APPENDICES

I. FISH SPECIES DATASET

Gilde	Vissoort	Biomassa (kg/ha)[1]					Aantallen (stuks/ha)[1]				
		2006	2008	2011	2014	2019	2006	2008	2011	2014	2019
Eurytoop	Aal	27,8	27,1	50,5	26,8	21,2	196	133	179	79	50
	Alver	-	-	0,0	0,1	0,0	-	-	1	5	0
	Baars	1,3	0,8	6,1	5,9	7,8	78	172	727	833	1.255
	Blankvoorn	7,0	9,9	8,8	13,0	8,9	242	92	353	806	516
	Brasem	25,9	148,6	57,1	100,3	69,8	209	453	737	873	693
	Driedoornige stekelbaars	-	-	0,0	0,0	-	-	-	8	3	-
	Giebel	-	-	-	-	0,4	-	-	-	-	0
	Hybride	0,1	1,0	0,2	0,9	0,1	2	3	3	17	1
	Karper	-	-	1,8	0,4	1,7	-	-	0	0	0
	Kleine modderkruiper	0,0	-	-	-	-	2	-	-	-	-
	Kolblei	1,0	2,2	1,6	1,0	0,6	15	19	42	58	6
	Pos	0,1	0,1	1,7	1,2	0,4	14	23	615	224	63
	Snoek	0,1	0,3	2,1	4,3	3,4	15	1	3	5	4
	Snoekbaars	6,3	9,7	10,0	12,5	17,2	7	7	28	55	110
Limnofiel	Bittervoorn	-	-	-	0,0	-	-	-	-	7	-
	Rietvoorn	1,4	0,1	0,0	0,0	0,2	0	0	4	26	12
	Spiering	-	-	-	-	0,0	-	-	-	-	0
	Tiendoornige stekelbaars	-	0,0	0,0	0,0	-	-	1	1	1	-
	Vetje	0,0	-	0,0	0,0	-	1	-	4	1	-
	Zeelt	1,4	-	0,1	0,1	0,0	4	-	1	6	0
Rheofiel	Riviergrondel	-	-	-	-	0,0	-	-	-	-	0
	Rivierdonderpad	0,0	0,0	0,0	0,0	-	6	1	9	2	-
	Winde	0,1	1,1	0,2	1,2	1,1	2	8	12	7	12
Exoot	Marmergrondel	-	-	-	0,0	-	-	-	-	6	-
	Pontische stroomgrondel	-	-	-	-	0,0	-	-	-	-	3
	Roofblei	0,2	0,0	0,4	1,9	2,4	0	1	2	3	2
	Zonnebaars	-	-	0,0	0,0	0,0	-	-	1	-	0
	Zwartbekgrondel	-	-	-	0,0	0,7	-	-	-	9	171
Marien	Dunlipharder	-	-	-	-	0,2	-	-	-	-	0
	Totaal	**72,7**	**200,9**	**140,6**	**169,6**	**136,1**	**793**	**914**	**2.730**	**3.026**	**2.899**

[1] *0,0 = <0,05 kg/ha of <0,5 stuks/ha; - = niet aangetroffen*

[2] *Source: Waterschap Brabantse Delta, contact: Kees Fraanje*

II. MACROPHYTES DATASET

Datum	Latijnse naam	Nederlandse naam	Waargenomen
01/07/2016	Angelica sylvestris	Gewone engelwortel	1
01/07/2016	Angelica sylvestris	Gewone engelwortel	1
01/07/2016	Convolvulus sepium	Haagwinde	2
01/07/2016	Convolvulus sepium	Haagwinde	2
01/07/2016	Epilobium hirsutum	Harig wilgenroosje	2
01/07/2016	Epilobium hirsutum	Harig wilgenroosje	2
01/07/2016	Galium aparine	Kleefkruid	4
01/07/2016	Galium aparine	Kleefkruid	4
01/07/2016	Phragmites australis	Echt riet	1
01/07/2016	Phragmites australis	Echt riet	1
01/07/2016	Solanum dulcamara	Bitterzoet	1
01/07/2016	Solanum dulcamara	Bitterzoet	1
01/07/2016	Stachys palustris	Moerasandoorn	3
01/07/2016	Stachys palustris	Moerasandoorn	3
01/07/2016	Urtica dioica	Grote brandnetel	1
01/07/2016	Urtica dioica	Grote brandnetel	1
01/07/2016	Valeriana officinalis	Echte valeriaan	3
01/07/2016	Valeriana officinalis	Echte valeriaan	3
19/07/2016	Acorus calamus	Kalmoes	1
19/07/2016	Acorus calamus	Kalmoes	1
19/07/2016	Carex otrubae	Valse voszegge	4
19/07/2016	Carex otrubae	Valse voszegge	4
19/07/2016	Convolvulus sepium	Haagwinde	3
19/07/2016	Convolvulus sepium	Haagwinde	3
19/07/2016	Convolvulus sepium	Haagwinde	2
19/07/2016	Convolvulus sepium	Haagwinde	2
19/07/2016	Epilobium hirsutum	Harig wilgenroosje	1
19/07/2016	Epilobium hirsutum	Harig wilgenroosje	1
19/07/2016	Epilobium hirsutum	Harig wilgenroosje	1
19/07/2016	Epilobium hirsutum	Harig wilgenroosje	1
19/07/2016	Galium aparine	Kleefkruid	2
19/07/2016	Galium aparine	Kleefkruid	2
19/07/2016	Galium aparine	Kleefkruid	5
19/07/2016	Galium aparine	Kleefkruid	5
19/07/2016	Glechoma hederacea	Hondsdraf	1
19/07/2016	Glechoma hederacea	Hondsdraf	1
19/07/2016	Glyceria maxima	Liesgras	1
19/07/2016	Glyceria maxima	Liesgras	1
19/07/2016	Iris pseudacorus	Gele lis	1

19/07/2016	Iris pseudacorus	Gele lis	1
19/07/2016	Lemna minor	Klein kroos	3
19/07/2016	Lemna minor	Klein kroos	3
19/07/2016	Lycopus europaeus	Wolfspoot	1
19/07/2016	Lycopus europaeus	Wolfspoot	1
19/07/2016	Lycopus europaeus	Wolfspoot	2
19/07/2016	Lycopus europaeus	Wolfspoot	2
19/07/2016	Mentha aquatica	Watermunt	3
19/07/2016	Mentha aquatica	Watermunt	3
19/07/2016	Nuphar lutea	Gele plomp	1
19/07/2016	Nuphar lutea	Gele plomp	1
19/07/2016	Persicaria hydropiper	Waterpeper	3
19/07/2016	Persicaria hydropiper	Waterpeper	3
19/07/2016	Phragmites australis	Echt riet	1
19/07/2016	Phragmites australis	Echt riet	1
19/07/2016	Rorippa amphibia	Gele waterkers	3
19/07/2016	Rorippa amphibia	Gele waterkers	3
19/07/2016	Rorippa amphibia	Gele waterkers	1
19/07/2016	Rorippa amphibia	Gele waterkers	1
19/07/2016	Rubus	Braam	2
19/07/2016	Rubus	Braam	2
19/07/2016	Rubus	Braam	1
19/07/2016	Rubus	Braam	1
19/07/2016	Salix	Wilg	1
19/07/2016	Salix	Wilg	1
19/07/2016	Scutellaria galericulata	Blauw glidkruid	1
19/07/2016	Scutellaria galericulata	Blauw glidkruid	1
19/07/2016	Solanum dulcamara	Bitterzoet	2
19/07/2016	Solanum dulcamara	Bitterzoet	2
19/07/2016	Solanum dulcamara	Bitterzoet	2
19/07/2016	Solanum dulcamara	Bitterzoet	2
19/07/2016	Sonchus palustris	Moerasmelkdistel	2
19/07/2016	Sonchus palustris	Moerasmelkdistel	2
19/07/2016	Sonchus palustris	Moerasmelkdistel	3
19/07/2016	Sonchus palustris	Moerasmelkdistel	3
19/07/2016	Stachys palustris	Moerasandoorn	1
19/07/2016	Stachys palustris	Moerasandoorn	1
19/07/2016	Stachys palustris	Moerasandoorn	2
19/07/2016	Stachys palustris	Moerasandoorn	2
19/07/2016	Symphytum officinale	Gewone smeerwortel	3
19/07/2016	Symphytum officinale	Gewone smeerwortel	3
19/07/2016	Urtica dioica	Grote brandnetel	7
19/07/2016	Urtica dioica	Grote brandnetel	9

20/06/2019	Convolvulus sepium	Haagwinde	7
20/06/2019	Convolvulus sepium	Haagwinde	9
20/06/2019	Epilobium hirsutum	Harig wilgenroosje	9
20/06/2019	Epilobium hirsutum	Harig wilgenroosje	9
20/06/2019	Eupatorium cannabinum	Koninginnekruid	9
20/06/2019	Eupatorium cannabinum	Koninginnekruid	9
20/06/2019	Lycopus europaeus	Wolfspoot	9
20/06/2019	Lycopus europaeus	Wolfspoot	9
20/06/2019	Phalaris arundinacea	Rietgras	1
20/06/2019	Phalaris arundinacea	Rietgras	1
20/06/2019	Phragmites australis	Echt riet	1
20/06/2019	Phragmites australis	Echt riet	1
20/06/2019	Rumex	Zuring	1
20/06/2019	Rumex	Zuring	1
20/06/2019	Solanum dulcamara	Bitterzoet	2
20/06/2019	Solanum dulcamara	Bitterzoet	2
20/06/2019	Stachys palustris	Moerasandoorn	1
20/06/2019	Stachys palustris	Moerasandoorn	1
20/06/2019	Symphytum officinale	Gewone smeerwortel	1
20/06/2019	Symphytum officinale	Gewone smeerwortel	1
20/06/2019	Urtica dioica	Grote brandnetel	2
20/06/2019	Urtica dioica	Grote brandnetel	2
20/06/2019	Cirsium arvense	Akkerdistel	1
20/06/2019	Cirsium arvense	Akkerdistel	1
20/06/2019	Convolvulus sepium	Haagwinde	1
20/06/2019	Convolvulus sepium	Haagwinde	1
20/06/2019	Epilobium hirsutum	Harig wilgenroosje	3
20/06/2019	Epilobium hirsutum	Harig wilgenroosje	3
20/06/2019	Galium aparine	Kleefkruid	2
20/06/2019	Galium aparine	Kleefkruid	2
20/06/2019	Glyceria maxima	Liesgras	1
20/06/2019	Glyceria maxima	Liesgras	2
20/06/2019	Iris pseudacorus	Gele lis	4
20/06/2019	Iris pseudacorus	Gele lis	4
20/06/2019	Lycopus europaeus	Wolfspoot	3
20/06/2019	Lycopus europaeus	Wolfspoot	3
20/06/2019	Phalaris arundinacea	Rietgras	3
20/06/2019	Phalaris arundinacea	Rietgras	3
20/06/2019	Phragmites australis	Echt riet	1
20/06/2019	Phragmites australis	Echt riet	1
20/06/2019	Rumex hydrolapathum	Waterzuring	1
20/06/2019	Rumex hydrolapathum	Waterzuring	2
20/06/2019	Solanum dulcamara	Bitterzoet	2

20/06/2019	Solanum dulcamara	Bitterzoet	1
20/06/2019	Symphytum officinale	Gewone smeerwortel	1
20/06/2019	Symphytum officinale	Gewone smeerwortel	1
20/06/2019	Urtica dioica	Grote brandnetel	1
20/06/2019	Urtica dioica	Grote brandnetel	1
20/06/2019	Angelica sylvestris	Gewone engelwortel	1
20/06/2019	Angelica sylvestris	Gewone engelwortel	1
20/06/2019	Arrhenatherum elatius	Gewone glanshaver	1
20/06/2019	Arrhenatherum elatius	Gewone glanshaver	1
20/06/2019	Cirsium arvense	Akkerdistel	1
20/06/2019	Cirsium arvense	Akkerdistel	3
20/06/2019	Epilobium hirsutum	Harig wilgenroosje	3
20/06/2019	Epilobium hirsutum	Harig wilgenroosje	1
20/06/2019	Galium aparine	Kleefkruid	1
20/06/2019	Galium aparine	Kleefkruid	3
20/06/2019	Iris pseudacorus	Gele lis	3
20/06/2019	Iris pseudacorus	Gele lis	1
20/06/2019	Phragmites australis	Echt riet	1
20/06/2019	Phragmites australis	Echt riet	2
20/06/2019	Solanum dulcamara	Bitterzoet	7
20/06/2019	Solanum dulcamara	Bitterzoet	7
20/06/2019	Symphytum officinale	Gewone smeerwortel	5
20/06/2019	Symphytum officinale	Gewone smeerwortel	5
20/06/2019	Urtica dioica	Grote brandnetel	2
20/06/2019	Urtica dioica	Grote brandnetel	2

[2]*Source: Waterschap Brabantse Delta, contact: Kees Fraanje*

III. VOLKERAK_1 / ST. ANTHONIEGORZEN

This area is located in close proximity to the Volkerak lock complex, near the Hollands Diep, see Figure 1 and Figure 2 below. It is characterized by relatively low elevation levels of +0,30 m NAP to +0,80 m NAP. It has a surface area of approximately 65 ha.

Figure 1. Overview of location Volkerak_1 / St. Anthoniegorzen, indicated with white lines. (Source: Google Maps)

Figure 2. Drone view of the St. Anthoniegorzen, showing the main channel in the area (called Vleij) and the smaller secondary channels in the distance.Lake Volkerak can be seen on the left. (Ton, 2019)

The water in the various channels in this area is connected to surrounding polders. Various culverts are present, some of which can be manually closed an opened to initiate or stop the inflow and outflow of water.

Historically, the area was located outside the dikes, meaning that the area was subject to fluctuations of water levels of surrounding water bodies. After the impoldering, the area evolved into an important habitat for a variety of bird species. Because of these developments and taking into account one of the goals of the project to increase biodiversity, it is challenging to initiate alterations in this area without disturbing current biological and ecological values. Therefore, it is important to assess surrounding areas and potentially establish a link with the *St. Anthoniegorzen*.

The first potential method is to connect the St. Anthoniegorzen to the low-elevated areas to the south, near *Fort Sabina*. Over a length of approximately 1 km, the elevation in this area increases from approximately +0,10 m NAP in the north to approximately +0,60 m NAP in the south, see Figure 3 on the next page. This gradient potentially allows the development of an area with characteristics of a wetland. The surface area is approximately 60 ha.

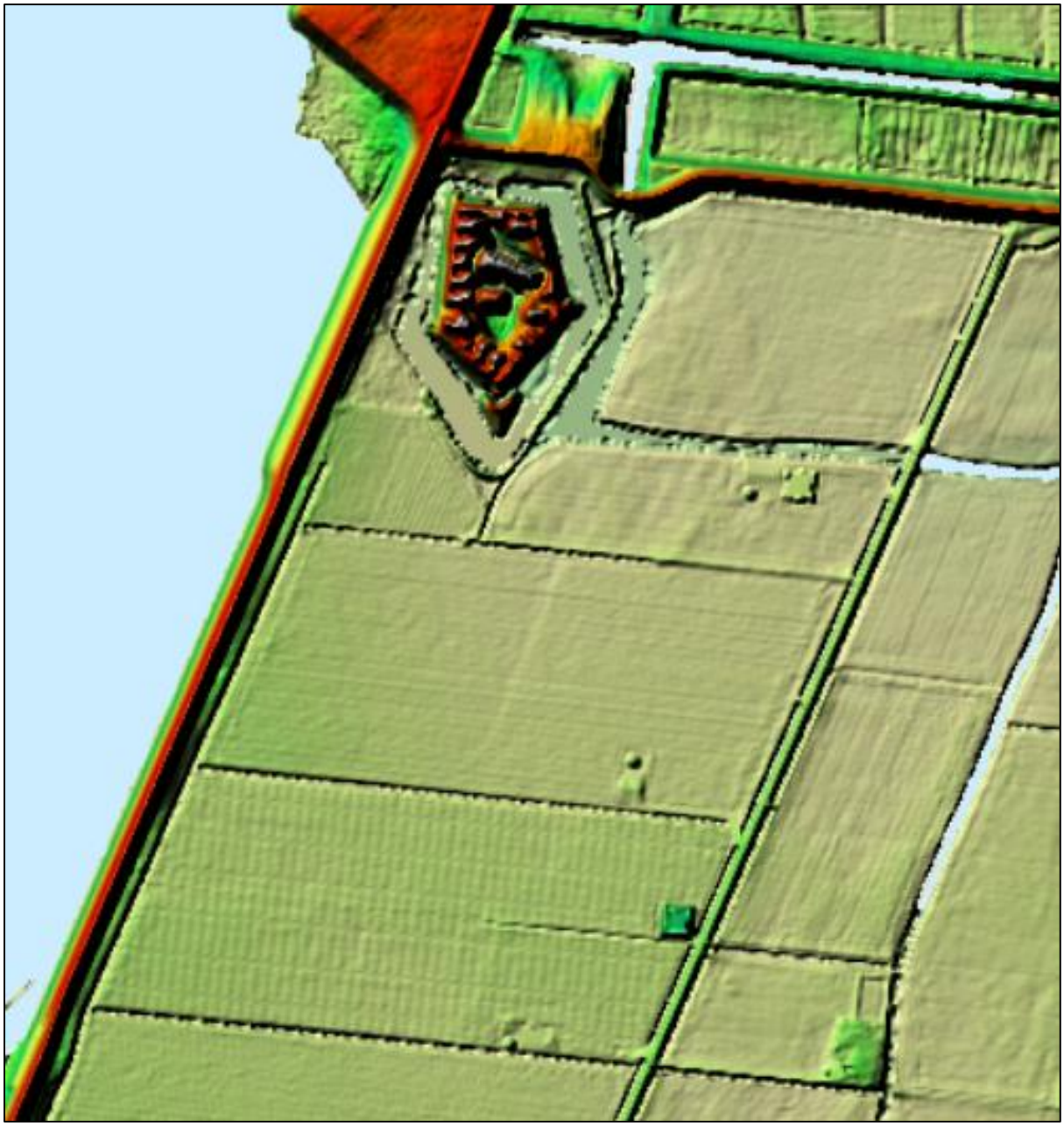

Figure 3. Overview of the location to the south of the St. Anthoniegorzen, with Fort Sabina clearly visible in the north west. Elevation levels range from +0,10 m NAP in the north to +0,60 m NAP in the south. (Source: Esri Nederland, AHN)

The construction of a weir at the dike that separates this area from lake Volkerak would enable controlled inflow and outflow of water. It would primarily serve as a source of outflow of water to lake Volkerak, as water levels in lake Volkerak do not consistently exceed the elevation levels of the area. Depending on current nature values in these areas, inflow and outflow rates may be (negatively) affected.

IV. STEENBERGSEVLIET_1 / SASPOLDERTJE

This location is located only 500 m upstream of lake Volkerak, bordering the nature reserve *Dintelse Gorzen* to the north. It has a total surface area of approximately 11 ha. This area is characterized by the presence of a channel system with some small bifurcations (Dutch: *vertakkingen*) (see Figure 4 on the next page).

Inflow of water is either from the northern side of the system or from sub-surface flow. Surrounding areas are characterized by relatively low elevation however, so the inflow of water from seepage and other subsurface water flow types can be assumed to be low.

Since the channel system is relatively small, the water level in the channel directly follows the water level in the main river (Steenbergse Vliet). The area can be considered to be part of the riparian zone, as it is located between the main river and the dike.

Because inflow of water from the main river is limited to the channel opening (approximate width of 15 m) in the north, overall flow velocity in this system is low. Introducing another opening in the south of this area would increase water inflow from the main river, as this water flows from south to north. Additionally, increasing flow velocity will prevent the water in this system to get a high temperature in summer, which would further increase eutrophication rates.

Vegetation in the area consists of various grass species. Although not very abundant, this includes common reed (*Phragmites australis*). Introducing additional plant species is preferable, as the grazing by cattle in this area has a negative effect on the vegetation on land, including common reed. A focus on riparian vegetation (*Dutch: oevervegetatie*) is required.

Figure 4. Satellite image of location SteenbergseVliet_1 / Saspoldertje. The channel and its small bifurcations are clearly visible. (Source: Google Maps)

V. STEENBERGSEVLIET_2

This location is similar to previous area (*SteenbergseVliet_1 / Saspoldertje*) as it also shares characteristics of a wetland, see Figure 5. With a maximum elevation of +0,20 m NAP, the area is expected to be subject to periodic flooding. Comparing this maximum elevation with water levels at this location, it can be concluded that the water level exceeds this value (+0,20 m NAP) only two days per year on average. This makes this specific area unsuitable for the construction of a floodplain, as this would require more frequent inundation.

Figure 5. Satellite image of location SteenbergseVliet_2. (Source: Google Maps)

Looking at the areas adjacent to this location however, the area to the south is characterized by relatively low elevation of approximately +0,50 m NAP. Excavations could further lower this elevation. This area is used for agricultural purposes and it is separated from the river by a dike with a maximum height of approximately +1,40 m NAP. A secondary dike of roughly +2 m NAP is present approximately 150 m to the south.

Taking these morphological characteristics into account, hypothetical measures could include the following:

- Development of a (low-gradient) buffer-strip
- Side slope reduction
- Creation of riparian wetlands/ponds

These measures are discussed in-depth in chapters 2.4.1, 2.4.3 and 2.4.4 respectively.

These measures could be realized by breaching the dike adjacent to the river, exposing the low-elevated area behind it to periodic inundation. This would create a wetland zone of

approximately 0,25 km² (25 ha). Extending the dike adjacent to the river to the north west southwards would protect surrounding areas from flooding.

If these measures were to be realized, additional measures on alteration of tile-drainage could further improve nutrient removal. In this specific case, drainage tiles could be opened up in the area with highest elevation (at the south) and the water will flow to the river via the buffer-strip of approximately 150 m.

Figure 6 below shows the hypothetical location, indicated with white lines. The elevation gradient is clearly visible on this map (green = low elevation; red = high elevation).

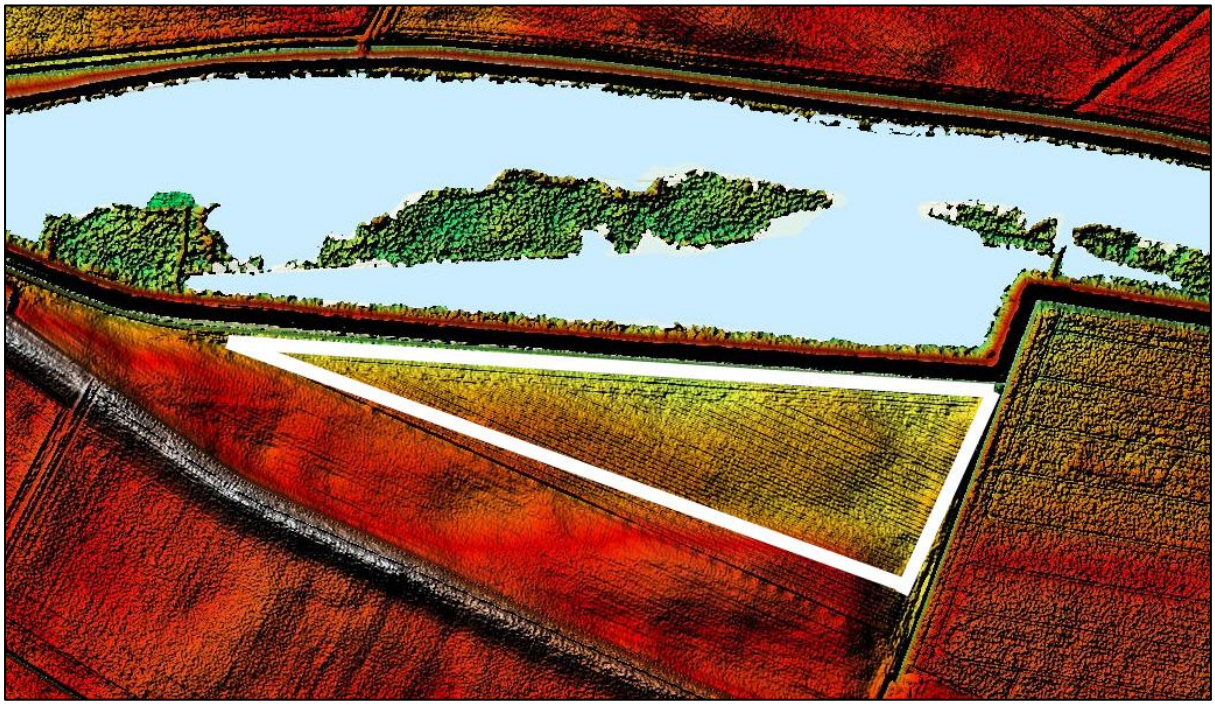

Figure 6. Hypothetical location of the creation of a wetland/floodplain (marked with white lines) adjacent to the river Steenbergse Vliet on an elevation map. (Source: Esri Nederland, AHN)

VI. STEENBERGSEVLIET_3

This location is characterized by the presence of a secondary (smaller) channel, see Figure 7 below. The surface area of this location is approximately 2 ha.

Figure 7. Satellite image of location SteenbergseVliet_3, including the outlet of pumping station Gemaal Visvliet, indicated with a white circle. (Source: Google Maps)

A pumping station is located to the north west of the area, called *Gemaal Visvliet* (capacity: 0,92 m^3/s). Excess water from surrounding polders is pumped into the Steenbergse Vliet via this pumping station. The outlet of this pumping station is located just downstream of this area, indicated with a white circle in Figure 7. This means that water from the surrounding polders is discharged directly into the main river.

Considering the fact that this water contains a significant amount of nutrients (based on the fact that the water originates from agricultural land), a potential effective method would be to create a flow-through wetland area that is capable of (partially) removing nutrients from this discharged water. Alternatively, the discharged water could be directed to flow through the already existing secondary channel as seen in Figure 7.

For the first method, the area adjacent to the ditches north of the river Steenbergse Vliet could be used as a location for wetland creation. Figure 8 shows the top view of this specific area. This area has a total surface area of approximately 2,1 ha. Analysis by using *Vastgestelde Legger Waterschap Brabantse Delta* indicates that water from surrounding ditches flows to the pumping stations from three different directions, as indicated with white arrows in Figure 8. In order to create a functional wetland, diversions from the ditches need to be made so that

the water can flow through the wetland. Current elevation levels in this specific area range from +0,40 m NAP to -0,30 m NAP. Lowest elevation levels are found directly adjacent to the ditches.

Additionally, alteration of tile-drainage could be applied by opening up drainage pipes directly into the created wetland. This would also bypass the difficulties of constructing the diversions from the ditches into the wetland.

For the second method, the water that is discharged from the pumping station into the main river needs to be diverted to area with the secondary channel as seen in Figure 8 below. Creating an area downstream with similar characteristics would be challenging, as space is limited on both sides of the river in the nearby downstream part.

Figure 8. Location overview of the area adjacent to the pumping station Visvliet, including the flow path of the water from the ditches as indicated with white arrows. (Source: Google Maps)

VII. STEENBERGSEVLIET_4

This location is characterized by two waterbodies adjacent to the main channel, with a pumping station (capacity: 0,91 m^3/s) present in the middle, discharging water from the surrounding polders into the Steenbergse Vliet. The two waterbodies, with a total surface area of approximately 5 ha, were formed between 2011 and 2013, as seen in Figure 9 below.

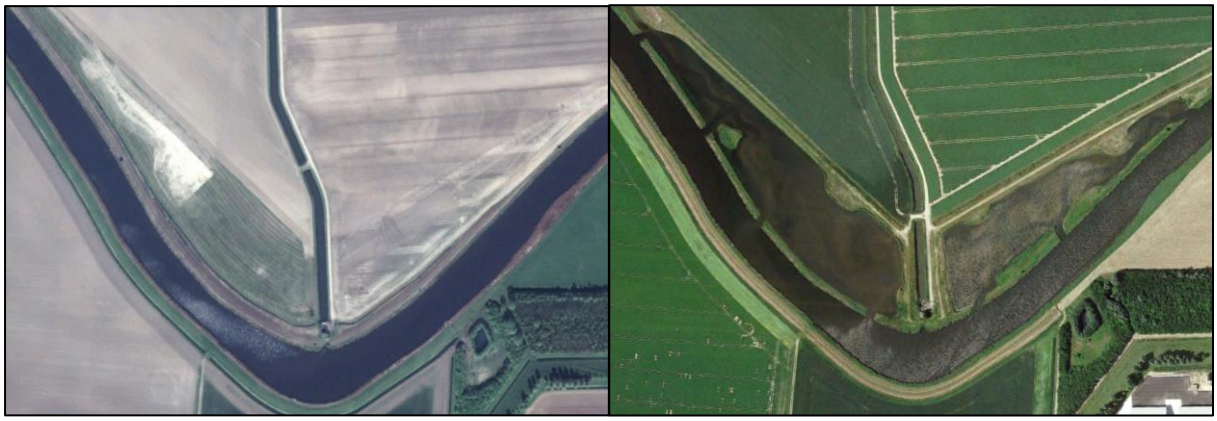

Figure 9. Location SteenbergseVliet_4, in 2011 (left) and 2013 (right). (Source: Google Earth Pro Historical Imagery)

The waterbodies are permanently waterlogged, with direct exchange of water taking place with the main river to the south. The embankments bordering the main river have elevation levels of between approximately +0,20 m NAP and +2,00 m NAP. Various small gaps are present in these embankments, allowing the exchange of water.

The excess water from the surrounding polders is currently pumped directly into the river. This water is assumed to contain a large amount of nutrients, as the water originates from agricultural soils. In order to use the two adjacent waterbodies as a source of nutrient removal, it is essential that the discharge water is redirected via these areas. This measure can be realized by constructing pipes that redirect the water to these areas. This would result in the necessity of closing the gaps in the embankments or making them more narrow, as that would prevent the water to flow directly into the main river. This will increase the retention time of the water in these areas, allowing a greater potential of nutrient removal. If the gaps were made narrow enough, the discharge water would mix with the top layer of the water in the waterbody, which would potentially get the desired result as well.

Vegetation in these waterbodies is only present on the shores, as the water in these waterbodies is too deep for development of emergent plants. Making these waterbodies shallower would be a first step in the development of an area with characteristics of a (small-scale) wetland. Figure 10 on the next page shows the elevation map of the area. (Partial) excavation of the agricultural soils to the north of the river could provide the necessary soil needed to make the area of interest more shallow.

Figure 10. Elevation map of location SteenbergseVliet_4 (green = low elevation; red = high elevation). (Source: Esri Nederland, AHN)

VIII. STEENBERGSEVLIET_5

Similar to the location in Figure 6, this area is characterized with the presence of a low-elevated area adjacent to the main river on the south, see Figure 11 below. It has a surface area of approximately 2,5 ha.

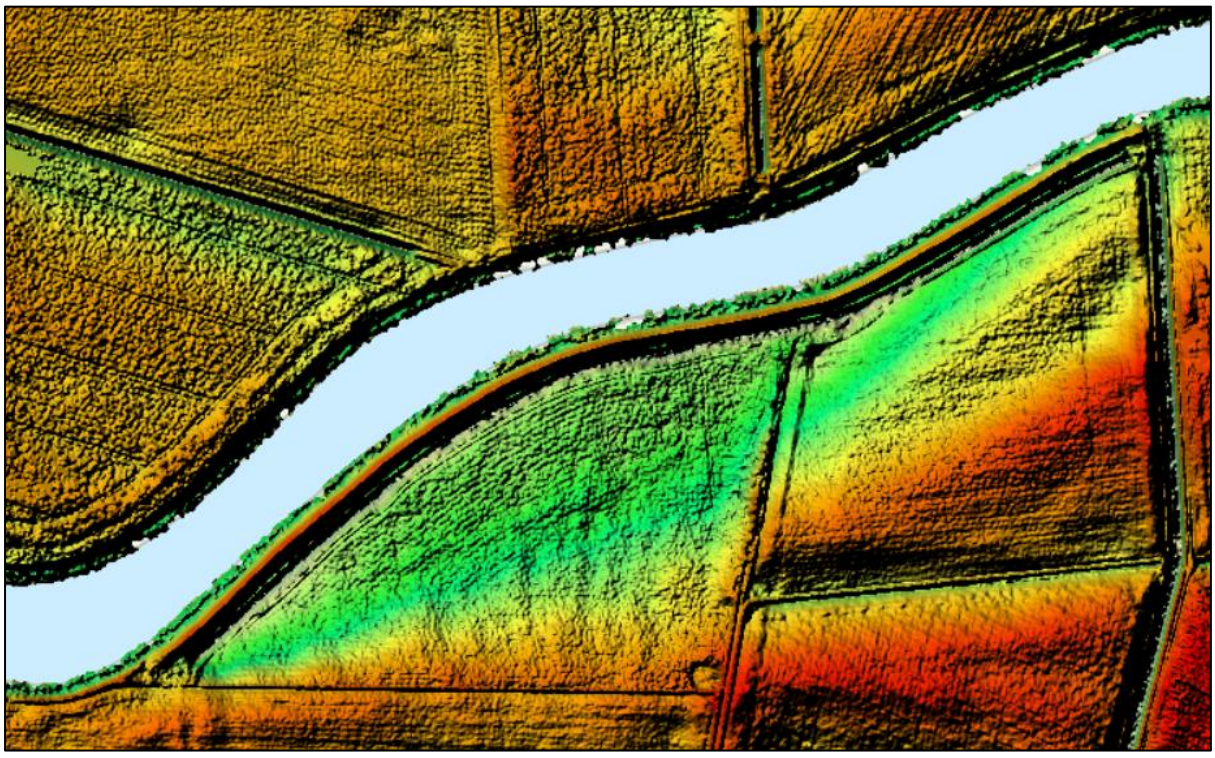

Figure 11. Elevation map of location SteenbergseVliet_5 (green = low elevation; red = high elevation). (Source: Esri Nederland, AHN)

Elevation levels in this area are approximately +0,30 m NAP. The areas to the south are characterized by higher elevation levels of approximately +1,30 m NAP. The relatively low elevation levels of the area adjacent to the river potentially make it suitable for wetland development. This development could be realized by either relocating the dike adjacent to the river or making an opening on the north east side, as this would allow the inflow of water into the low-elevated area. As peak levels in this part of the river are not expected to exceed the maximum elevation of the area, dredging a secondary channel would enable the water to flow from the main channel into the area. This would result in an area with similar morphology as the area seen in Figure 5, except with a more defined channel and in- and outflow.

IX. STEENBERGSEVLIET_6 / DE BAAK

Just 400 m south of the main river Steenbergse Vliet, a waterbody named *De Baak* is located with a surface area of approximately 6,5 ha, see Figure 12 below. On the north of this waterbody, a pumping station named *Gemaal Brooymans* is located (capacity: 9,67 m^3/s), pumping water from De Baak (and indirectly water from channels and ditches flowing into this waterbody) to the main river to the north.

Figure 12. Overview of waterbody De Baak, the pumping station Brooymans in the middle and the river Steenbergse Vliet on the north. (Source: Google Maps)

There have already been attempts to improve this area in the past. Measures included: 1. improved water regime (Dutch*: waterhuishouding*); 2. restoration of creeks; 3. construction of ecological connection zones (Dutch*: ecologische verbindingszones*). The main reason for these measures is the prevention of water nuisance. During periods with high precipitation, the pumping station is not capable of discharging all the excess water. Since 2018, the pumping station now pre-emptively discharges water to the Steenbergse Vliet when high water levels are expected in the upstream areas (Waterschap Brabantse Delta, n.d.).

As water from De Baak and its connected channels and ditches is discharged into the main river via the pumping station, it is assumed that the water contains a relatively large amount of nutrients, as the water originates from upstream agricultural soils.

There is currently no data available on some physical properties of this water body such as depth and flow rates. However, a hypothetical scenario can be set up which includes measures that prevent excess nutrient inflow into the main river.

If the water depth is concluded to be too deep for natural wetland development, this would result in the consideration of measures to either:

- Directly decrease depth (e.g. by hydraulic deposition of sediment)
- Increase the total surface area of the water body (which indirectly decreases depth)
- Partially diverse the water to alternative areas

Based on literature research, converting ponds or water bodies into wetland-like areas, the maximum depth in the water body should not exceed 1,7 m (Huggins, Kastens, Baker, & Freeman, 2017).

Areas adjacent to De Baak are characterized by relatively low elevation levels, specifically the area bordering to the south west of the water body. Elevations in this area range from approximately -0,40 m NAP to +0,40 m NAP. If peak water levels are assumed to be +0,12 m NAP, these areas would in theory be suitable for creation of wetlands. Figure 13 on the next page shows the elevation map of the area, with the area within the white contour lines having elevation levels lower than assumed peak water levels (+0,12 m NAP). This area has a total surface area of approximately 50 ha.

Figure 13. Overview of location SteenbergseVliet_6 / De Baak, with white contour lines indicating elevation levels lower than +0,12 m NAP (assumed water peak levels). (Source: Esri Nederland, AHN)

X. DINTEL_1

Located just across the sugar beet factory *Cosun Beet Company*, pumping station *De Dintel* (capacity: 2,93 m^3/s) pumps water from the surrounding polders into the river Dintel. The area to the north west of the discharge point is characterized by low elevation levels and an embankment on the side of the river with a height of approximately +1,20 m NAP. The elevation levels in this area range from +0,20 m NAP to +0,80 m NAP. The total surface area is approximately 11 ha. Figure 14 below shows the location of the area, indicated with white lines. The pumping station is located in the far bottom right of the map.

Figure 14. Overview of the location Dintel_1, with the pumping station De Dintel located in the bottom right. (Source: Google Maps)

Similar to location *SteenbergseVliet_3* (Appendix VI), the discharge water from the pumping station is expected to contain a relatively large amount of nutrients. As the pumping station is located close to the low-elevated area to the north west, a potential measure would be to initiate the development of a wetland/floodplain in this area. Especially since this area is embanked by a dike with a height of +1,20 m NAP, it is expected that the discharge water will be well-retained in this area. The area could potentially be developed into an area characterized by a shallow, low-gradient elevation (in Dutch referred to as *plas-dras*). An

erosion resistant trench/gully at the point with the lowest elevation would then redirect the water to the main river to the south.

Optionally, the areas further to the north west could be included in the potential project area, as they are also characterized by low elevation levels of approximately +0,60 m NAP. This would increase the total surface area to a maximum of 40 ha.

XI. MARK_1

This location is assigned as a spawning ground of fish in Vastgestelde Legger Waterschap Brabantse Delta. It is located in one of the many meanders of the river Mark, approximately 21 km upstream of lake Volkerak. It has a surface area of approximately 5 ha, excluding the dry adjacent area to the west, see Figure 15 below.

Figure 15. Satellite view of location Mark_1. (Source: Google Maps)

The area adjacent to the spawning ground is characterized by a grassland with an elevation of approximately +1,50 m NAP. This is a relatively high value compared to the surrounding areas. Nevertheless, this area could potentially be developed into a small-scale wetland. In order to prevent disturbance of the adjacent spawning ground, it is important to develop this area separated from the spawning ground area.

The development of a small-scale wetland could be initiated by dredging a channel through the area. Considering a channel with of 10 m, this would result in an area of approximately 55 m on both sides of the channel at the widest point in the area.

In order to guarantee one of the key characteristics of wetlands (permanently waterlogged areas) these areas need to have an elevation of maximum +0,20 m NAP, as this is the value that corresponds to the peak water level. Bifurcations in the secondary channel can further accommodate this by the development of partially submerged vegetation along these bifurcations.

Additionally, the area could be developed into a small floodplain by leaving the outflow to the river closed. The enclosed area is then subject to periodic flooding from the main river.

XII. MARK_2

Along the river Mark, this location is one of the areas with the lowest elevations. These values range from -0,50 m NAP to -1,40 m NAP. The dike at the north of the area has a height of approximately +2 m NAP and the dike on the east has a heigh of approximately +1,20 m NAP. On the right side of this second dike, a channel is present, named *Halsche Vliet*. North west of the area, a pumping station (capacity: 1,28 m^3/s) is present, pumping water from the polder to the river Mark to the north, see Figure 16 below. The total surface area is approximately 16 ha.

Figure 16. Satellite image of location Mark_2, with the pumping station in the top right and two dikes on the top and right of the area. (Source: Google Maps)

Because of its low elevation, this area would in theory be suitable for the development of a floodplain. Elevation gradients are steep, meaning that the development of a natural wetland would be challenging, as this would require a less steep gradient.
In theory, the creation of a floodplain could be easily initiated by breaching the secondary dike to the right of the area. A more controlled approach would be to lower this dike at a certain spot, allowing excess water from the channels to flow into the low-elevated area.

Since this area is very low-elevated, an option would be to discharge the water via the pumping station to the main river if a certain water level is exceeded. Additionally, the area could be developed with the construction of a secondary channel through the low-elevated area, so stagnant water is less of an issue.

Figure 17. Elevation map of location Mark_2, with the main river (Mark) to the north and a smaller channel (Halsche Vliet) to the east. (Source: Esri Nederland, AHN)

XIII. MARK_3

Just east of previous location *Mark_2*, an area with a total surface area of approximately 185 ha is located. This location is part of one of the water storage areas (Dutch*: bergboezems*) of Breda. The area is characterized by average elevation levels of approximately -0,20 m NAP. A pumping station (capacity: 1,28 m^3/s) is present to the north west of the area. A number of weirs are present in the area, capable of adjusting water levels manually. See Figure 18 below for the location of these weirs, indicated with orange squares.

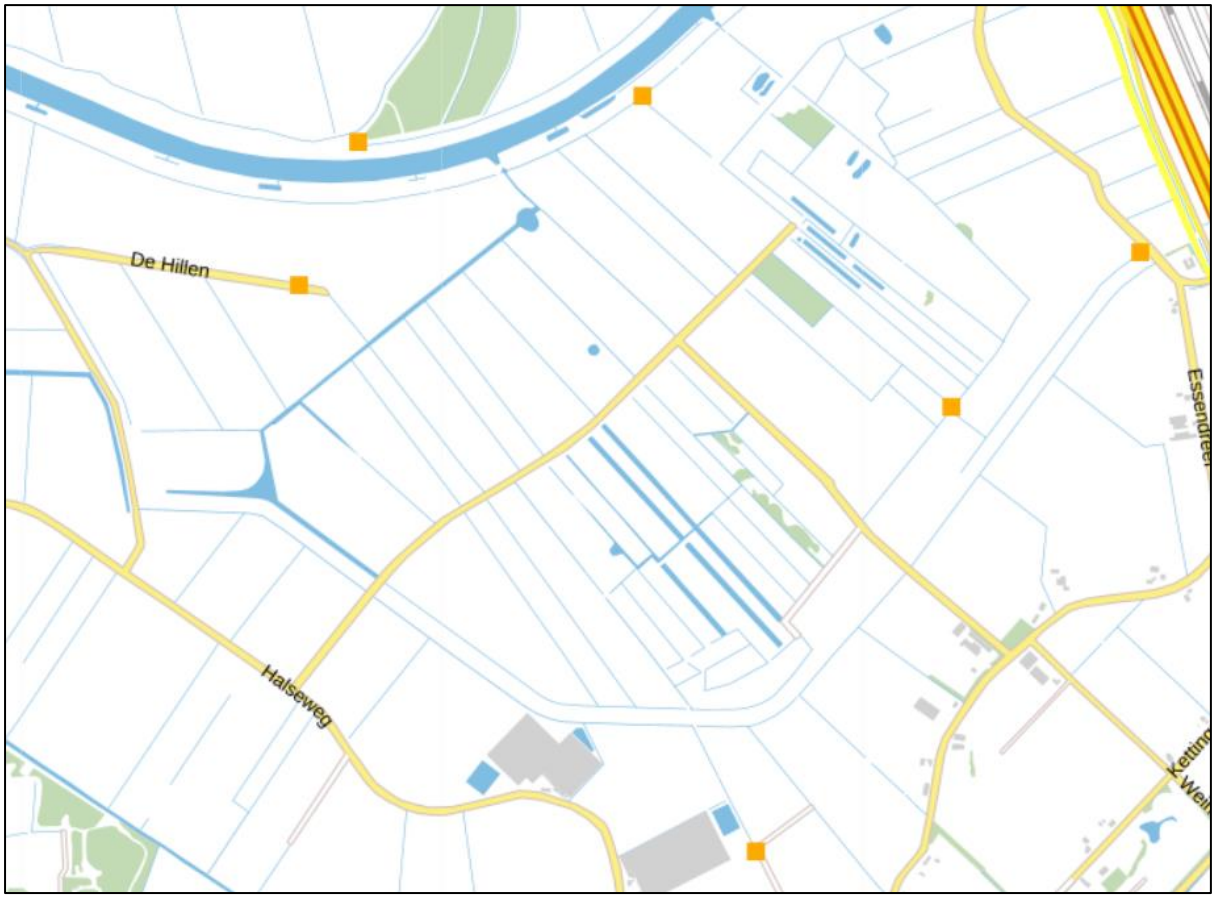

Figure 18. Overview of the area and the location of the weirs (indicated with orange squares). (Source: Vastgestelde Legger Waterschap Brabantse Delta)

The area is chosen as a location of interest because of its relatively low elevation levels (see Figure 19), the presence of weirs (enabling manual control of water levels), its large total surface area, its close proximity to the main river (Mark) and the embankments around the area (enabling efficient retainment of excess water from the main river).

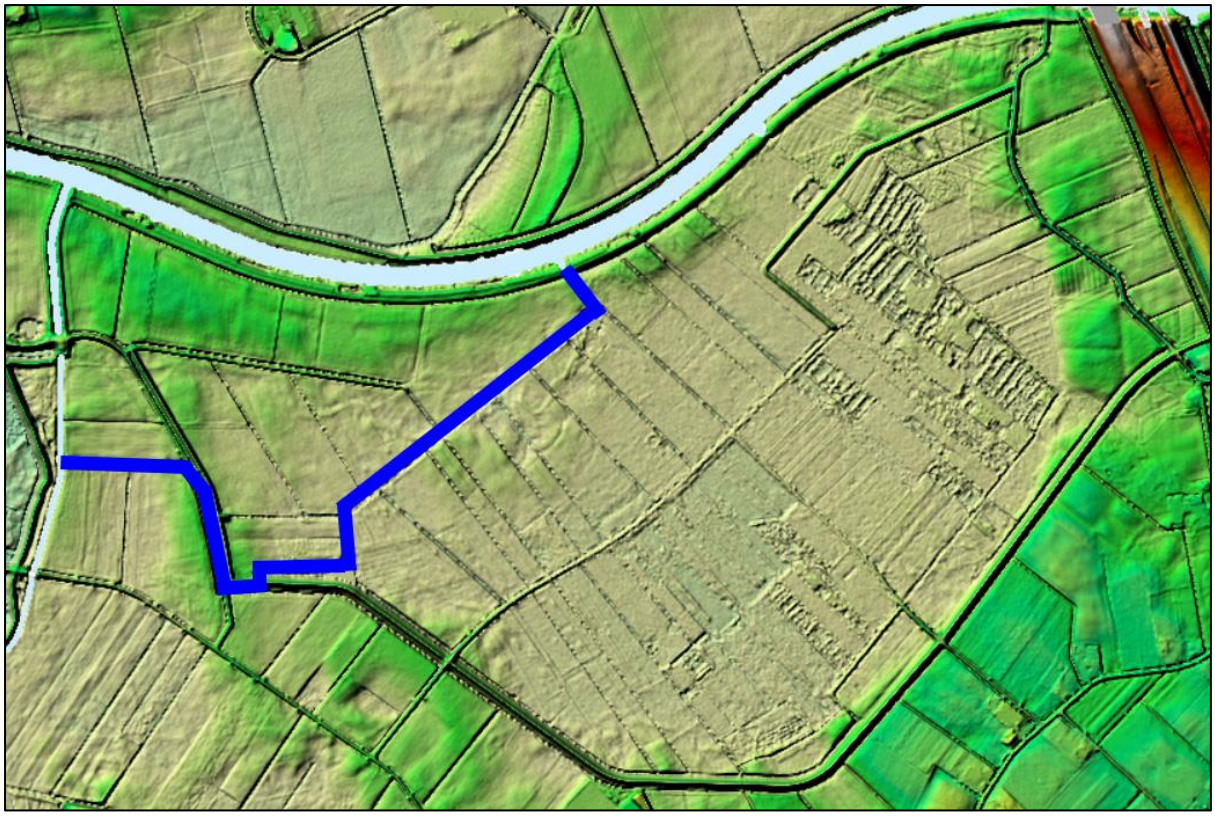

Figure 19. Elevation map of location Mark_3, being approximately -0,20 m NAP on average. The blue line indicates the location of the channel that flows from the main river (Mark) to the secondary channel (Halsche Vliet). (Source: Esri Nederland, AHN)

Location De Hillen is located near this area, meaning the results from observations from water levels can be used. Water levels in the river Mark at this location permanently exceed the average elevation of the area of -0,20 m NAP. This would allow a set of weirs near the river to manually control the inflow of water, even in period with low water levels in the river. The same concept is used in the Vierde Bergboezem.

In this area, a stream is present that flows from the main river in the north to the secondary channel (Halsche Vliet) in the west. It is indicated with a blue line in Figure 19 above. The length of this stream is approximately 2 km. One proposed development is that this stream is extended further inland with the development of meanders. This will increase the nutrient removal effectiveness and simultaneously provide valuable habitat for a variety of organisms.

The other low-elevated areas (*bergboezems*) near this area (see Figure 18 in chapter 2.5.1 in the main report) can be developed in a similar way. The advantage of this particular area however is its relatively low elevation compared to the other areas.

XIV. MARK_4 / MEANDER ULVENHOUT

The areas around the river Mark south of Breda are more frequently subject to periodic flooding, as there are no embankments present directly around the channel.

The first area of interest is located approximately 45 km downstream of the Dintel/Mark river system. The area is characterized by a set of meanders next to the main channel, see Figure 20. The areas surrounding these meanders are characterized by low elevation levels relative to the water level, see Figure 21. It has a total surface area of approximately 11 ha.

Potential measures at this location include the development of a wetland between the main river and the secondary meanders or the development of a floodplain. The vegetation in this area is currently characterized by plain grassland. When inundation frequency is increased (by soil excavation for example), the development of more plant species can be initiated. This would enable more nutrient removal in these areas.

Figure 20. Satellite view of the meanders next to the main channel. (Source: Google Maps)

Figure 21. Elevation map of location Mark_4 / Meander Ulvenhout. (Source: Esri Nederland, AHN)

XV. MARK_5

Only 1,5 km upstream of location Mark_4 / Meander Ulvenhout, another low-elevated area is present with a surface area of approximately 3 ha, see Figure 22 below. The area is located directly next to the river on the west side, with a set of meanders present in the south.

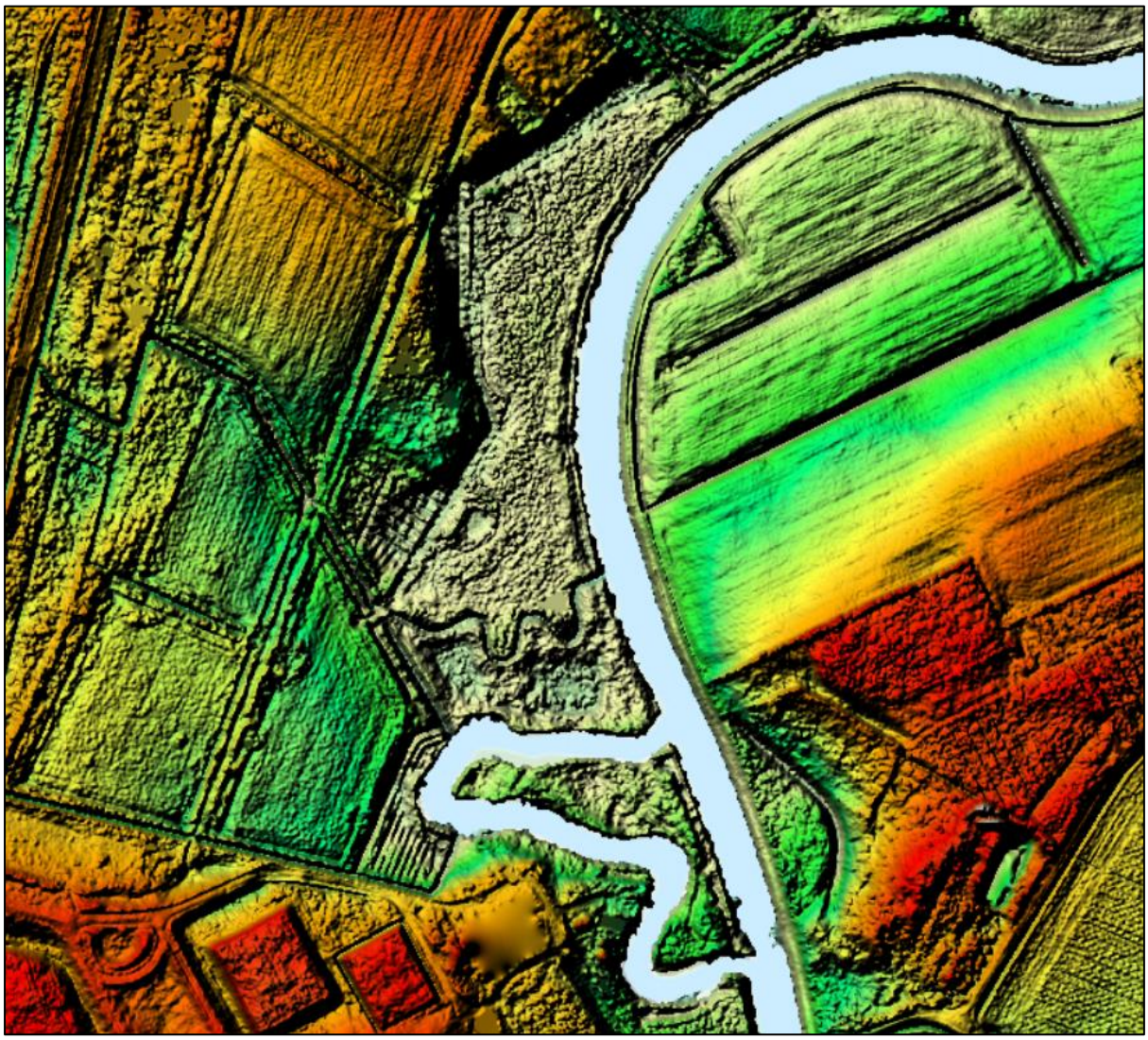

Figure 22. Elevation map of location Mark_5. (Source: Esri Nederland, AHN)

This area is subject to inundation approximately once every two years on average. Because of its low elevation relative to the surrounding areas, the area can be considered to be potentially suitable for wetland development. This could be realized by extending the secondary meander in the south to the north through the low-elevated area. Current vegetation in this area consists of grassland with trees near the higher elevated areas and on the banks of the river.