Adaptation to climate change

Interreg 2 Seas Mers Zeeën

Water Resilient Cities

European Regional Development Fund

Increase Urban resiliance to climate change through improved storm water management

Action Plan Middelburg:

City center drainage masterplan

MIDDELBURG

Part 1 : Why we need and want more sustainable drainage

“Water in the street? You better get used to it!”

That was the headline of an article in the Dutch newspaper *Provinciale Zeeuwse Courant* of 2 September 2015 following the downpour in Zeeland that lasted a few days. In some places there was such an extreme rainfall in a short period of time that the public sewage system could not cope.

Middelburg was affected as well. During the evening and night of 30 to 31 August 2015, approximately 90 millilitres of rain fall. That is nine buckets of water per square metre. Several sewers in Middelburg were not able to handle this extremely large amount of rain. Some streets were flooded for a while and dozens of houses suffered water damage. The public sewage system could not cope for a while and streets flooded. Homes, shops and businesses suffer from water damage or are temporarily closed down because of the rain.

Was the municipality able to prevent water damage? Is the municipality going to ensure that there won’t be any water damage anymore in the future? These questions are asked of the municipality on a weekly basis. Middelburg’s inability to avoid water damage is directly connected to climate change.

The infrastructure and climate change

Higher temperatures, an increasing sea level rise, wetter winters, heavier rain showers and the chance of drier summers according to the Dutch national weather forecasting service KNMI is that what the Netherlands can expect. As for precipitation, France, England, Belgium and The Netherlands must take into account that heavy showers will increase in number, intensity, amount of precipitation and possibly also in size of the affected area.

The public infrastructure is not prepared for these heavier showers. If we don't take action, the urban environment will be subjected to flood events more often and buildings will increasingly suffer from more damage. Furthermore, neither the public sewage system or the infrastructure of Middelburg are prepared for these heavy showers. That is why Middelburg could not prevent the water damage caused by the extreme precipitation during the evening and night of 30 to 31 August 2015. It is the rationale behind the precaution of this action plan.

If we don't take action here in The Netherlands and therefore also in Middelburg, the urban and public environment will be flooded more often and buildings will increasingly suffer from more damage.

In the night of 30 to 31 August 2015, major flooding occurred in Middelburg. © Loes de Jong

What will Middelburg do to prevent flooding and water damage in the future?

What Middelburg needs to do, is (just like the rest of The Netherlands and the surrounding countries) to adapt to the climate change. Middelburg will do this by adapting the public spaces.

How will the municipality do this? By setting up roads, parks, playgrounds et cetera in a way so that they are able to drain water and/or collect water temporarily.

In the context of the project Water Resilient Cities and in particular Workpackage 2: developing SUDS in our cities, Middelburg has identified in 2016/2017 where flooding can occur during a short, very heavy rain shower or during a long precipitation period of several days. The result of this inventory is an indication of the locations or areas where flooding might occur, including measures, global investments and opportunities for creating added benefits.

All of this in close cooperation with the thirteen municipalities of Zeeland, Scheldestromen Water Authority and the water drinking company Evides. Together they form the Samenwerking Afvalwaterketen Zeeland (SAZ+). Through SAZ+ thirteen municipalities of Zeeland, the Scheldestromen Water Authority and the water company Evides have joined forces to work together even more effectively in the water chain of Zeeland.

Within the partnership (SAZ), stakeholders have exchanged thoughts and have discussed challenges, experiences and possible solutions. From late 2016 until now, this partnership has assembled several times to achieve a regional and local action plan for the retrofit of strategic SUDS in public spaces. This quick scan, first inventory, addresses the solution directions for the city of Middelburg. Following that, a quick scan has been performed all over Zeeland.

Based on the results of the inventory, Middelburg will implement measures to avoid flooding, or where this is not possible, to mitigate it as much as possible. It begins at locations or in areas with a high priority. One of these areas is the region of Molenwater and Dauwendale. The project WRC invests in close cooperation with the WRC partners to avoid flooding and water damage.

Can the municipality guarantee that water damage will never occur again? No, we can never guarantee that.

The risk remains that a rain shower is too big to handle, causing water damage nevertheless. By adapting the public spaces, this risk will however be much lower compared to now.

Interfaces with policies and preconditions

The local action plan arises from the policy plan climate-change adaption and is linked to the following policy plans:

1. Note Public Health
2. Middelburg's Vision Environment including Sustainability Policy For Energy Neutral Middelburg
3. Environmental Vision and Environmental Plan (based on the Environmental and Planning Act)
4. Municipal sewage plan
5. Green policy plan
6. In addition there are more links to other (municipal) policy area's and ambitions or implementation of activities, tasks, works (for example Events Policy, Tourism, Security and Disaster Management).
7. Visiewaterketen Zeeland 2018 (SAZ+)

National and Regional Framework

Spatial adaptation is one of the Delta Decisions arisen from the Delta Programme. This Delta Decision aims at structuring The Netherlands in a water robust and climate resilient way, which will be done by anticipating the rising sea level and subsidence (increasing flood risk), higher temperatures in the summer (heat stress) and more extreme weather conditions (flooding and prolonged drought)when there are spatial and economic developments.

An important part of the Spatial adaptation Delta Decision is that all the authorities have the ambition to make The Netherlands as climate resilient and water robust as they possibly can by 2050. For this purpose, the 'regional consultation climate-change adaption' (in Dutch: RegioOverlegKlimaatAdaptatie) was founded in Zeeland and is working on 4 topics: water safety, flooding, drought and heat stress.

Together with the other 13 municipalities in Zeeland, Province and Water Authority, the project "future-proof water management in urban area's" has been carried out. An approach has been developed for the water scenarios 'short heavy wet', 'prolonged wet' and (limited

for) 'prolonged dry' to achieve a climate resilient water management. Middelburg actively participates in the 'regional consultation climate-change adaption' and therefore mutual coordination and knowledge sharing is secured.

Aim

The aim of this document is to set a long term strategy and series of actions for increasing sustainable drainage implementation.

The municipality's and extern partners' vision for Middelburg as a whole or a certain area is taken into account when the goals are set for a climate resilient city. It could be that a good living environment quality plays a leading role, or the desire to remain an attractive environment for businesses or to become more attractive for tourism.

The aims are partly legally defined for a *water robust structure*: there are legal protection levels for flood defences and norms for flooding. Furthermore, questions are asked such as: what should be done to prevent the area from becoming more vulnerable, despite all the developments? Is it necessary to make the area more resilient in case of a calamity? Which functions or objects must remain functional? Is the prevention of flooded cellars needed?

How often is it acceptable that there is water in the street of a residential neighbourhood? And what about shopping streets? Of course it also depends on costs and benefits.

Furthermore, climate change has many other effects as well.

The 4 strategic tasks of the national Environmental Vision are also the guideline for Middelburg's vision on climate-change adaptation:

- a climate resilient and climate neutral society;
- a future-proof and accessible living and working environment;
- a valuable living environment;
- a sustainable and competitive economy

Part 2: The sustainable drainage action plan

Inventory

The inventory is shown below. In this inventory, potential locations with flooding are described per core, including measures and global investments.

Per location a coding system is used:

- Code Red: Known and urgent issue; Short-term action.
- Code Yellow: Potential issue, less urgent; Action often on longer-term (combining with other works).
- Code Green: Location where measures are already taken.

The described locations are visualised in a GIS map (see page 32). In this map, the codes yellow and red are combined together as one red symbol being “Action is required here”.

The type of action and required investment amount are estimated based on the combination of expert judgement and existing data experience and key numbers and give a rough estimate of the required action. With this information, the municipality of Middelburg is able to adjust its time schedule with other disciplines and to possibly combine these works with other works in the future.

1. Arnestein

In this neighbourhood, there are still no real issues noted. However, water in the street during heavy rainfall is detected. The industrial area is equipped with an improved separate sewer system. The external overflows of the surface water sewer are all at -1.00 m New Amsterdam Level (NAP) with a ground level of NAP+0.00 m to NAP +0.50 m.

When the quick scan is performed, the following (potential) locations with flooding are discovered in case of a short heavy wet situation.

ARN01: location Anodeweg; code yellow (<10 cm water); The solution can be to let the road descend more towards the Ampereweg. The Amperewegheas a fall to the south where the surface water is situated. The works can normally be done combined with the repaving but this street is asphalted. The urgency is low but asphalt lasts for a long time.

ARN02: location Diodeweg / Ampereweg; code yellow (10 cm water); The Diodeweg descends towards the Ampereweg but this street lies 10cm higher. This creates an obstacle where water remains standing. Solution is to level off this "bulge" in the Ampereweg. Urgency is low but asphalt lasts a long time.

ARN03: location Herculesweg and Voltaweg; code yellow; Along the Herculesweg and the Voltawegthereare various waters situated. These waters are however difficult to access from the street because the street is surrounded bykerbs. Therefore, water in the street does not have a chance to run off to the surface water. It is proposed to place a lowered kerb every few metres in order for water to run off.

ARN04: location Elektraweg and Grenadiersweg; code yellow; Along the Elektraweg and Grenadiersweg there is surface water. The berm between the Elektraweg and the water is lies higher than the street and surrounding area. A natural drainage to the water is interrupted, causing possible water in the street. It is recommended to lower the berm (in a number of places) in order for water torun off.

ARN05: location Kuipersweg 1; Code yellow; At this location, there is a depression in the road/area of approx. 10-15cm. The property #1 (kind of transformer building) also lies lower than the area which makes it a potential

damage location. The doorsteps lie significantly higher and therefore probably limit the inflow. In case of heavy rainfall, this area will be flooded. To avoid this situation, adjustment to the road is necessary or possibly a drainage ditch in the green area with a culvert under the Grenadiersweg.

ARN06: location Arnesteinweg 13-15-17; code yellow; A depression in the road of approx. 20 cm at NAP -0.08 m results in a water in the street situation at this location. The area and buildings seem to be 10-20 cm higher (>NAP+0.15 m) than the street so there is a buffer available. Optimising the drainage of the water is possible by creating a drainagethrough the berm to the surface water at the Grenadiersweg. The road is situated at approx.. NAP +0.07 m.

ARN07: location Arnesteinweg 33-61; code yellow; At these locations in the Arnesteinweg, there are depressions in the road where approx. 15 cm water remains standing. The adjoining plots and buildings are approx. 20-30 cm higher than the road and remain dry for now. The water is able to flow across the street to the Waldammeweg. Probably no damage in this location but nevertheless a water in the street location.

No issues are expected for a prolonged wet surface. The T=100 water levels remain limited to approx. 0.30 m under ground level.

No issues are expected for a prolonged period of dry surfaces; a groundwater level is not expected here, neither are dried up ditches or desired level

2. Griffioen

In this residential neighbourhood, there is a flooding issue nearby the Eikenlaan and surroundings; rainwaterflows down the street to the houses and indoor the scullery/kitchen lies significantly lower than the streetlevel. Therefore the combined sewer does not need a area with a lot of pressure to drain wastewater via floor drains etc. back into the houses.

Approx. half of the residential area has a surface water sewer and there are a few big water surfaces. Below, the situations are described for which measures for short heavy wet showers are required. In addition, there are a several optimisations described for the current (sewage) situation.

GR01: location President Kennedylaan and Hammarskjoldlaan; code yellow; The President Kennedylaan and Hammarskjoldlaan are relatively on the same street level. Near the Hammarskjoldlaan 23 a passage to the surface water is possible, including the construction of an extra exhaust for the surface water sewer. The four driveways west of the President Kennedylaan all have a rise towards the houses. Optimisation of the road structure. This can be continued with the roadworks. An extra exhaust for the sewer are, however, additional costs.

GR 02: location Mazzinilaan; code red; The Mazzinilaan is a low-lying street where a lot of hardening runs to. Due to a lack of drainage possibilities, there will be water in the street here. There is a possibility to drain via the park on the east side of the street towards the roundabout. There is also a surface water sewer (no data known) where a joint could be installed as an extra drainage possibility.

GR 03: location Europalaan; code yellow; At the Europalaan there is surface water. The berm in between is significantly higher than the street and therefore water remains in the street. It is recommended to create several passages or to lower the berm enabling water to run towards the surface water.

GR 04: location Eikenlaan and surroundings; code red; At this location, a lot of flooding is caused by the overflowing sewer when there is a heavy rainfall (water runs back into the low-lying houses), as well as water in the street. It concerns the following streets:

- Lijsterbeslaan;
- Eikenlaan;
- Tamariskenlaan;
- Kornoeljelaan.

At the Kornoeljelaan and Eikenlaan, there is surface water where excess rainwater can be drained to. The streets all slope down reasonably in this direction but kerbs and berms impede water flowing /discharging actual running into the pond.

The pond, however, does not have an overflow system, thus inundation can still occur when there is too much water in the pond. A solution for this could be to extend the surface water sewer at the intersection Olmenlaan / Eikenlaan to the Eikenlaan and to install an exhaust in the pond.

It is then also necessary to place a dam in the surface water exhaust to prevent that the pond gets completely drained / water level regulation. The water level is allowed to rise to a maximum of approx. NAP -0.85 m because of inundation; A part of the road surfacing can be carried out with the regular roadworks. Construction of sewage system and adjustments to berms bring additional costs.

GR 05: location Kastanjelaan; code yellow; Optimisation surface water sewage by connecting the surface water sewer with the surface water sewer in the Olmenlaan;

GR06: location Elzenlaan; code yellow; Optimisation surface water sewage by connecting this surface water sewer with the surface water sewer in the Hazelaarslaan.

GR07: location Seispark; code yellow; Optimisation by creating several passages/ inlets ? from the road to the surface water / Connecting kolks directly to the surface water.

No issues are expected for a prolonged wet surface. The T=100 water levels calculated by the water authority do however not apply to the Domburg canal. In practice, there are indeed issues with the high water levels in the Domburg canal in case of heavy and prolonged precipitation.

No issues are expected for a prolonged dry surface; too low groundwater level is not expected here, neither are dried up ditches.

3. Arnemuiden

In this core, flooding happens in case of heavy precipitation. In August 2015, approx. 50mm fell in a short amount of time that resulted in damage. During the quick scan, the following locations have been identified:

For short heavy wet:

Arn 01: location Roelseweg; code red; Here the issue is the low position of the ground level towards the surroundings and the rest of the draining area (to approx. 1.5 m height difference) and its limited waking between external overflows and ground level; The solution should be approached in detail because also the functioning of the existing sewage is important..

Arn 02: location Tuindorp 21; code yellow (depression in ground level 20 to 30 cm). Drainage to the canal is not possible because of thehigh water level.

Arn 03: location OranjeNassaustraat; code yellow (street trapped between two higher levelled speed bumps 15-20 cm); Solution is to adjust the height of the speed bumps and to drain the street towards the Canal.

Arn 04: location Korenbloemlaan/Bereklauw; code yellow (Speed bump causing water in the street); Solution is to lower the speed bump and to drain the water via the Pinksterbloemlaan towards surface water.

Arn 05: location Korenbloemlaan (between Akkerlaan and Boterbloemlaan); code yellow (depression in ground level 20 cm); Solution is to adjust the road towards Akkerlaan at some stage and to let it descend towards surface water.

Arn 06: location intersection Korenbloemstraat / Bremstraat; code yellow (depression in ground level; solution is to adjust the road at some stage towards surface water east ofCitersweg.

General remark: A lot of streets around the Banjaard and Roompot end at the water. Level off these ends towards surface water in order to place an extra exhaust from the road.

For a prolonged wet surface, there are no locations found where inundation is possible for the T=100 water levels.

No issues are expected for a prolonged dry surface; too low groundwater level is not expected here, neither are dried up ditches.

4. Dauwendaele

DD 01: Location Meanderlaan / Meanderhofstraat; code yellow (SUDs in ground level); At three places, there are SUDS in the road. Probably water in the street and chance of damage. There is a surface water sewer present and therefore no problems have arisen yet. Take a closer look at the location to see if measures are needed.

DD 02: Location Roozenburglaan 165 and surroundings; code yellow (Speed bumps limit drainage); Solution are water passable speed bumps / to lower or to remove speed bumps.

DD 03: Location Dolfijnstraat 21; code yellow (SUD of 0.10 m in the street); Solution is to let the firebreaks drain above ground to the surface water.

DD 04: Location Kruitmolenlaan 152; code yellow (SUD in ground level); Solution is to let the berm drain to the surface water.

DD 05: Location Dauwedaalselaan and surroundings; Optimising drainage via berm.

DD 06: Location Dauwedaalselaan 70 and surroundings; code yellow (SUD of 0.15 m in ground level); Solution is to lower the road towards the surface water a little bit.

DD 07: Location Safiersplaats /Diamant; code yellow; Optimising drainage via berm to the surface water.

DD 08: Location Diamant 36 and surroundings; code yellow (SUD in ground level); Solution is to drain the

rainwater to green area. Probably already happened in the current situation;

No issues are expected for prolonged wetness. The T=100 water levels remain under the ground level.
No issues are expected for prolonged dryness; too low groundwater level is not expected here, neither are dried up ditches, with exception of De Overloper:

DD 09: Location De Overloper, Vrijlandstraat, Goudend,. Code red. Flooding of carpark and surrounding. Solution: SUDS. Investment € 0,25 million.

Design De Overloper

5. Zuid

Mag 01: Location Belfort / Reijersweg; code yellow; Build an extra surface water exhaust at this location to increase the drainage capacity of the surface water sewer;.

Mag 02: Location Wachttoren / Speeltoren and surroundings; code yellow; Adjust berms in order to drain water from the street to the surface water.

Mag 03: Location Minaret 16 and surroundings; code yellow (SUD in ground level of 0.20 m); Solution is to adjust the topsoil towards firebreak / surface water. Possibly fitted with a drainage sewer/surface water sewer which can be connected to the existing system.

Mag 04: Location Prinsenhove; code yellow (SUD in ground level); Solution is to adjust the street in order to create an above-ground drainage to the surface water.

Mag 05: Location Poortershove / Rentmeesterlaan and surroundings; code yellow; Use the green strip/park as rainwater storage.

Mag 06: Location Statenlaan / Weerhaan; code yellow; Prepare berms in order to drain water from the street into the surface water.

Mag 07: Location Radenhove; code yellow (SUD in ground level); An above-ground drainage to the surface water is simply not achievable. However, thereis a surface water sewer in the Rentmeesterlaan to which connection could be possible.

Mag 08: Location Amnestielaan / Schweitserstraat; code yellow; Speed bump is an obstacle. Lower it / make it water passable in order to let the water run off towards the surface water.

Mag 09: Location Teresastraat / Oud Vlissingseweg; code yellow (SUD of 0.2 m in ground level); Finding a solution in the above-ground construction will be difficult since there is no surface water nearby. There is however a surface water sewer to which connection is possible.

Mag 10: Location Statenlaan 15 and surroundings; code yellow (SUD in ground level); Solution is to slope down the road surface towards the surface water.

Mag 11: Pieter Boddaertstraat 1 and surroundings; code yellow (SUD in ground level); Solution is to create an above-ground passage to the surface water.

Mag 12: Location Veldzigt; code yellow; To provide berms at various locations to drain from the street to the surface water. Optimise the improved separate sewer system to a separate sewer system.

6. Nieuw Middelburg and VeersePoort

NMV 01: Location Prinses Beatrixstraat 18; code yellow (SUD in ground level); Probably not an issue yet since there is a surface water sewer.Given the area's altitude, a surface water sewer is the most logical drainage possibility. Above-ground drainage will not be possible.

NMV 02: Location PrinsesBeatrixstraat 53; code yellow (SUD of approx. 0.20 m in ground level); Probably can be solved by lowering the speed bump near the Nassaulaan.

NMV 03: Location Nassaulaan 101; code yellow (SUD/bump); Solution is to adjust the berm towards the surface water.

NMV 04: Location Nassaulaan; code yellow; Optimisation of the berm towards the surface water.

NMV 05: Location Kon. Emmastraat 5 and surroundings; code yellow (SUD of 0.20m between two speed bumps); Solution is to lower the Zacharias Jansenstraatduring roadworks or to expand the existing water surface sewer system further towards the surface water.

NMV 06: Location Veersesingel 242; code yellow (SUD in ground level); Solution is to lower the plateau in the Veersesingel by approx. 20-30cm or to build a surface water sewer combined with point **NMV 05.**

NMV 07: Location Leliestraat 36; code yellow (SUD of 0.20 m in groundlevel); It is probably possible to lower the Jasmijnstraat towards the Zacharias Jansenstraat by approx. 0.20 m during repaving.

NMV 08: Location Veersepoort / Scholeksterstraat; code yellow (General remark). Neighbourhood has two surface water sewers. It couldbe possible to optimise the system so less water needs to go to the sewage

treatmentand more water can run off to the surface water.

NMV 09: Location Steenloperstraat; code yellow (SUD in groundlevel); Solution is to lower the street towards the surface water (max. of 0.10 m is required).

NMV 10: Location VeersePoort / Zacharias Jansenstraat; code yellow; Lower the VeersePoort nearby the intersection with the Zacharias Jansenstraat in order to optimise the drainage towards the ditch.

NMV 11: Location Leliestraat 39 and surroundings; code yellow (SUD of 0.30 m in ground level); Above-ground drainage seems difficult because of the higher situated area. Installing a drainage sewer to the ditch is the most logical measure.

7. Centrum

Cen 01: Location Karelsgang and Havendijkstraat; code yellow (SUD in ground level); This concerns an approx. 10-15cm deep depression in the street. Doesn't necessarily cause problems. An above-ground solution will be difficult because the area lies on higher ground. Connecting to the existing water surface sewer seems achievable.

Cen 02: Location VeerseBolwerk 3 and surroundings; code yellow; Low area in a green environment. Adjust berm in order for water to run off to the ditch.

Cen 03: Location Suikerpoort / Spuistraat; code yellow (SUD of 0.30 m in ground level); Above-ground drainage doesn't seem possible so far because the area lies on higher ground. Installing a drainage sewer to the ditch seems a logical measure.

Cen 04: Location Segeersstraat 19 and surroundings; code Red (SUD of 0.40 m in ground level); Drainage via the topsoil is actually not possible because the area lies on higher ground. Installing a drainage sewer to the ditch seems a logical measure. **See also Cen 14**;

Cen 05: Location Herenstraat 14 and surroundings; code Red (SUD of 0.40 m in ground level); Drainage via the topsoil is actually not possible because the area lies on higher ground. Installing a drainage sewer to the ditch seems a logical measure. **See also Cen 14**;

Cen 06: Location Abdijplein; code green; Known location where flooding and damage actually occurs. The Province is the owner of the Abbey and has taken measures by placing blocks at the entrance of the Zeeuws Museum.

Cen 07: Location SintJorisstraat 9 and surroundings; code yellow (SUD in ground level); No direct solution available.

Cen 08: Location SintJorisgang; code yellow; No direct solution available. Could however be linked to the flooding location in the SintJorisstraat**Cen 07**.

Cen 09: Location Blindenhoek; code red (SUD in ground level); No direct solution available. Possibly a drainage pipe directly to the ditch. Measure is being processed by the municipality.

Cen 10: Location Lambrechtstraat; code yellow (SUD of 0.20 m in ground level); It is possible to lower the street slightly and therefore decreasing the chance of flooding over the doorstep.

Cen 11: Location SintAntheunisstraat; code yellow (SUD of 0.50 m in ground level); Measure of above-ground drainage is not possible because the area lies on higher ground. Here it will be possible to install a drainage pipe.

Cen 12: Location Klein Vlaanderen 30 and surroundings; code yellow (SUD of 0.20 m in ground level); Above-ground drainage is not possible because the area lies on higher ground towards the bridge / surface water. Installing a drainage pipe is possible.

Cen 13: Location SintSebastiaanstraat; code yellow (SUD of 0.30 m in ground level); Drainage via the topsoil is probably not possible regarding the higher situated area. Drainage via a drainage pipe is possible.

Cen 14: Location SintJansgang; code Red (SUD of approx. 1.00 m in ground level); Drainage via a 1,000mm drainage pipe has been proposed by the municipality and is in development. Also other flooding locations could get connected to this. See**Cen 04**and**Cen 05**. Also possible application of Aquaflow.

Cen 15: LocationKerspel / Gravenstraat; code Red (SUD of 0.40 m in ground level); Drainage via the topsoil is probably not possible because the area lies on higher ground. Drainage via a drainage pipe is possible.

Cen 16: Location Koestraat; code yellow (SUD in ground level); Measure (drainage pipe?) combined with **Cen 15**;

Cen 17: Location Lange Geere; code Red (SUD in ground level); Issue is known by the municipality and a surface water sewer has already been installedwhich decreased the chance of problems. Remains a potential flooding location. Given the course of the ground level, an above-ground drainage is difficult to achieve.Maintain the situation as yet.

Cen 18: Location Poelendaelsesingel; code yellow (SUD in ground level); Adjust berm in order for rainwater to drain to the surface water.

Cen 19: Location Looierssingel (past Hof van Thange); code yellow (SUD in ground level); Check if above-ground drainage via the shrubbery is possible.

Cen 20: Location Molenwater. Code red. Flooding of Molenwater and adjacent properties. Slution: SUDS in Molenwater.

8. Klarenbeek

Klb01: Location Nieuwehovenseweg / Brandenburg-laan; code yellow (optimisationdrainageof berm).

Klb02: Location Brandenburglaan / Generaal Eisenhouwerlaan; code yellow (bumpholds back water); Solution isto lower or remove the bump and to install adrainage to the watercourse. Either above ground level by adjusting the road and/or underground by creating an exhaust for the existing surface water sewer.

Klb 03: Location Generaal Hakewill Smithstraat and surroundings; code yellow (optimising bermsfor direct drainage).

Klb 04: LocationGeneraalHakewillSmithstraat / Laan der Commandos; code yellow (bump holds back water); Solution is to adjustthe street/bump in heightduring roadworks (material clinker bricks);.

Klb 05: Location Pieter Gootjesstraat; code red (SUDof 0.44 m in ground level); The SUD is located deep, hampering the above-ground drainage. Expanding the surface water sewer in order to guarantee a direct drainage seems to be the most logical

solution.Constructionall the way up to the Arie van Driellaan is necessary.

Klb 06: Location President Rooseveltlaan (13); code yellow (SUD in ground level); Thispotential problem location is probably not a problem in practice since there is a bigØ800 mm surface water sewer that can drain the collected rainwater. Might optimise the above-ground drainage towards the water near theGeneraalHakewillSmithstraatand use impeller covers in the future.

Klb 07: LocationNoordweg 100; code yellow (SUD/bump in the road, approx. 0.15 m); Solution isto build the road in a way that it slopes down south to the TerVestelaan (surface water). Benefiting from roadworks (clinker paving).

Klb 08: Gerrit van de Veenstraat 28 and surroundings; code yellow; Lower the back alley towards watercourse for above-ground drainage of the water.

9. Prooyenspaak

No significant flooding locations have been found in this neighbourhood.

10. Stromenwijk

Str 01: Location Biesbosstraat; code yellow (SUD of 0.2 m in ground level); Green park at the Bioesbosstraat is a low point in the area. There is no direct drainage to the surface water so a storage in the park could be built here (area lies approx. 0.30 – 0.40 m higher). The municipality has indicated that it wants to detach the area more.

Str 02: Location Rijnstraat and surroundings; code green/yellow; This neighbourhood has a surface water sewer since 2016 (- now) which is dimensioned optimally. Everything is installed with a diameter PVC Ø400mm unless a bigger size was needed for the drainage norm Bui 08. This approach results in equivalent costs compared with “meeting the norm” but makes sure that nearly the complete neighbourhood is “Bui 10 proof”. The chance of flooding and damage has decreased considerably without making additional costs.

Str 03: Location Koudekerkseweg / Korczakstraat; code yellow (SUD of 0.4 m in ground level); This is a main road with a SUD of approx. 0.4 m. It is necessary to check in detail if flooding has occurred here and where the water

can run off to. This location potentially obstructs an access road!

Str 04: Location Poelendaelseweg / Burgerweidestraat; code yellow (SUD in ground level); The Poelendaelsestraat rises approx. 0.60 m towards the ditch. An above-ground drainage does not seem achievable here. Furthermore, the target is to install a drainage sewer to which also other endpoints of existing surface water sewers can be connected. Another solution is to adjust the Baarsjesstraat towards the surface water. The height difference is smaller and therefore easier to achieve.

Str 05: Location VlissingseMolenstraat 20 and surroundings; code yellow (SUD in ground level); Solution is to lower the drainage direction to the ditch by 0.30 m. If this is not achievable, installing a drainage sewer directly to the ditch is possible.

Str 06: Location Voorborchstraat; code yellow; Adjust the road towards the surface water in order to limit the amount of water in the street.

Note: In general, there are many locations where streets are situated next to a watercourse. The green areas and embankments cause impoundment here and obstruct the drainage of water in the street to the surface water. At these locations, penetrate the embankmentsfor a good drainage.

11. Sint Laurens

No complaints have been received in this core. The core St. Laurens consists mainly of a combined sewer system of which several streets are provided with surface water sewers.

Short heavy wet:

StL 01: When looking at this core, it is noticeable that the location is very convenient in terms of height. The core is situated on higher ground, adjacent to the nearby streets, and slopes down well to the outer edge / polders of the core. There is only one potential obstacle which is the Van Cittersstraat. The top lies seemingly higher than the doorposts and therefore water, that remains standing behind the speed bumps, floods into the houses quicker than that it flows over the bump to the lower situated areas. It is recommended to lower the speed bumps;

12. Nieuw & St. Joosland

No complaints have been received in this core. The core consists of 50% combined sewers, 50% surface water sewers.

NSJ 01: Location Sloehavenstraat / Scheldepoortstraat; code yellow; The area runs off in the direction of the intersection Sloehavenweg / Scheldepoortstraat. It is recommended to slope down the road from there towards the surface water / lower the intersection;

NSJ 02: Location Molendijk; code yellow; The area seems to drain above ground towards the Molendijk. On the southern side of the Molendijk, there is surface water to which the rainwater from the street can be drained. It is important to check to what extent the Molendijk already slopes down sufficiently. Possibly combining this with other works in the future.

NSJ 03: Location Achter de Kerk / Oude Rijksweg; code yellow; The Oude Rijkswegobstructs the possibility of draining water above ground towards the Sloehavenstraat. It is necessary to lower the road/intersection and can be included in the works;

NSJ 04: Location HogeStelle; code yellow; The street HogeStelle is flat and nearbyhouses 39 and 43, a piece of land remains fallow. It is possibleto create a drainage here/to lower this part towards the watercourse to the north.

13. Oranjeplaat

In the bungalow park “Oranjeplaat”, the chance of flooding in case of extreme rainfall is very small. A lot of green has been created in this area in order to have enough space around and between the houses for water seepage.

14. Kleverskerke

The core Kleverskerke does not seem to be a problem area in case of extreme rainfall. The core lies significantly higher than the maximum T=100 water level.

15. Total required investment

Cumulatively for the considered 14 cores / neighbourhoods, an investment amount of 3.4 million

is required; in addition to an investment amount of 14 x 0.025= 0.35 million.

Thus, it requires investments totalling approx. € 4 million to continue achieving a future-proof water management for the municipality of Middelburg.

Artist impression Molenwater Park

PART 3: WATER CHALLENGE

Pilot Molenwater park

As regards the water challenge, a variety of options were examined, including:

1. water along the southern canal, incl. restoring historical frame profile
2. a cascade of green infiltration facilities so called ‘boswadi’s’ or ‘green wadis’.
3. SUD’s
4. more urban water squares

A cascade of green wadis

The preference, that is further developed within the park design, is based on a cascade of green wadis. Lowered ground level zones (wadi) in a more extensive controlling world offer space to store rainwater temporarily during heavy showers. The water can slowly drain away, infiltrate to a limited extent or vaporise. This buffer is meant for water from disconnected streets and roofs of houses in the immediate vicinity of the park, in order to make the surrounding system more climate-resilient. The wadis are set up in an interesting way ecologically and have a great appeal to, among other things, dragonflies, butterflies and therefore

amphibians. In addition, they create attractive playing possibilities.

The reflecting pond

Water is always very appealing to people. The reflecting pond will therefore be the most important spot in the park. It is a spot where there is always water, unlike the wadis. The city reflects in the water which gives an extra dimension to this park in Middelburg.

The reflecting pond is designed in a way that it invites to play. A wide seating edge embraces the pond. The zone between the pond edge and seating edge can be flooded at the highest water levels and then becomes a water square (or playground). The painted lines in the square – 1000m3, 1500m3, 2000m3 – make the storage function legible.

The seating edge continues into an attractive platform that seems to float directly above the wadis. Scoop out tadpoles with a net and experience nature!

The platform is made out of wood from thinning the edge of the park.

A contemporary city park: character and atmosphere

A study visit to other city parks by the inhabitants/ stakeholders work group has contributed to making the right decisions regarding character and right atmosphere.

The location of the current Molenwaterpark in the middle of the city and as the only big green space in the city centre makes it the best choice for a contemporary city park, without losing sight of the ecology and history.

A contemporary landscape style is formed by a network of hilly paths together with a gently sloping relief at ground level. Also the park furniture and the lighting contribute to this.

The zone near the green wadis gets a more natural and ecological character. This combination makes the Molenwater a contemporary city park.

GIS map of Middelburg

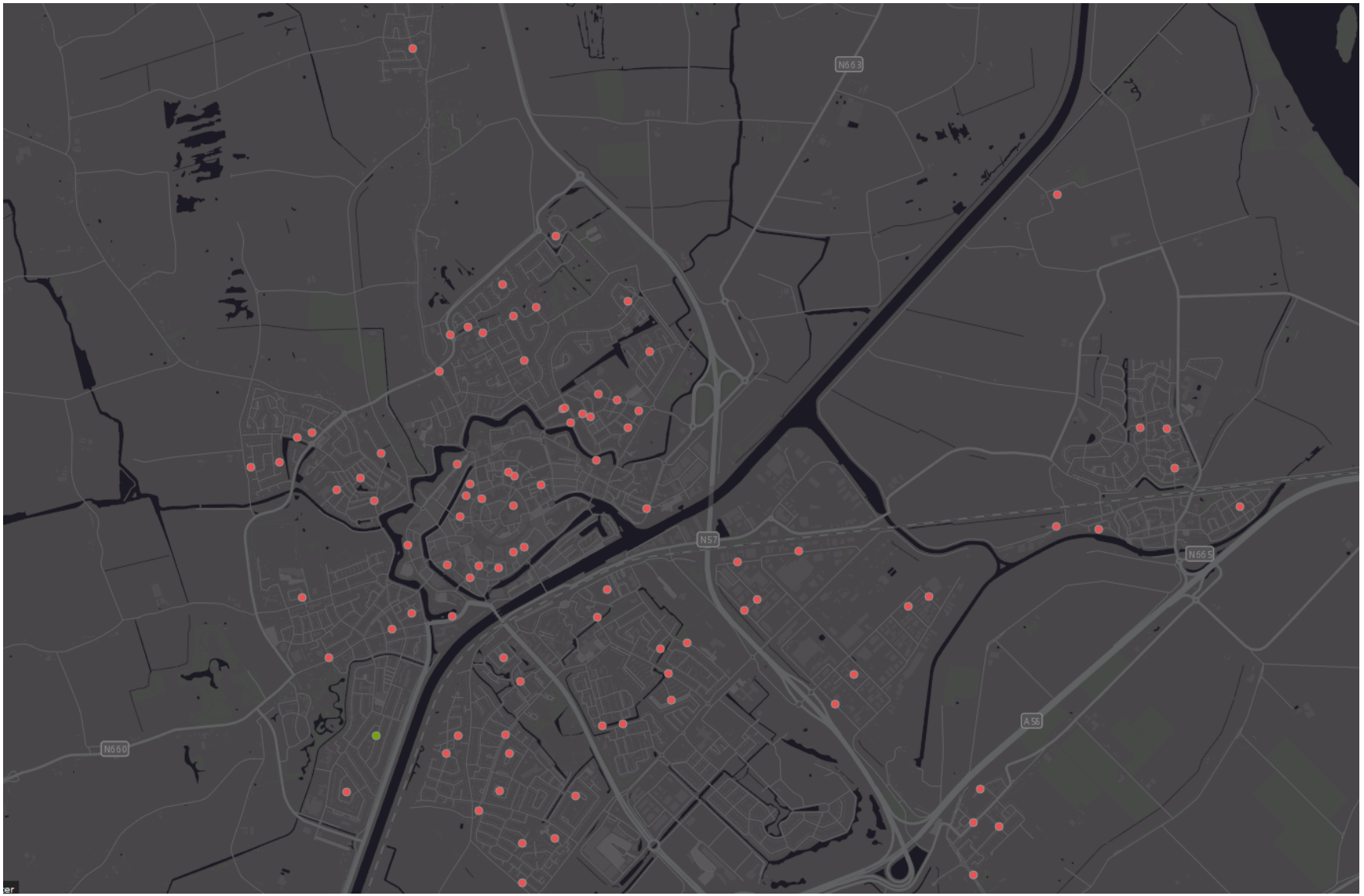
Link to the Geographic Information System (GIS) map.

The described locations in chapter 2 are visualised in a GIS map.

Per location a coding system is used:

- Code Red: Known and urgent issue; Short-term action.
- Code Yellow: Potential issue, less urgent; Action often on longer-term (combining with other works).
- Code Green: Location where measures are already taken.

In this map, the codes yellow and red are combined together as one red symbol being “Action is required here”.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Action Plan Middelburg:
City center drainage masterplan

Published by: Municipality of Middelburg, The Consortium Water Resilient Cities and Samenwerking Afvalwaterketen Zeeland (SAZ+). Through SAZ+ thirteen municipalities of Zeeland, the Scheldestromen Water Authority and the water company Evides have been involved in this masterplan and to join establishment of the GIS system.

Date: 30-06-2019

Interreg
EUROPEAN UNION
2 Seas Mers Zeeën
Water Resilient Cities
European Regional Development Fund

MIDDELBURG