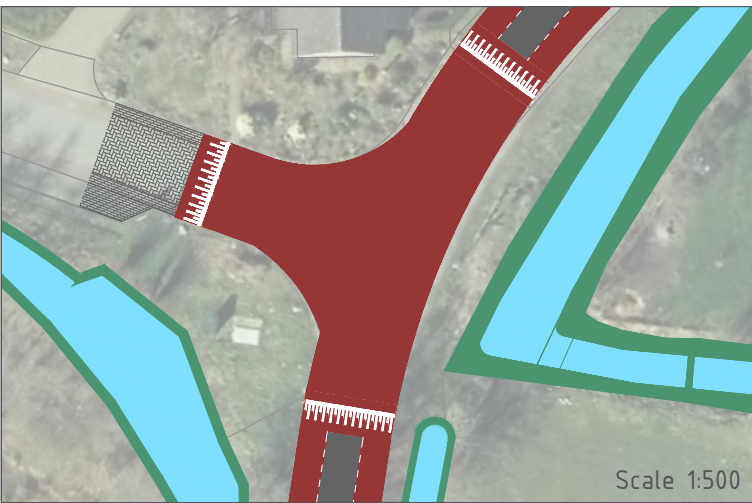
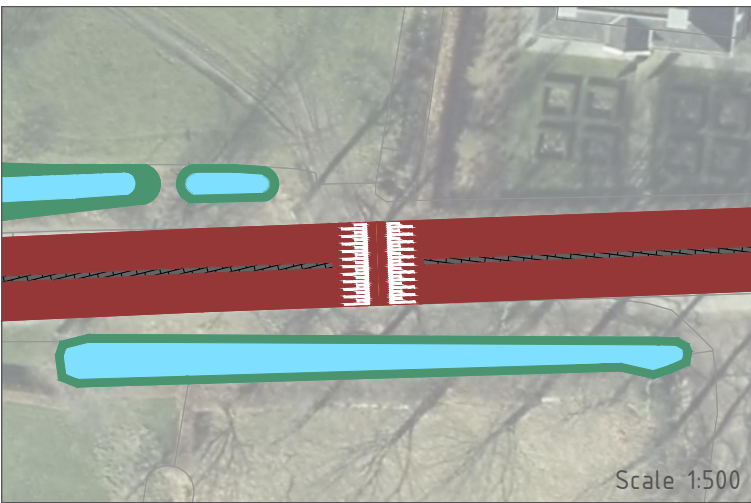
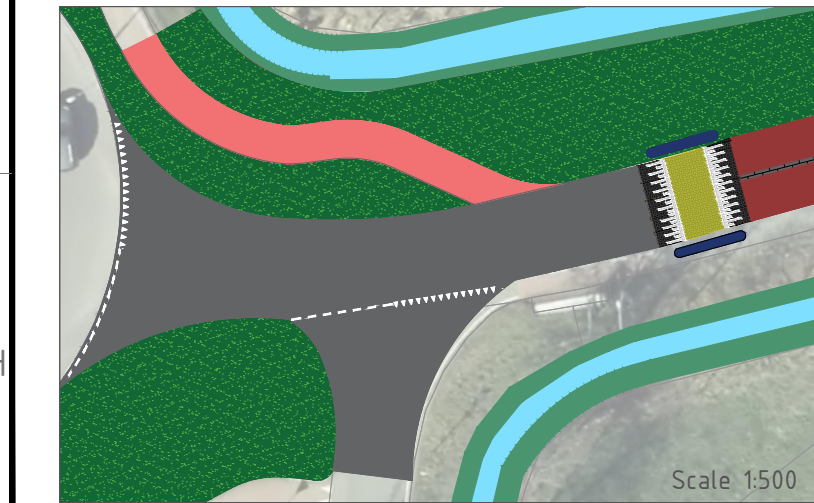
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wijziging





DESCRIPTION	
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	Road (asphalt)
	Shared space (StreetPrint)
	Rabat strip (StreetPrint)
	Side road (diverse patterns and colors)
	Bus platform with shelter
	Green area
	Ditch
	Cycle path
	Bicycle rack
	Bench
	Tree (new)
	Street light (new)
	Street light (current situation, erase)
	Signboard
	Bush



project

Fietsroute Plus Groningen - Leek

onderdeel

Final Thesis

tekeningomschrijving

Design 2b

situering

Hoofdstraat Midwolde and Lettelbert Municipality Leek



opdrachtgever

Provincie Groningen
St. Jansstraat 4
9711 JN Groningen
050 - 316 4911

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schaal

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formaat

A2.1

besteknummer

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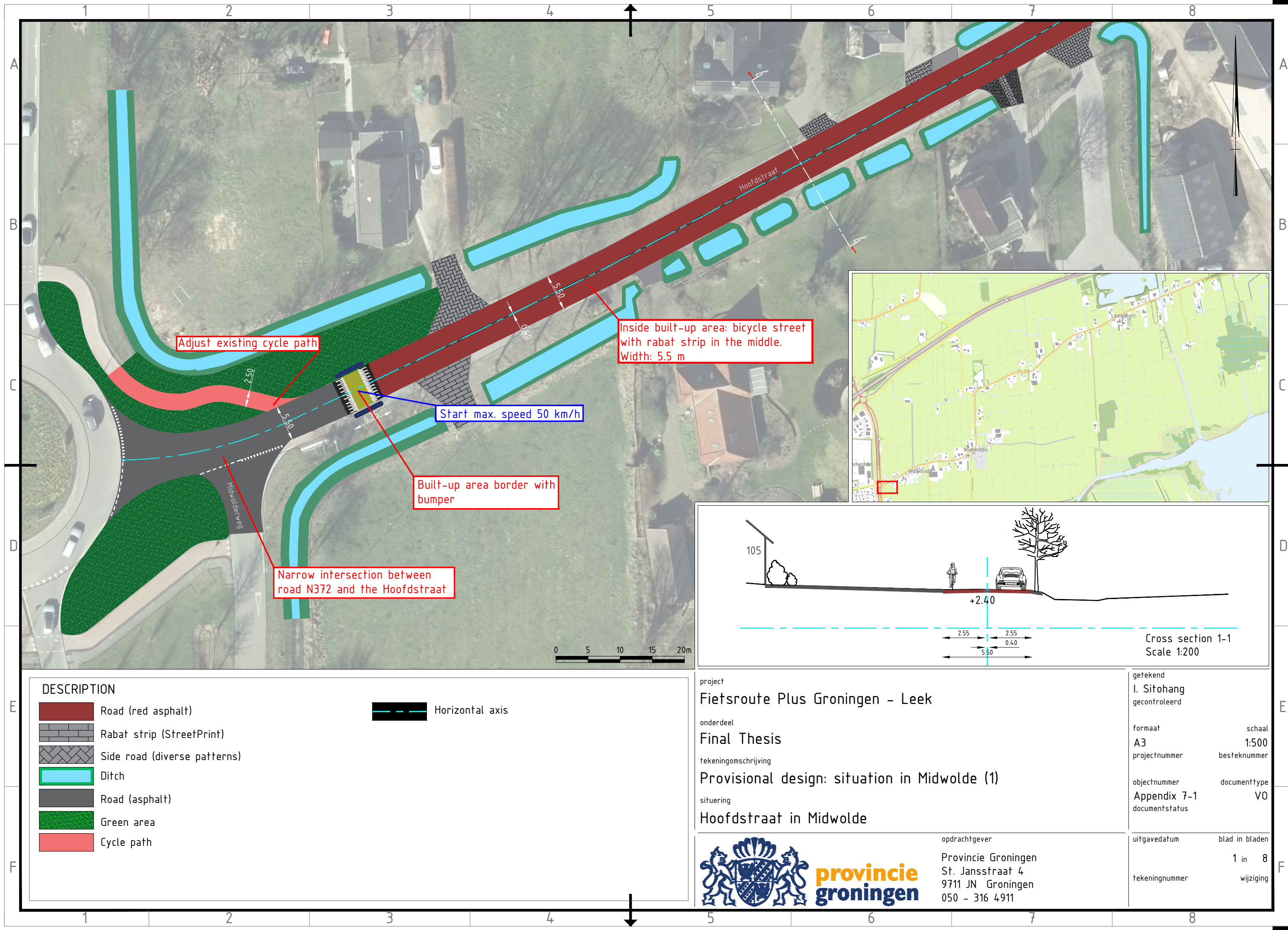
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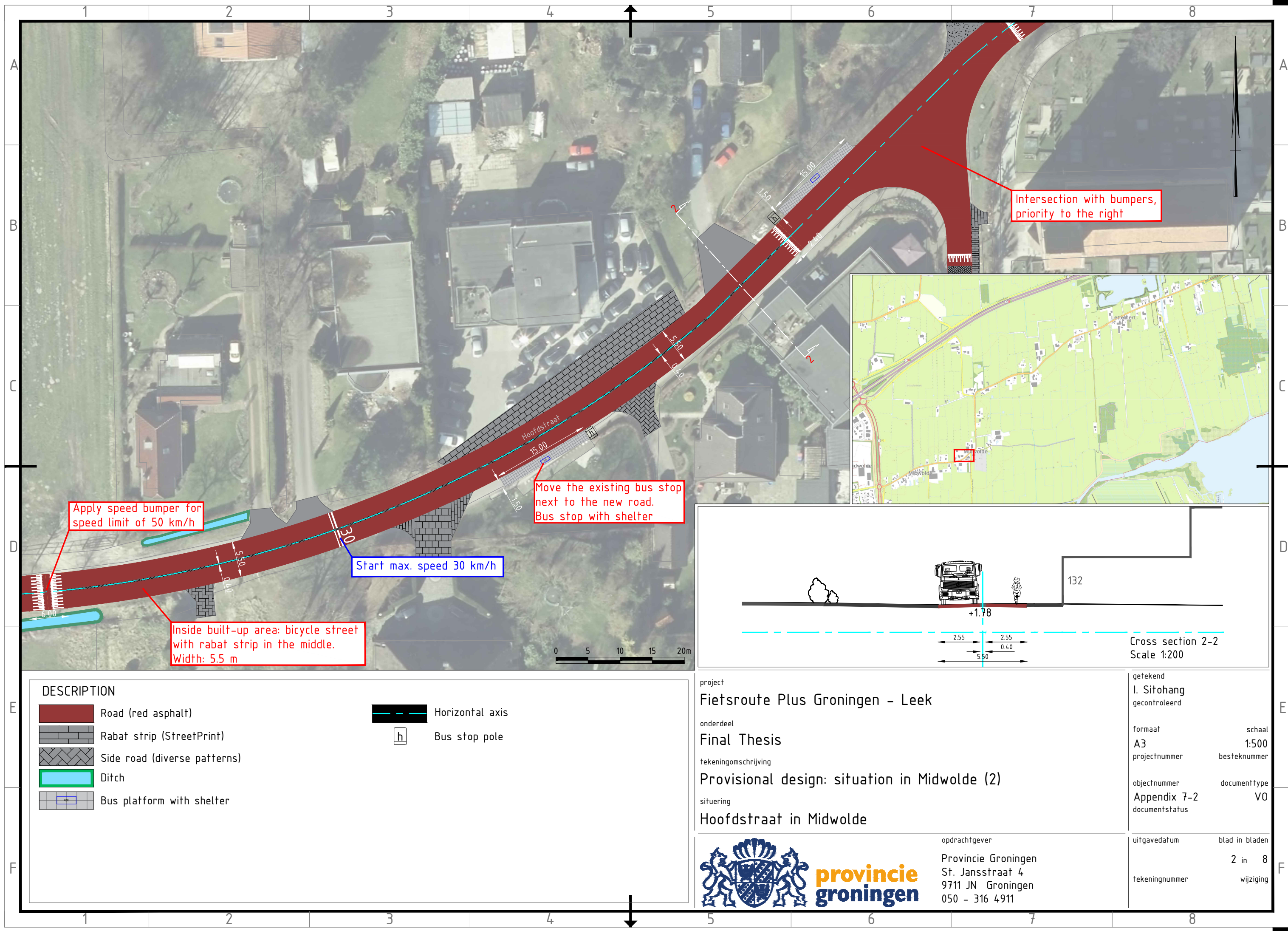
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tekeningnummer

wijziging





Apply speed bumper for speed limit of 50 km/h

Move the existing bus stop next to the new road. Bus stop with shelter

Start max. speed 30 km/h

Inside built-up area: bicycle street with rabat strip in the middle. Width: 5.5 m

Intersection with bumpers, priority to the right

DESCRIPTION

- Road (red asphalt)
- Rabat strip (StreetPrint)
- Side road (diverse patterns)
- Ditch
- Bus platform with shelter

- Horizontal axis
- Bus stop pole

project
Fietsroute Plus Groningen - Leek

onderdeel
Final Thesis

tekeningomschrijving
Provisional design: situation in Midwolde (2)

situering
Hoofdstraat in Midwolde

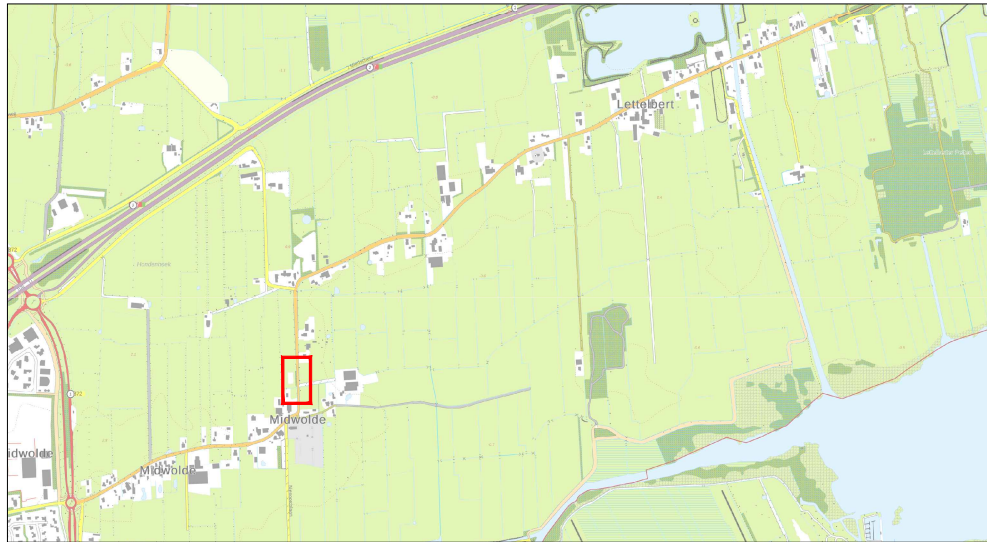
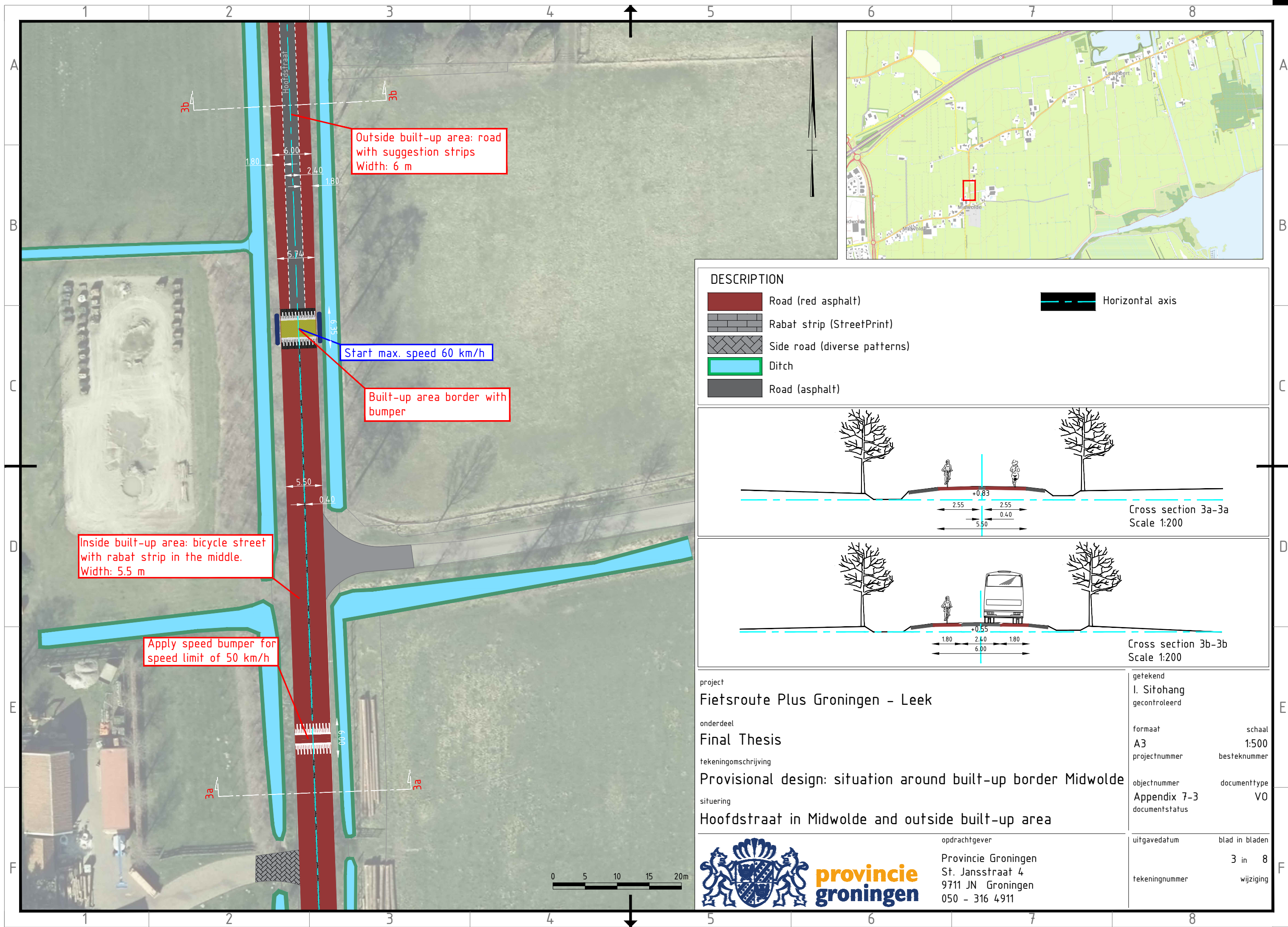


opdrachtgever
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050 - 316 4911

getekend
I. Sitohang
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projectnummer
objectnummer
Appendix 7-2
documentstatus

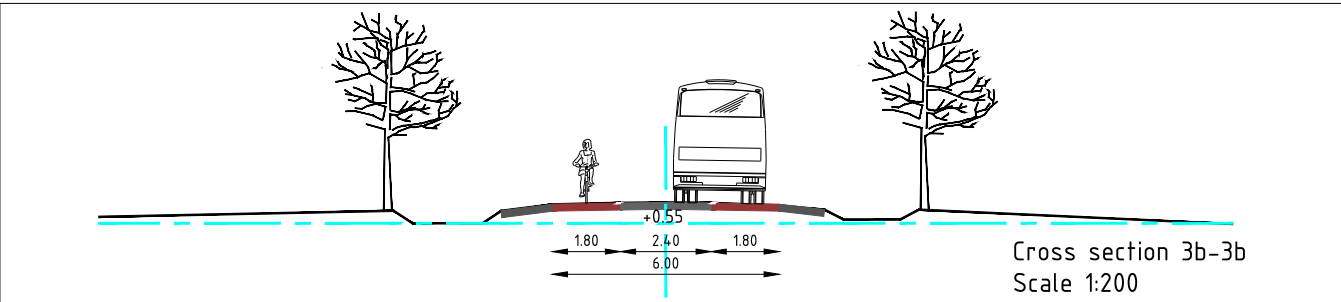
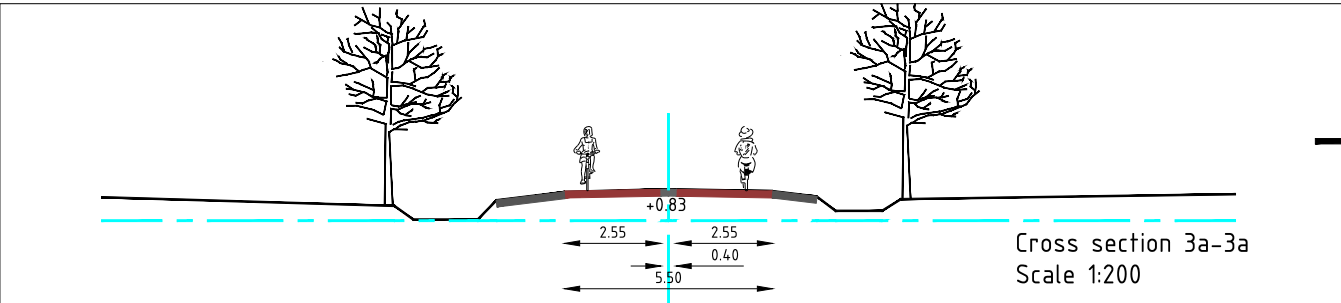
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Cross section 2-2
Scale 1:200

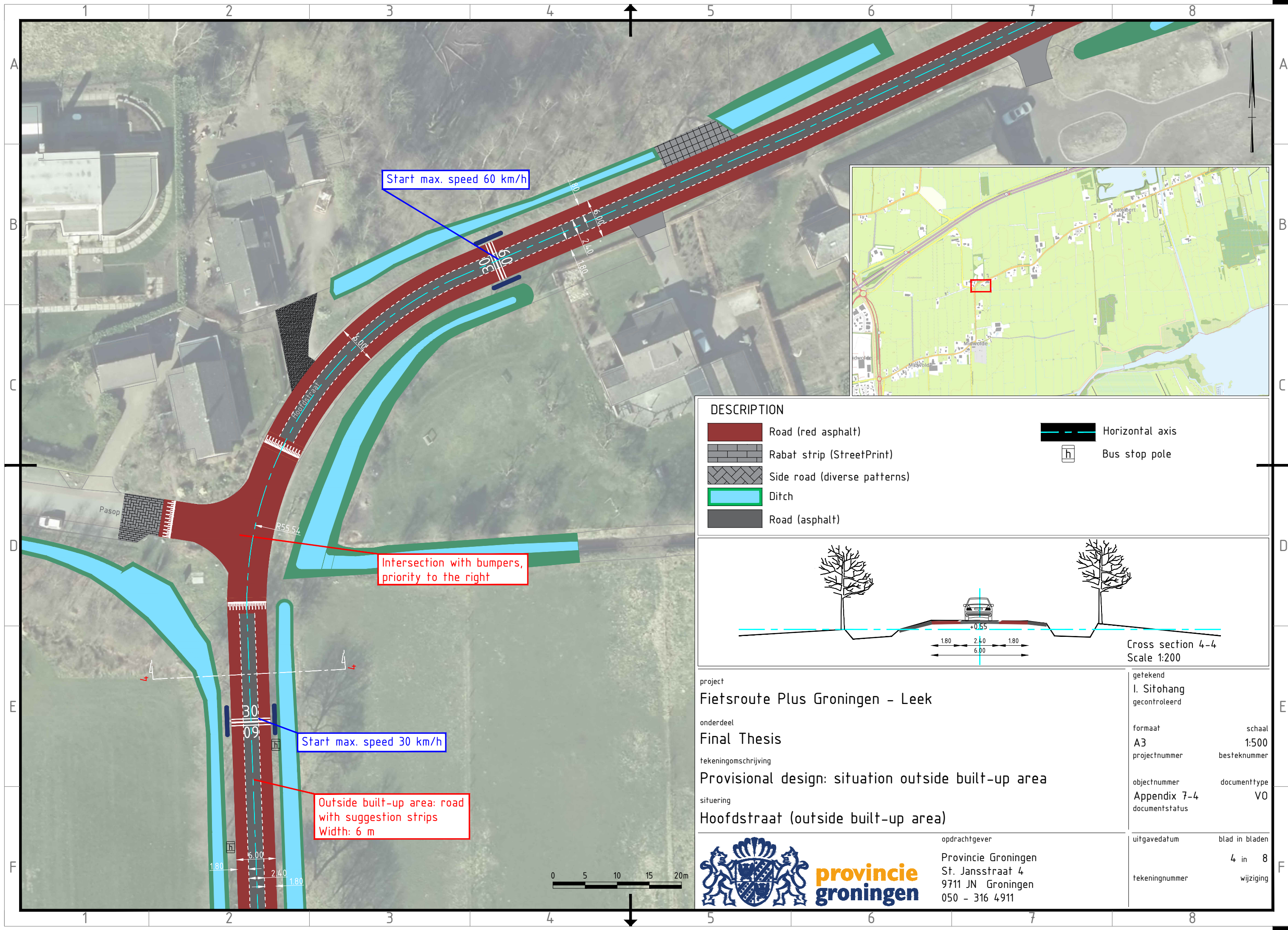


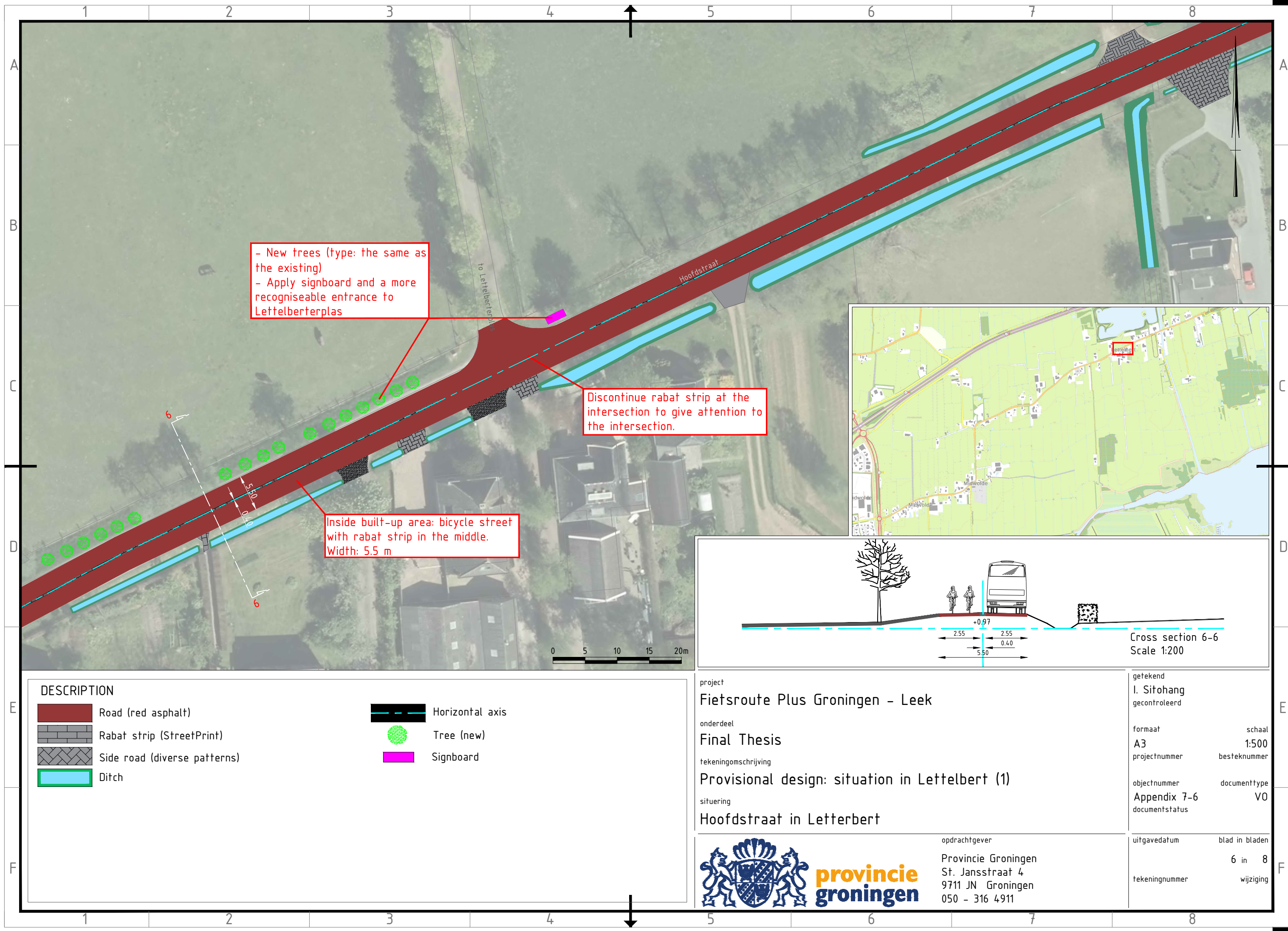
DESCRIPTION

- Road (red asphalt)
 - Rabat strip (StreetPrint)
 - Side road (diverse patterns)
 - Ditch
 - Road (asphalt)
- Horizontal axis



project Fietsroute Plus Groningen - Leek		getekend I. Sitohang	
onderdeel Final Thesis		gecontroleerd	
tekeningomschrijving Provisional design: situation around built-up border Midwolde		formaat A3	schaal 1:500
situering Hoofdstraat in Midwolde and outside built-up area		projectnummer	besteknummer
opdrachtgever Provincie Groningen St. Jansstraat 4 9711 JN Groningen 050 - 316 4911		objectnummer Appendix 7-3	documenttype VO
provincie groningen		uitgavedatum	blad in bladen 3 in 8
		tekeningnummer	wijziging





DESCRIPTION

- Road (red asphalt)
- Rabat strip (StreetPrint)
- Side road (diverse patterns)
- Ditch

- Horizontal axis
- Tree (new)
- Signboard

project

Fietsroute Plus Groningen - Leek

onderdeel

Final Thesis

tekeningomschrijving

Provisional design: situation in Lettelbert (1)

situering

Hoofdstraat in Letterbert



provincie
groningen

opdrachtgever

Provincie Groningen
St. Jansstraat 4
9711 JN Groningen
050 - 316 4911

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formaat

A3

projectnummer

besteknummer

objectnummer

Appendix 7-6

documentstatus

documenttype

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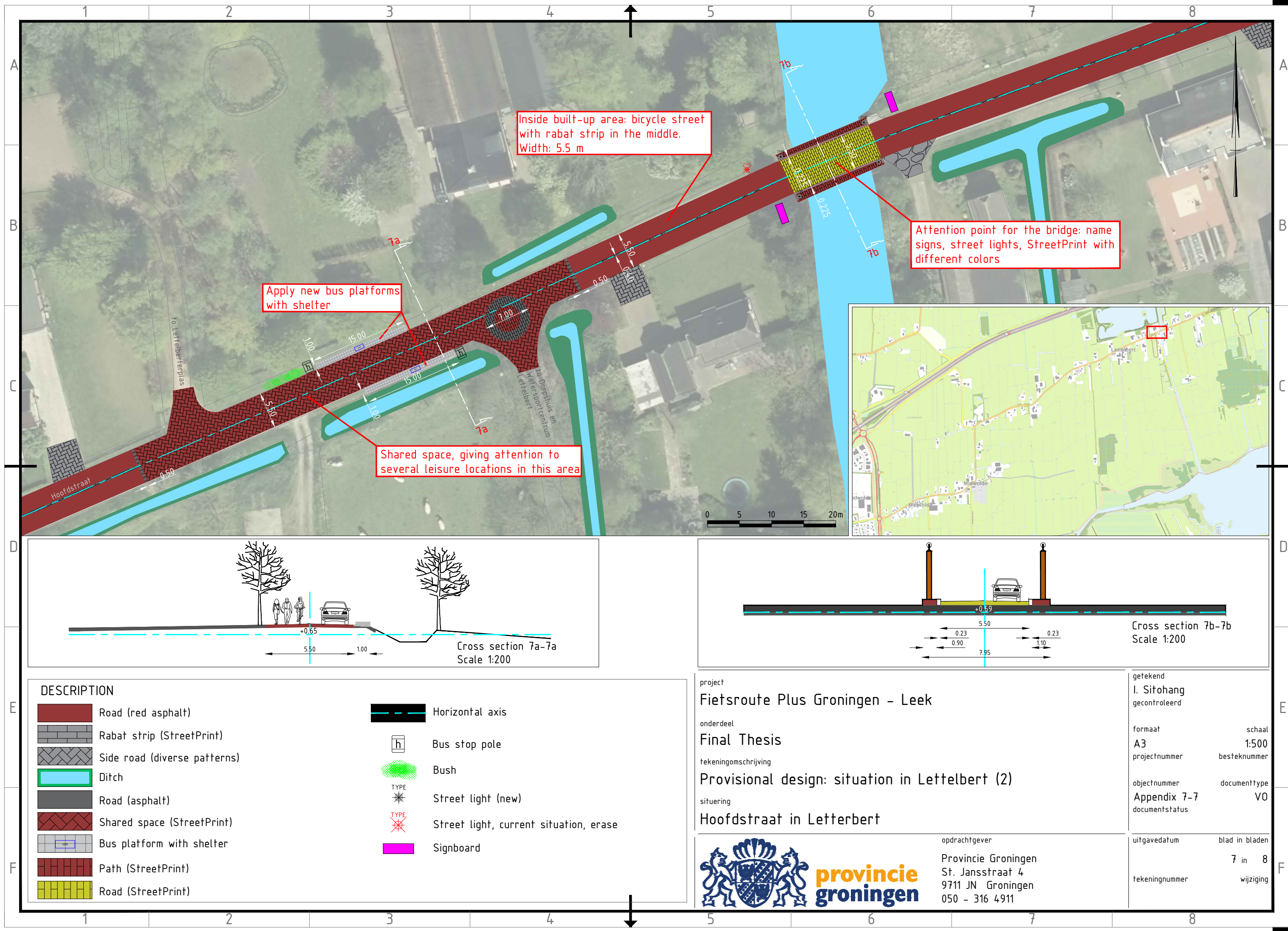
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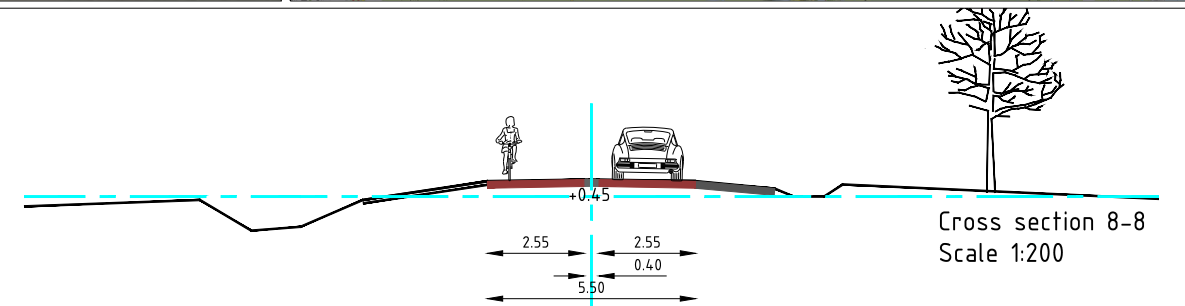
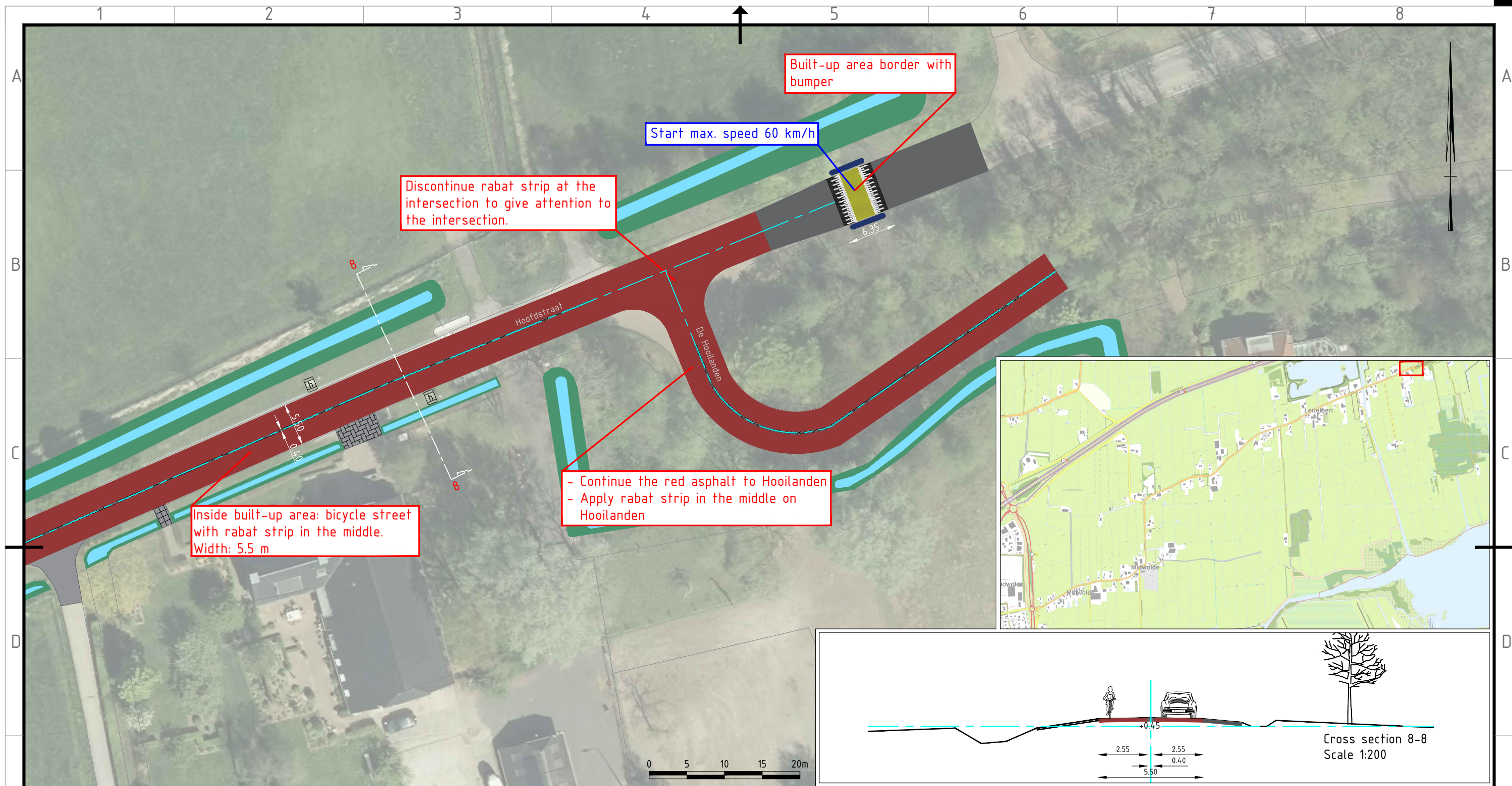
blad in bladen

6 in 8

tekeningnummer

wijziging





DESCRIPTION

- Road (red asphalt)
- Rabat strip (StreetPrint)
- Side road (diverse patterns)
- Ditch
- Road (asphalt)

- Horizontal axis
- Bus stop pole

project
Fietsroute Plus Groningen - Leek

onderdeel
Final Thesis

tekeningomschrijving
Provisional design: situation in Lettelbert (3)

situering
Hoofdstraat in Letterbert



opdrachtgever
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9711 JN Groningen
050 - 316 4911

getekend
I. Sitohang
gecontroleerd

formaat
A3

projectnummer
Appendix 7-8

documentstatus
documenttype
VO

uitgavedatum
8 in 8

tekeningnummer
wijziging



Appendix 8: Road Impressions



Situation 1: Inside the built-up area in Midwolde (current situation)

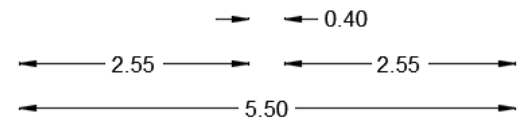
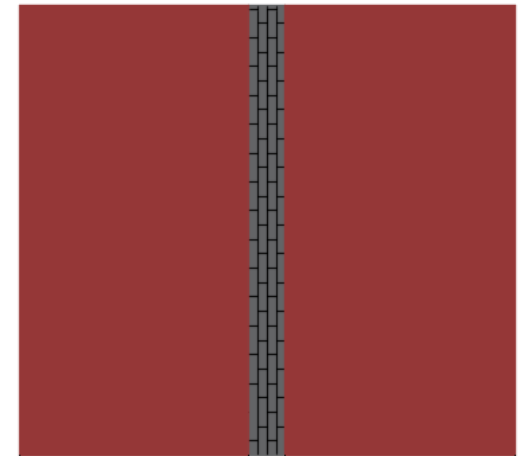


Situation 1: Inside the built-up area in Midwolde (road impression)

Bicycle street with rabat strip in the middle

Road: red asphalt

Rabat strip: StreetPrint





Situation 2: Outside the built-up area near Midwolde (current situation)

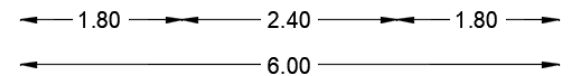


Situation 2: Outside the built-up area near Midwolde (road impression)

Road with suggestion strip

Road: red asphalt and grey asphalt

Marking: type 1 – 1 (10 cm)





Situation 3: Outside the built-up area near Lettelbert (current situation)

In the current situation, this part of the road is inside the built-up area. However for the design, it is designed as outside the built-up area. Therefore in the road impression (on page 7), the picture shows the situation outside the built-up area, right before the built-up border in Lettelbert.

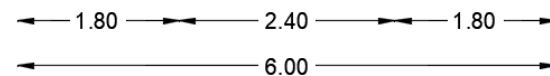


Situation 3: Outside the built-up area near Lettelbert (road impression)

Road with suggestion strip

Road: red asphalt and grey asphalt

Marking: type 1 – 1 (10 cm)





Situation 4: Inside the built-up area in Lettelbert (current situation)

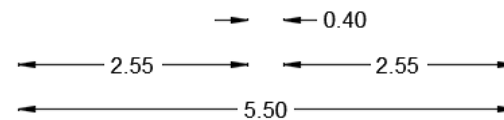
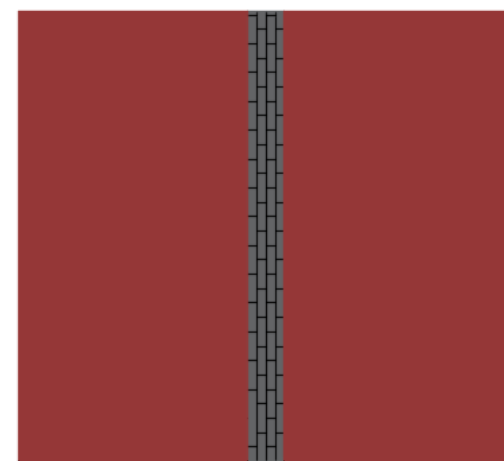


Situation 4: Inside the built-up area in Lettelbert (road impression)

Bicycle street with rabat strip in the middle

Road: red asphalt

Rabat strip: StreetPrint





Appendix 10: Approved project plan



FINAL PROJECT PLAN

The implementation of high-quality cycle path (Fietsroute Plus) along the Hoofdstraat in Midwolde and Lettelbert of Municipality Leek

Name : Irene Febryana Sitohang
Student Number : 372170
Study Program : International Civil Engineering Management
Group : 16
Supervisor : Dirk Ernten
Reader : Eric Boer



1. Introduction

Fietsroute Plus Groningen - Leek

The Provincie Groningen is currently working on the construction of high-quality cycle paths (herein is called Fietsroute Plus). The Fietsroute Plus is a wider and more comfortable cycle path that connects Groningen and nearby municipalities, which is constructed to encourage more people to commute with their bicycles from one municipality to the other. This is one of the concrete plan to implement the bicycle strategy 2016 - 2025 in the province of Groningen. The Fietsroute Plus connects the city of Groningen and nearby municipalities within the distance of 15 km. It is designed in such a way that the bicycle users have a pleasant and save travel so more people consider bicycle as a transportation with such distance to the city instead of using cars.

A work is in progress for the Fietsroute Plus Groningen - Leek. The first phase of the project is almost done, resulting in a chosen cycle route along highway A7. The Provincie Groningen has only to choose which side of the highway A7 the cycle path will come (north or south). The Fietsroute Plus will pass through the Hoofdstraat in Midwolde and Lettelbert in Municipality Leek.

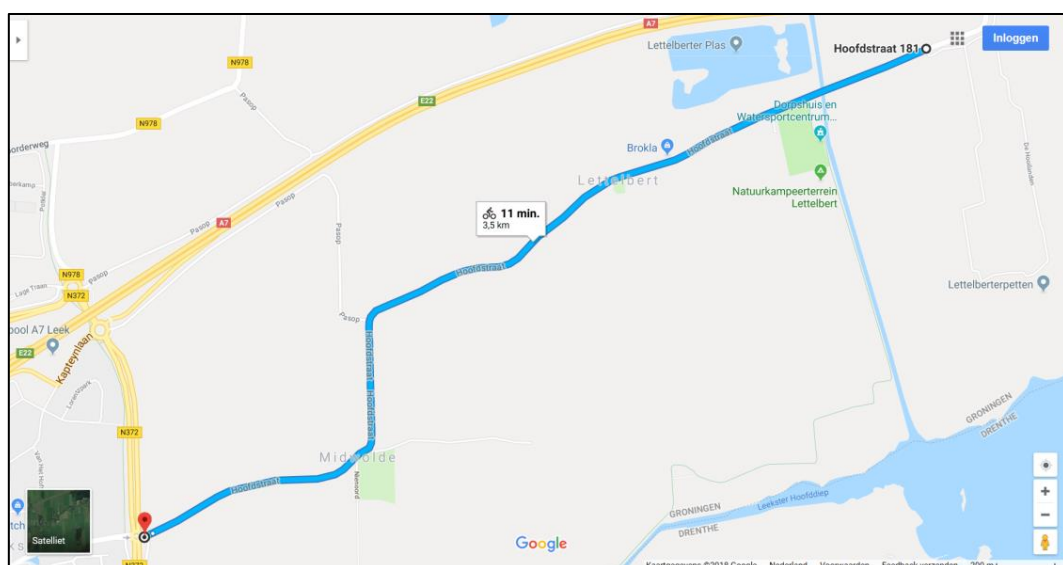


Figure 1: The Hoofdstraat in Midwolde and Lettelbert in Municipality Leek

Source: Google Maps

The Hoofdstraat in Midwolde and Lettelbert

It is important to define what the Hoofdstraat on this report means, because there are several streets which are called Hoofdstraat in Groningen. The project is dealing with the Hoofdstraat in Midwolde and Lettelbert in Municipality Leek, hereinafter referred to as the Hoofdstraat.

Sustainable Safety vision (Duurzaam Veilig¹) divides roads in the Netherlands into three types (see Table 1). According to the classification, the Hoofdstraat is classified as access road. The roads in the Netherlands are also distinguished whether they are inside the built-up area or outside the built-up area. This differentiation can be identified, for example, by the speed limit of the road. Inside the villages Midwolde and Lettelbert, the road is classified as inside the built-up area, and the road in between the villages is classified as outside the built-up area.

Table 1: Type of roads in the Netherlands according to Duurzaam Veilig vision

No	Type of road	Function	Example
1.	Stroomweg / through road	- Connect places with high speed - No conflict both on the road and at intersections	Road A7
2.	Gebiedsontsluitingsweg / distributor road	- Connect through road and access road - No conflict on the road but there are conflicts at intersections	Road N372
3.	Erftoegangsweg / access road	- Connects distributor road and resident's area - Conflict both on the road and at intersections	Hoofdstraat

Other type of roads are parallel road (parallelweg) and side road (zijweg). Parallel road is a road for slower traffic and usually can be found alongside a distributor road. There is no parallel road alongside Hoofdstraat. Side road is a small road that connects access road and a house. There are many side roads which are connected to Hoofdstraat. The Hoofdstraat is one of the routes that the cyclists use to

¹ More about Duurzaam Veilig, see https://www.swov.nl/sites/default/files/publicaties/gearchiverde-factsheet/uk/fs_sustainable_safety_background_archived.pdf

travel from Leek to Groningen. There are around 350 cyclists use the road in the working day. Vehicles such as cars, buses, and agricultural vehicles also use the road.

Bicycle

The bicycle is an important part of the life of the Dutch. People like cycling because it is healthy and faster, while cycling in the city. Nowadays, the Netherlands has almost 35000 km bicycle lanes for 22 million bicycles in the country (Statistics Netherlands, 2016). Especially in the province of Groningen, the Provincie Groningen is expanding its bicycle network inside the province and outside the province, for example by working on bicycle highway (fietsnelweg) Groningen - Assen².

The Fietsroute Plus will not only accommodate the 'normal' bicycle, but also other type of bicycles, for example e-bike and pedelec. E-bike and pedelec have maximum speed of 25 km/h and 45 km/h respectively. The use of both bicycles increases nowadays, and this fact is read positively by Provincie Groningen to encourage more cyclists to travel more with bicycle. That is why the organization is working on the Fietsroute Plus throughout the Province.

Problem

The Provincie Groningen made its own guideline for the Fietsroute Plus in the province. The guideline is meant for an ideal situation, where a separated cycle path can be constructed. It is not possible to construct a separated cycle path along the Hoofdstraat, because there is a lack of space for that. The Fietsroute Plus then will be implemented on the existing road and the road should be available for the vehicles as well. However, there are some points from the guideline that can be applied even with this condition. The problem with mixed use road is related to the traffic safety of the cyclists. Moreover, there are several speed limits along the road which cause the road to be not really safe for the cyclists.

² Assen is the capital city of the province of Drenthe.

The things which are known already in this project are as follows:

- a. A separated cycle path cannot be constructed because of the lack of space
- b. The Provincie Groningen wants to use the current road for the Fietsroute Plus
- c. There will be no new road constructed for the implementation of the Fietsroute Plus
- d. There are several points from the Fietsroute Plus guideline that can be applied
- e. The Provincie Groningen has done a bicycle survey in 2013 to the residents in Leek. 277 respondents were asked which resulted in insufficient score on the effect of car lighting and wind while cycling. Traffic safety scored just sufficient. Other aspects such as road flatness, delay on the road and intersection, cars nuisance, and mopeds nuisance scored as sufficient (Royal Haskoning DHV, 2014).

Meanwhile, the things which are unknown are:

- a. The answer of the main question and sub-questions
- b. The most suitable solution for the speed limit problem along the Hoofdstraat.
This issue is related to the main goal of the project.

Goal

The outcome of the project is the most suitable solution in terms of safety in traffic, which is tested with Multi Criteria Analysis (MCA). The MCA is based on the stakeholders' wishes, which are listed on State of Requirement. The result of this graduation project serves as the recommendation for the Provincie Groningen for the implementation of the Fietsroute Plus in Midwolde and Lettelbert, Municipality Leek. In the future, it will bring benefits for the residents in Leek to use bicycle as a transportation mode to Groningen with the Fietsroute Plus, considering some of its characteristics: wide, comfortable, and safe.

Research boundary

- a. The graduation project will focus on safety in traffic, which is divided into objective and subjective safety. Crime safety is not included.

- b. The location of the project is at Hoofdstraat in Midwolde and Lettelbert of municipality Leek (see Figure 1)
- c. The designs and the assessment with Multi Criteria Analysis are made according to the State of Requirements.

2. Research Method

Main question

Which is the most suitable solution in terms of safety in traffic for the implementation of Fietsroute Plus along the Hoofdstraat in Midwolde and Lettelbert of Municipality Leek?

The main question is related to the sub-questions. When all sub-questions are answered, the answer of the main question is obtained.

Sub-questions

1. What is the Fietsroute Plus and how does it differ from the regular cycle paths?

It is important to understand how Fietsroute Plus differs from the regular cycle paths. As a part of Fietsroute Plus Groningen - Leek, the end product of this graduation project should correspond with the following route of the whole project. Literature study will be done to answer this sub-question. The Provincie Groningen published Verbinden met de fiets which includes the guideline for the Fietsroute Plus. This publication is going to be the benchmark to compare the Fietsroute Plus with the regular cycle paths.

2. What is the problem at the location of the research, which is related to safety in traffic?

The goal of this sub-question is to know the current situation of the location of research and surroundings, with the focus on safety in traffic. Secondary data from Provincie Groningen will be used. There will be a workshop session with Tour de Force (a group of both public and private organizations which work together to increase the possibility of cycling in the Netherlands) and the related

government organizations and stakeholders on 9 April 2018 as well to gather ideas for the project.

3. What are the requirements of the involved stakeholders to solve the problem?

The outcome of this question is state of requirements, which is the following action of collecting data from sub-question 2. The stakeholders' wishes are put to consideration for the solution of the problem. The stakeholders include Provincie Groningen, Gemeente Leek, Tour de Force, the road users (residents, students).

4. What are the alternatives to solve the problem and how are they assessed?

The problem(s) and the wishes for this graduation project are known. The next step is to design some possible alternatives based on the information that have been gathered. The designs will be in presentation design level with AutoCAD. Then the designs will be assessed with Multi Criteria Analysis. The criteria are based on the state of requirements which has been formulated earlier. The sources related to road and bicycle infrastructure design are important during this phase.

5. How does the design of the most suitable solution in terms of safety in traffic look like?

The selected solution will be improved to the provisional design level with the cross section. The sources related to road and bicycle infrastructure design are important during this phase as well.

Research Approach

The project will be done by following PODOE method. With this method, the research is done systematically by identifying problem (*Probleem*), finding causes (*Oorzaak*), formulating objectives (*Doel*), designing and implementing solutions (*Oplossingen*), and finally doing evaluation (*Evaluatie*). Evaluation is meant to be done

after the implementation, so it is not possible to do the evaluation in this graduation project. This method corresponds with the graduation project flow (see Figure 2). During the progress of the project, there will be many consultations with experts from Provincie Groningen besides doing the literature study.

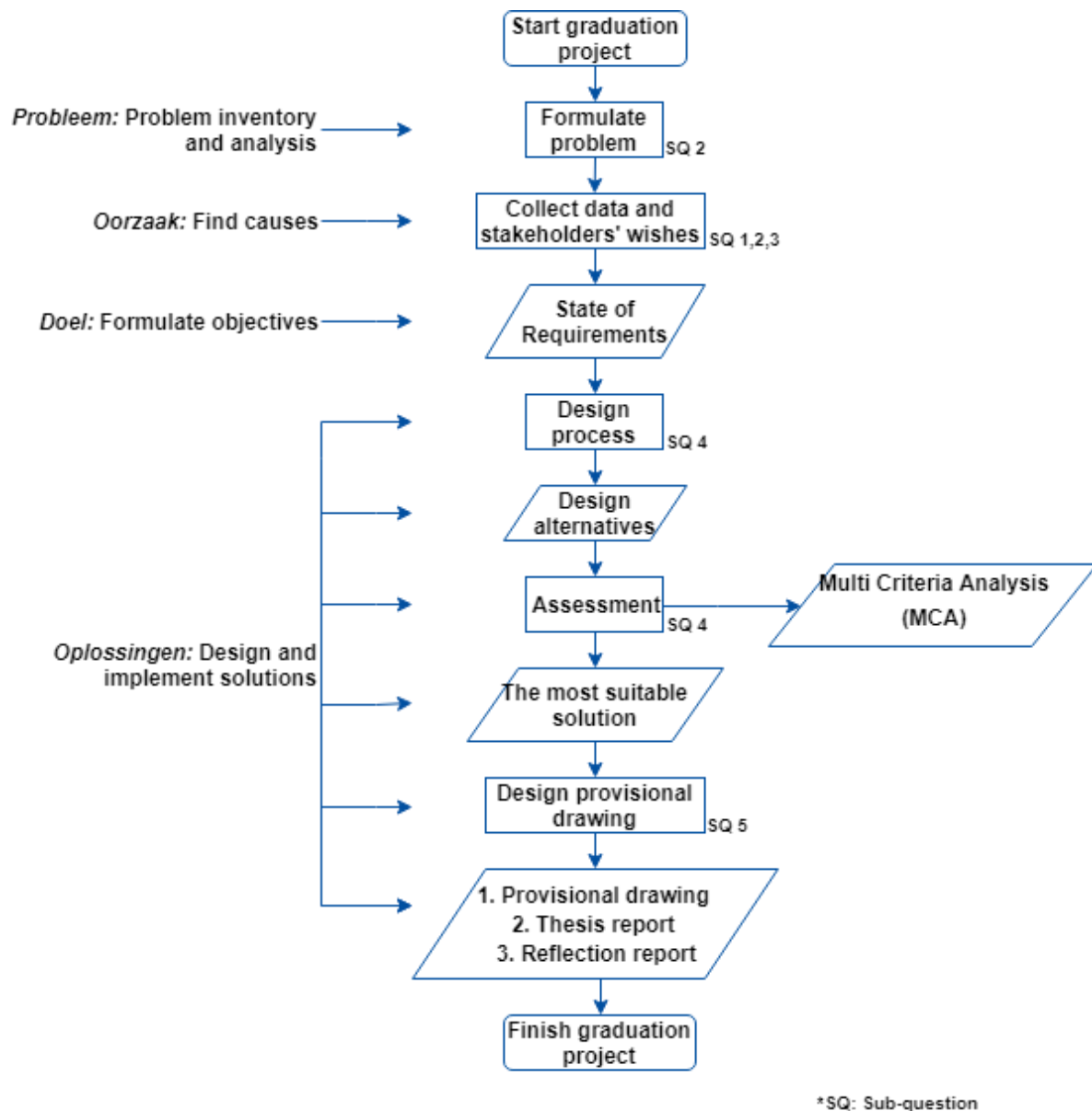


Figure 2: Graduation project research flow

Source: own work

3. Products to be delivered

- a. State of requirements
- b. Design alternatives (sketch designs)
- c. Multi criteria analysis to select the most suitable solution \

- d. Provisional designs and cross section
- e. Final thesis report
- f. Reflection report

4. List of sources

- a. Verbinden met de fiets, 2016, Provincie Groningen
- b. Fietsroute Plus Groningen - Leek: Analyse, afweging en advies
verkenningfase, 2016, Sweco Nederland B.V.
- c. ASVV 2012, CROW
- d. Enquête onder fietsers tussen Leek en Groningen Fietsroute Plus, 2014,
Royal Haskoning DHV
- e. Transport and Mobility 2016, Statistics Netherlands
- f. Fietsstraten in hoofdfietsroutes: Toepassingen in de praktijk, 2005, CROW
- g. Ontwerpwijzer fietsverkeer, 2016, CROW
- h. Uitvoeringsvoorschriften BABW inzake verkeerstekens, 2017, Ministerie
van Verkeer en Waterstaat

5. Plan and Organisation

Company data

Name: Provincie Groningen

Adress: Sint Jansstraat 4 9712 JN Groningen

Telephone number: +31 (0)50 3164911

Company supervisor

Name: Fokke Woudstra

Job position: Employee of Traffic and Transport Department

Telephone number: +31 6 15868910

Email address: f.woudstra@provinciegroningen.nl

I am mostly responsible in executing all the tasks since I am working on this graduation project by myself. I have a discussion/consultation weekly with my

company supervisor, and when it is needed, I discuss a certain topic with the people in the Provinciehuis. The other type of communication is done by email.

Competences to be completed during the graduation project

CIT01: Preparing a State of Requirement (SoR) and checking designs on this basis

CIT02: Preparing alternatives and options

CIT03: Evaluating and selecting alternatives and options

CIT04: Detailing, calculating, and drawing

CIT14: A02+A03: Managing processes and project-oriented working

CIT17: SC02: Managing (Managing and/or coaching)

CIT19: Z01+Z02: Ability to work independently and ability to learn independently

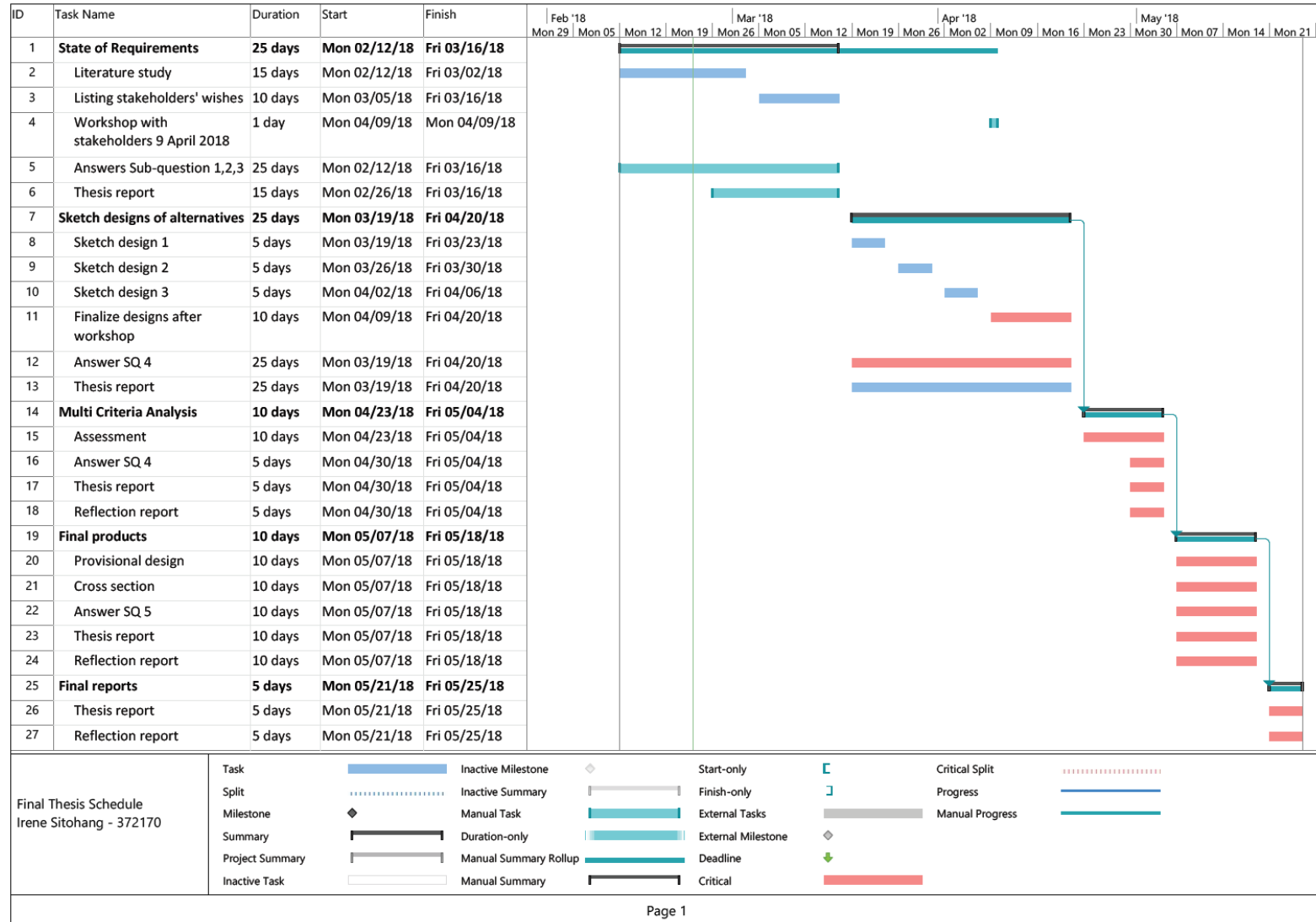
Risk Analysis

The risks that might occur during the graduation project are as follows:

- a. The upcoming workshop in April 2018 is done in the middle of designing process, during which the state of requirements has been drawn up. The result of the workshop has a potential to influence or even to change the state of requirements and the designs. This risk can be minimized by considering all possible things that might be important for the project. Moreover, after the workshop there are 2 more weeks to finalize the designs before the assessment with Multi Criteria Analysis.
- b. Unexpected events: sick, or other unfortunate events

Graduation Project Timeline

Period: 12 February 2018 - 29 June 2018



ACADEMIE VOOR ARCHITECTUUR, BOUWKUNDE & CIVIELE TECHNIEK

Toestemmingsformulier tot opname en beschikbaarstelling afstudeerscriptie in een digitale kennisbank



**Hanzehogeschool
Groningen**
University of Applied Sciences

De Hanzehogeschool heeft een digitale kennisbank opgezet waarin de Hanzehogeschool scripties die door studenten in het kader van hun studie aan de Hanzehogeschool hebben geschreven, toegankelijk worden gemaakt voor derden. Hierdoor wordt het proces van creatie, verwerving en deling van kennis binnen het onderwijs mogelijk gemaakt en ondersteund.

De in de kennisbank opgenomen scripties zullen gedurende minimaal zes jaar in de kennisbank worden opgenomen en toegankelijk gemaakt voor potentiële gebruikers binnen en buiten de Hogeschool. Om opname en beschikbaarstelling mogelijk te maken dient dit toestemmingsformulier te worden ingevuld en ondertekend.

Door opname en beschikbaarstelling in de digitale kennisbank wordt het auteursrecht niet overgedragen.

Indien je toestemming wilt geven, vul je naam en de titel van de afstudeerscriptie hieronder in.

Rechten en plichten student indien de afstudeerscriptie wordt gepubliceerd:

Irene Febryana Sitohang verleent aan de Hanzehogeschool kosteloos de niet-exclusieve toestemming om zijn afstudeerscriptie getiteld

The implementation of high-quality cycle path (Fietsroute Plus) along the Hoofdstraat in Midwolde and Lettelbert of Municipality Leek
op te nemen in de digitale kennisbank

en om deze afstudeerscriptie beschikbaar te stellen aan gebruikers binnen en buiten de Hanzehogeschool. Hierdoor mogen gebruikers de afstudeerscriptie geheel of gedeeltelijk kopiëren en bewerken. Gebruikers mogen dit alleen doen en de resultaten publiceren indien dit gebeurt voor eigen studie en/of onderwijs- en onderzoeksdoeleinden en onder de vermelding van de naam van de student en de vindplaats van de afstudeerscriptie.

De toestemming om de afstudeerscriptie aan derden beschikbaar te stellen gaat in vanaf het moment dat hiervoor getekend is.

De student verklaart dat de stagebiedende organisatie dan wel de opdrachtgever van de afstudeerscriptie geen bezwaar heeft tegen opname en beschikbaarstelling van de afstudeerscriptie in de digitale kennisbank.

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- De afstudeerscriptie is vertrouwelijk en mag niet worden gepubliceerd:

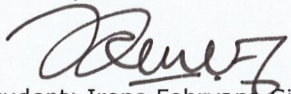


Rechten en plichten gebruiker indien de afstudeerscriptie word gepubliceerd:

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Hieronder tekenen door alle studenten van de afstudeergroep bij al dan niet verlenen van toestemming voor het publiceren van het afstudeerwerk:

Datum: 28 Mei 2018



Naam student: Irene Febryana Sitohang

Studentnummer: 372170

Opleiding: Civiele Techniek

Afstudeerrichting: International Civil
Engineering Management

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*Dit formulier graag uploaden in OnStage bij de aangegeven stap.
Het formulier hoeft niet geprint te worden.*