The ***Green Heart*** of Groningen

School of Architecture Urban Planning Construction Engineering

M.Sc. Landscape Architecture - Landscape Heritage

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POLITECNICO DI MILANO

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1

INTRODUCTION

1. INTRODUCTION

1.1 THE CONTEXT

PEATLANDS

Peatlands are the **worlds largest carbon stock** while covering only **3% of global land surface** and storing **more than twice the carbon stored in forests** throughout the world.

Because of this carbon storage capacity, **peatlands play a significant role in climate change mitigation and adaptation.**

1.1 THE CONTEXT

PEATLANDS

- The term “peatland” refers to the peat soil and the wetland habitats growing on the surface.

- Peatlands are **a source of life for many plants, animals, and people.**

- Offer important **ecosystem services:**
  - regulating water flows
  - mitigation of flood and drought
  - reducing the risk of fire
  - providing fresh water, food
  - host an astonishing biodiversity

1.1 THE CONTEXT

PEATLANDS

- Significant **archaeological and paleo-environmental archives.**
- hold records of past vegetation, climate, landscapes, and artefacts from previous human societies.
- peatlands are **living historic landscapes and part of our biocultural heritage.**

1.2 HISTORY

PEAT IN THE NETHERLANDS

In the Netherlands since time immemorial, peat was used mainly for two major purposes:

1. Excavated peat as a fuel source.
Because peat is extremely rich in carbon.

1.2 HISTORY

PEAT IN THE NETHERLANDS

2. Draining the peat soil for agriculture.
The distinguished polder structures are the result of peat mining that are seen throughout the country.

1.2 HISTORY

PEAT IN THE NETHERLANDS

Peat is more than just a resource for the Dutch it is a culture.

The traditional land use that has established and evolved for roughly a thousand years on Dutch peat soil, **is not simply a way of exploiting the land, but a way of living and a cultural identity.**

The peat culture, or the **lifestyle of the farmer, as the intangible heritage** is deeply invested in this tradition as is the physical manifestation and tangible heriatge of polder landscapes.

1.2 HISTORY

PEAT IN THE NETHERLANDS

1.2 HISTORY

PEAT IN THE NETHERLANDS

Dike breach near Bemmel, 1799, Christiaan Josi, 1802

1.2 HISTORY

PEAT IN THE NETHERLANDS

The Saint Elizabeth's Day Flood, Master of the St Elizabeth Panels, Anonymous, c.1490-c.1495

2

THE BASICS

2. THE BASICS

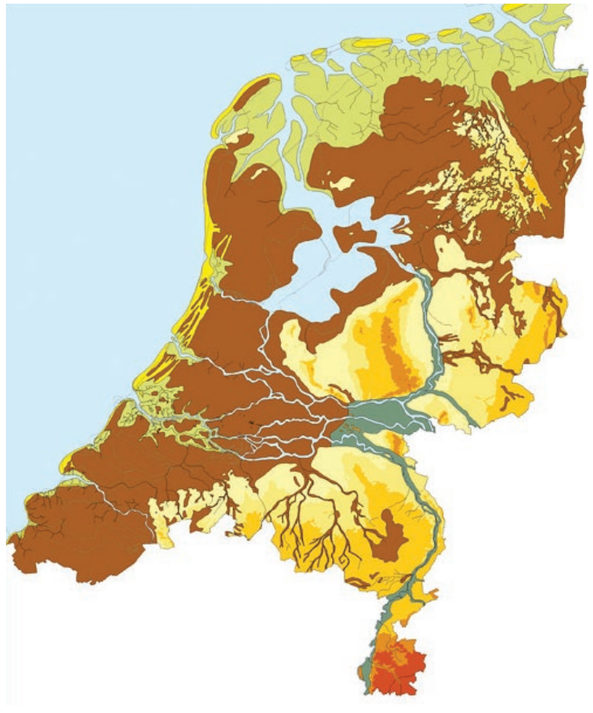
2.1 WHAT IS PEAT?

Peat soil is made up of **partially decomposed organic matter under waterlogged conditions.**

2.2 LANDSCAPE TYPES OF NETHERLANDS

An estimated **90% of the original raised bogs have now dissapeared** as the reult of drainage for farming and peat extraction.

Peatlands (brown) during Roman times



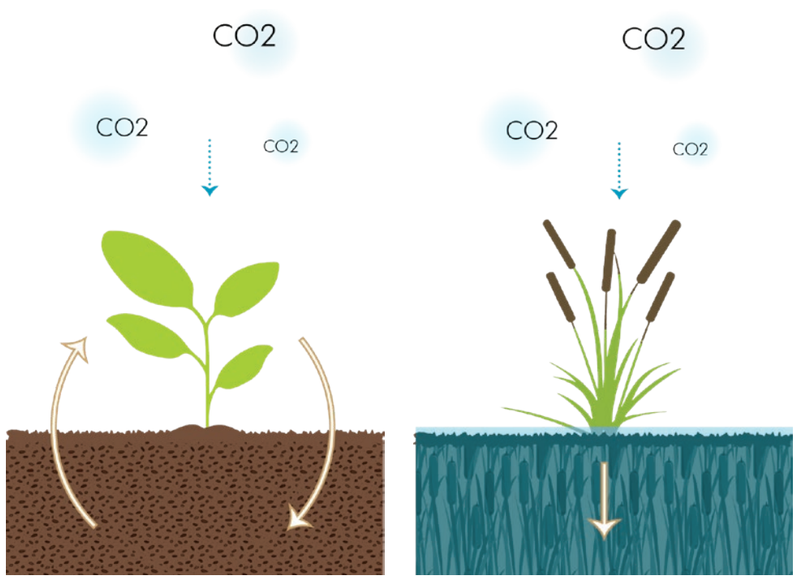
2.3 PEAT FORMATION

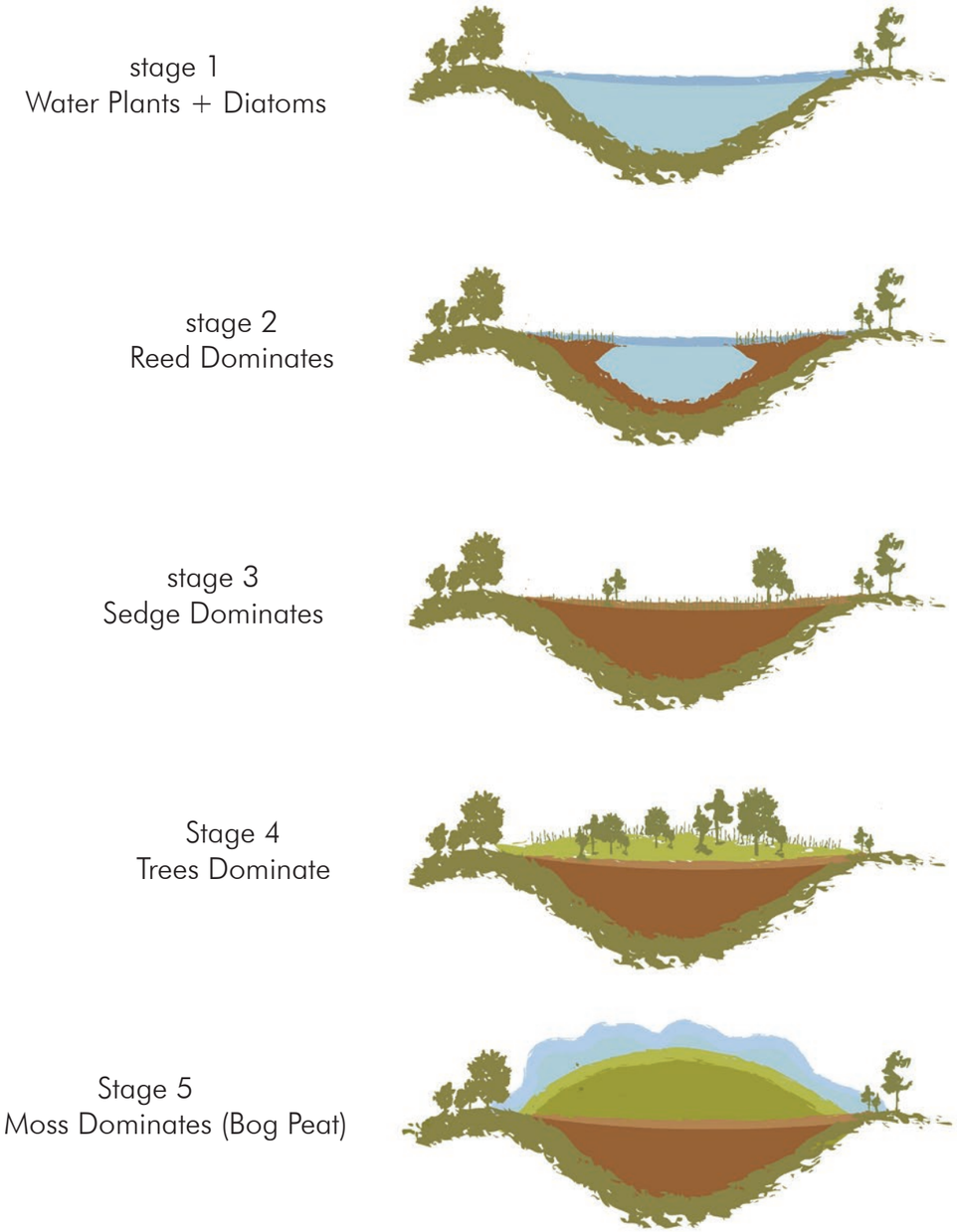
TERRESTRIALISATION PROCESS

Terrestrialisation:
- is a form of **succession**
- means **infilling of water by plants**

Peat bogs regulate their own hydrology and are called **ecosystem engineers**:
- act like **sponges**
- retain water from cell level to plant level to ecosystem level
- retain water **up to 30 to 40 times of their own weight**

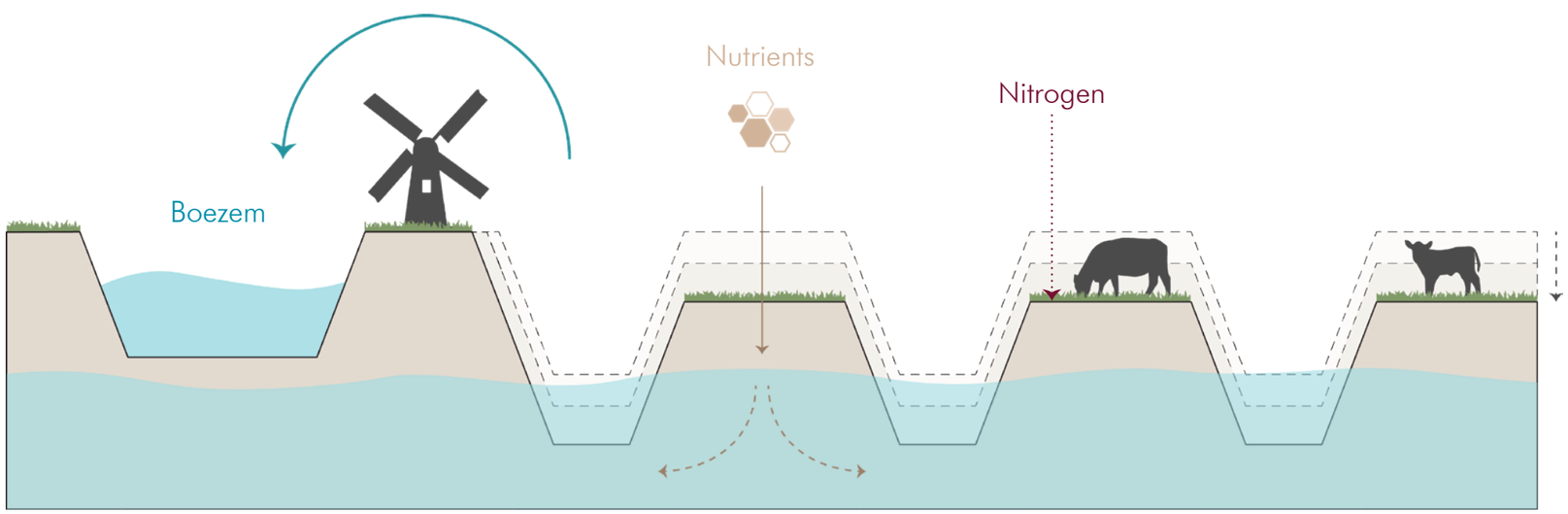
Peat has no closed nutrient cycle underwaterlogged conditions. The carbon absorbed from the atmosphere and from the plant are locked away in the soil, making it a huge carbon sink.





Source: *Peatlands Management Unit; https://raisedbogs.ie/project-team/*

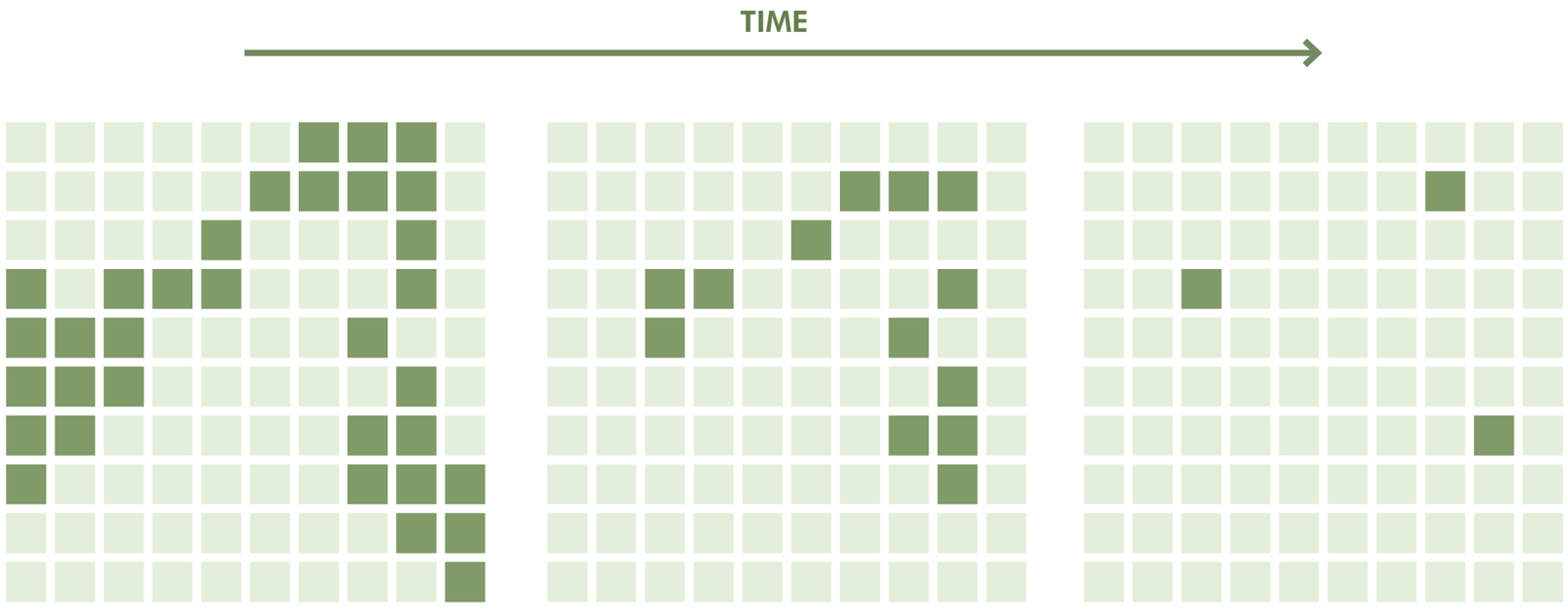
2.4 MAIN CAUSES OF PEAT LOSS



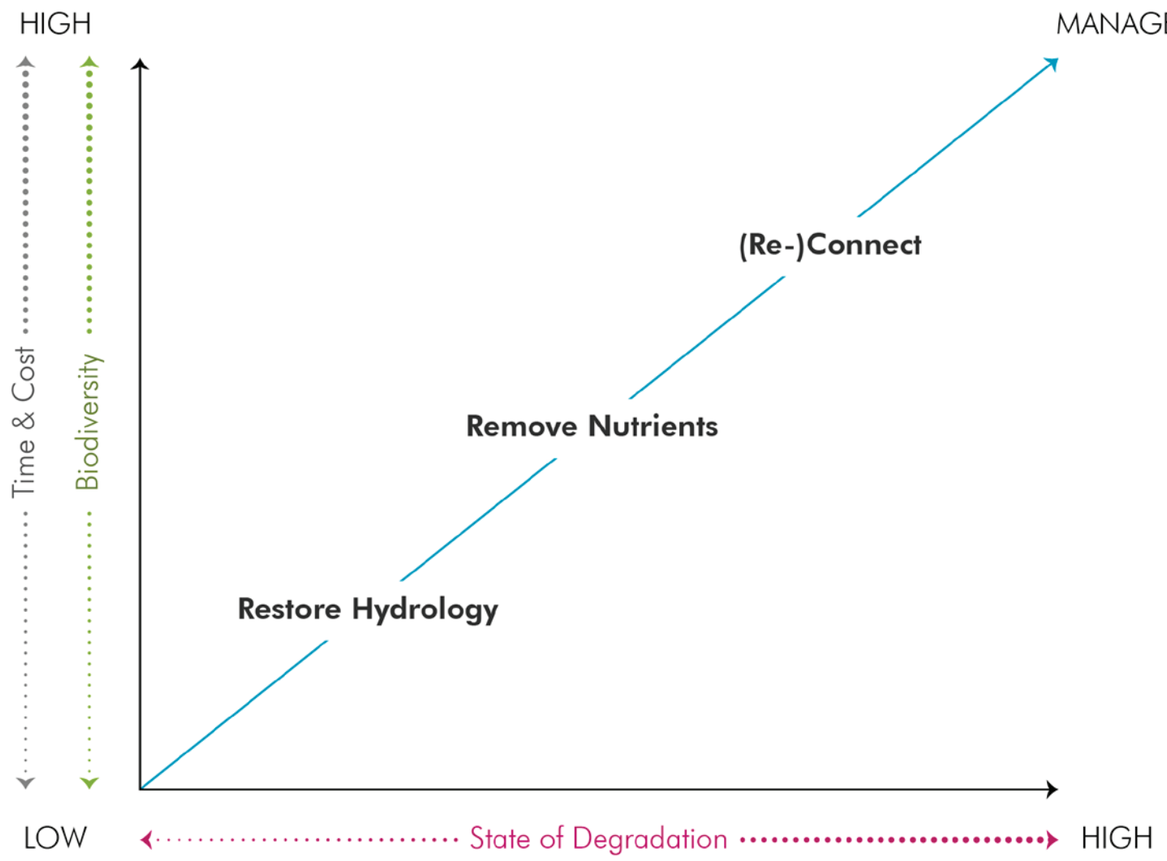
- The main causes of peat loss are the following:
  1. **Constant drainage of peat**
  2. **Nutrient overloading**
  3. **Becoming too isolated**

- Currently, **the peat is subsiding at the rate of 1cm per year.**

- **Drained peatlands** contribute to **5% of global anthropogenic GHG emissions.**



2.5 PEAT RESTORATION



3

A SEA OF LAND

3. A SEA OF LAND

3.1 THE POLDER-BOEZEM SYSTEM

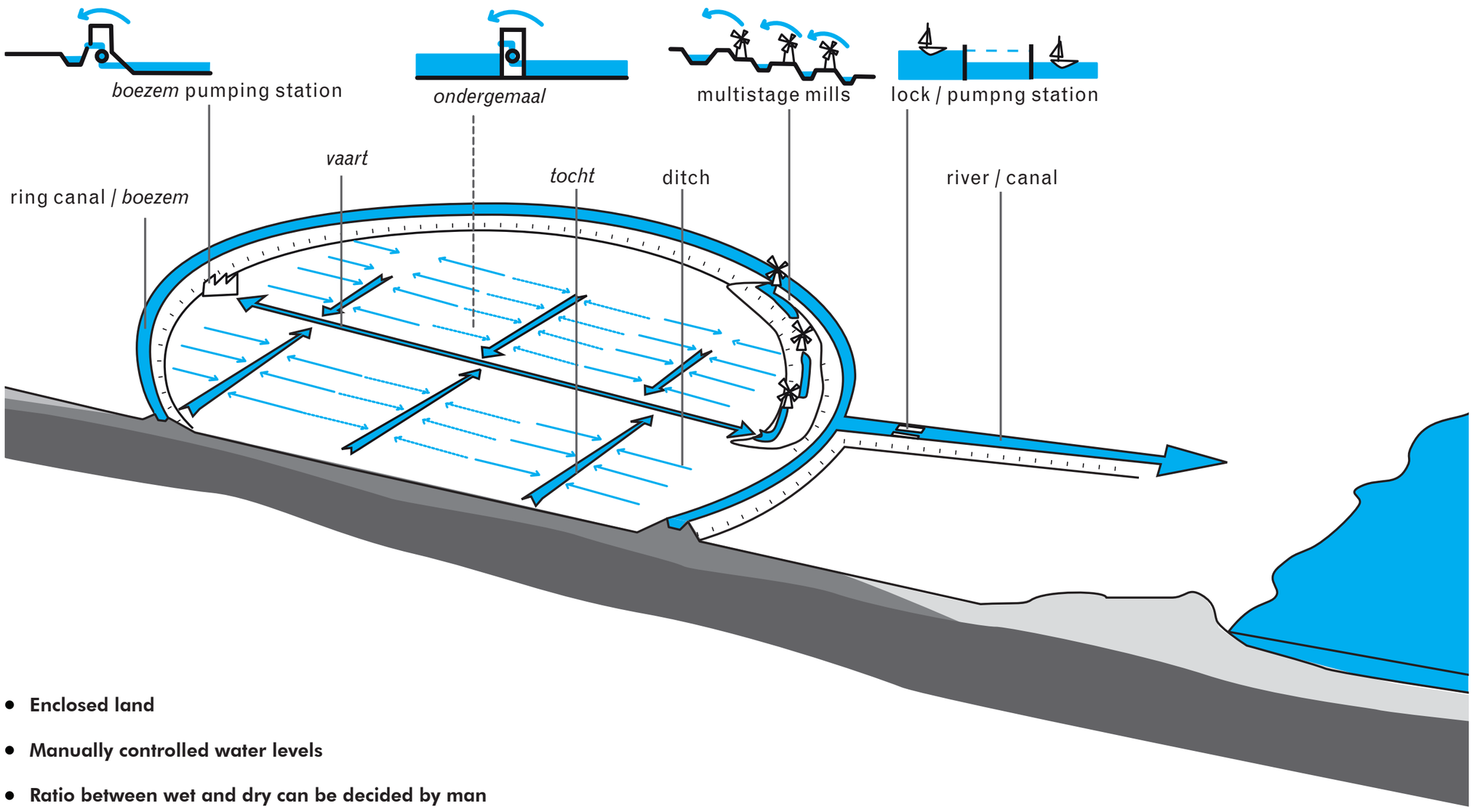
The relationship between man and peat has changed dramatically since ancient times.
Today, Dutch peatlands are regarded as **highly valuable, unique and fragile landscapes** that face **increasing challenges for survival.**

These polder landscapes of the Netherlands are characterised by **vast, open stretches of grasslands** and **sustained economically through dairy farming.**

This spatially unique constructed landscape is **an important aspect of the Dutch national identity.**

3.2 THE POLDER-BOEZEM SYSTEM

THE POLDERS ✳



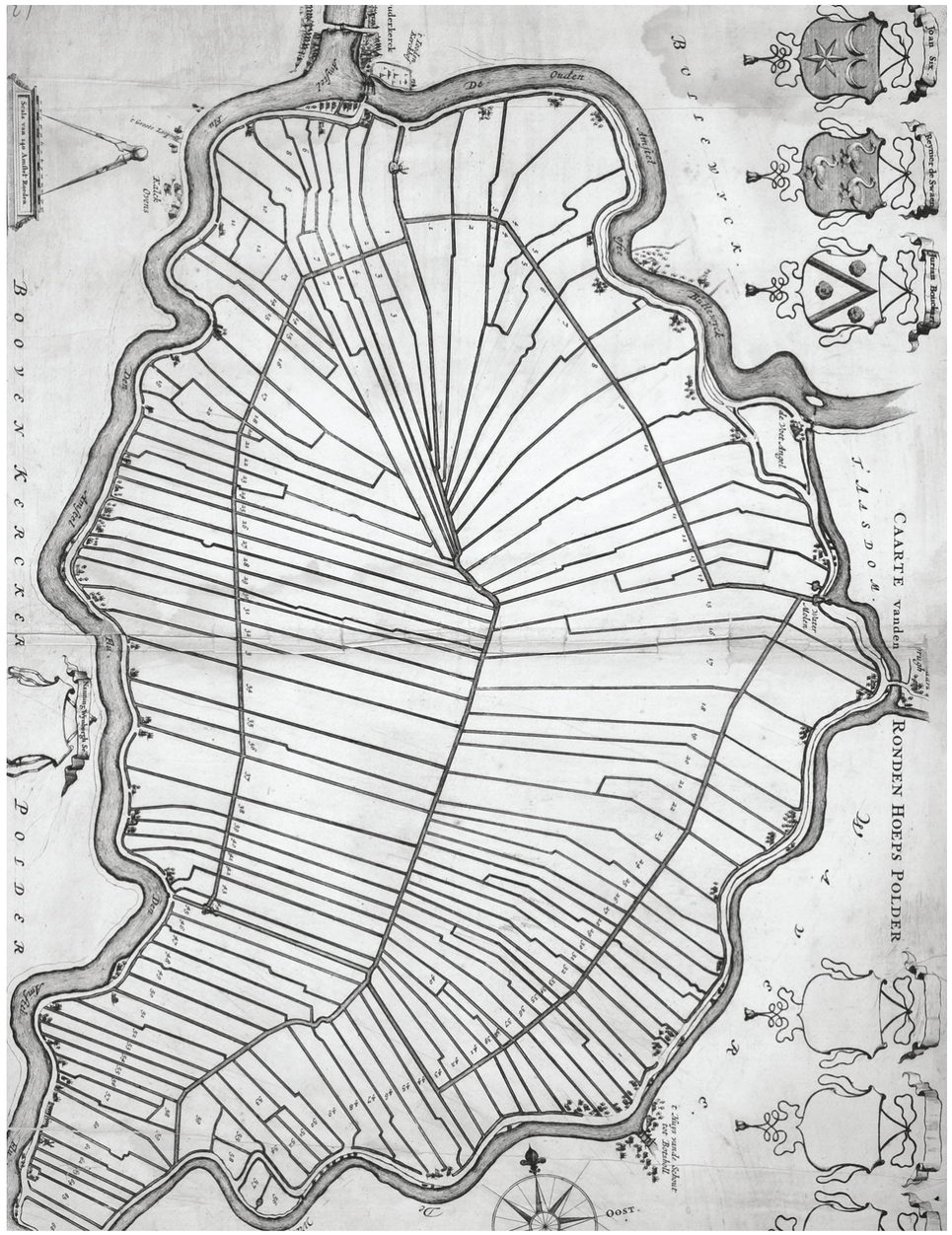
- **Enclosed land**
- **Manually controlled water levels**
- **Ratio between wet and dry can be decided by man**

✳ *Bobbink, I., & Loen, S. (2013). Water inSight: An exploration into landscape architectonic transformations of polder water. TU Delft University of Technology, Architecture.*

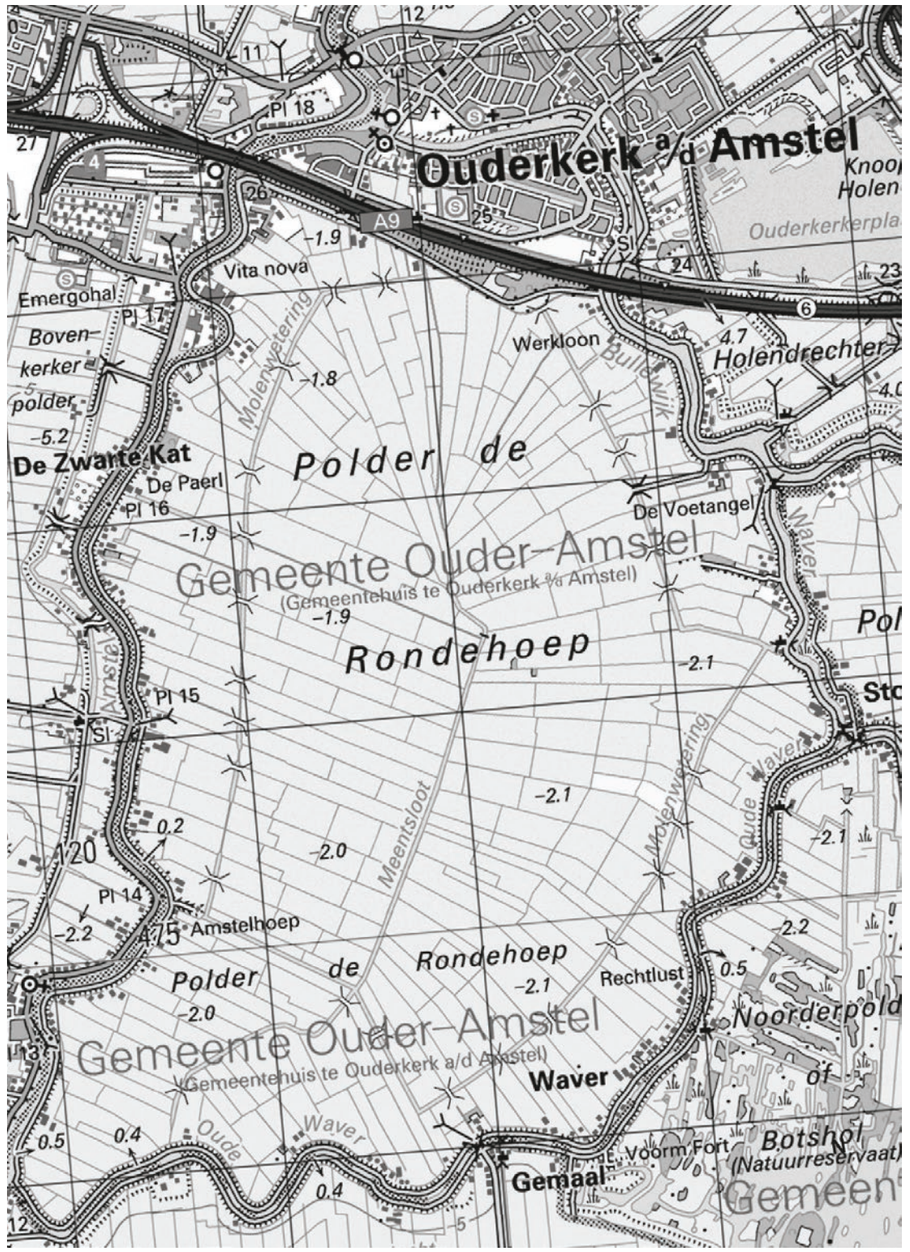
3.3 THE POLDER-BOEZEM SYSTEM

DE RONDE HOEP POLDER EXAMPLE ✴

De Ronde Hoep Polder in 17th Century



De Ronde Hoep Polder in 2007



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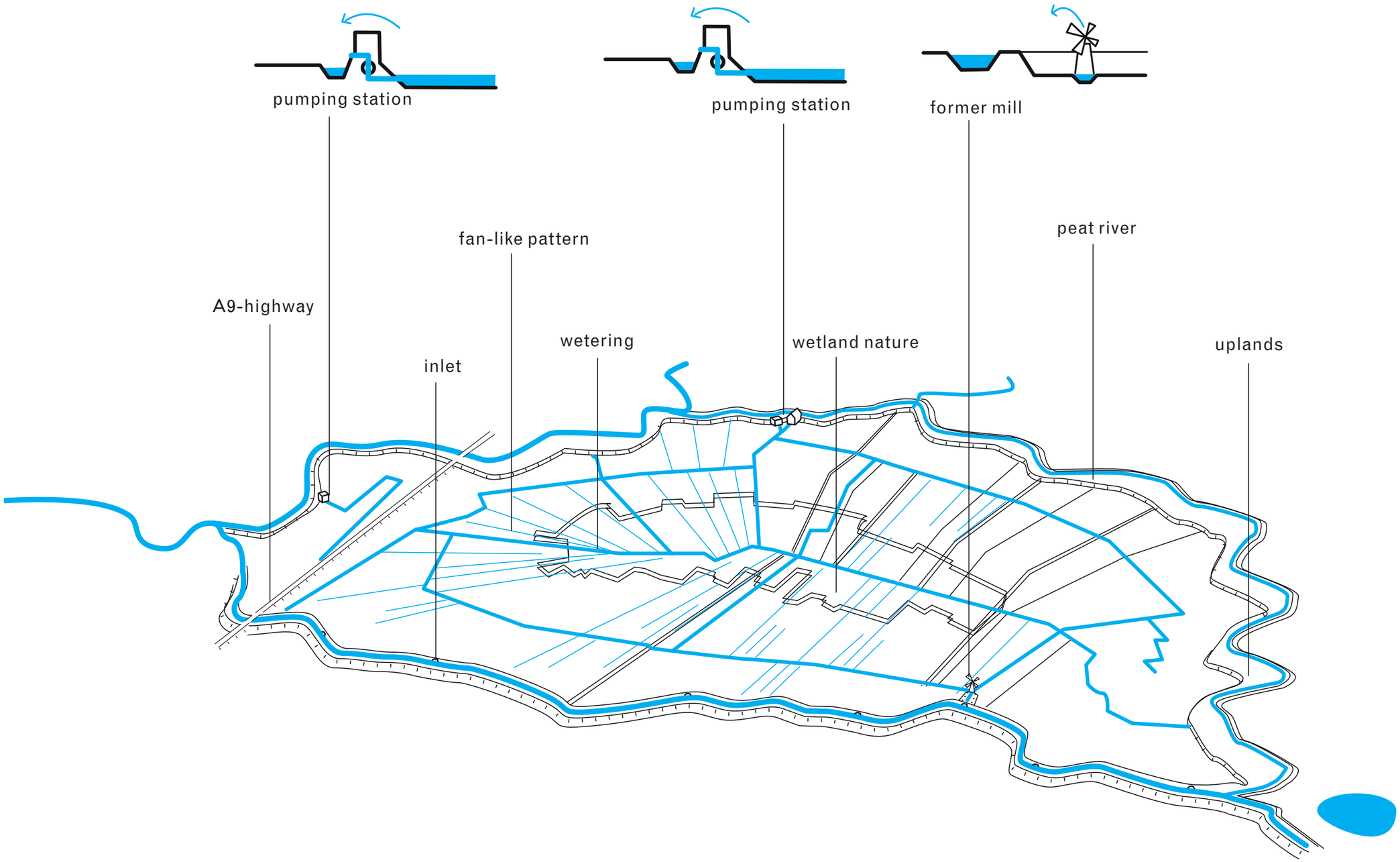
✴ *Bobbink, I., & Loen, S. (2013). Water inSight: An exploration into landscape architectonic transformations of polder water. TU Delft University of Technology, Architecture.*

3.3 THE POLDER-BOEZEM SYSTEM

DE RONDE HOEP POLDER EXAMPLE ✶

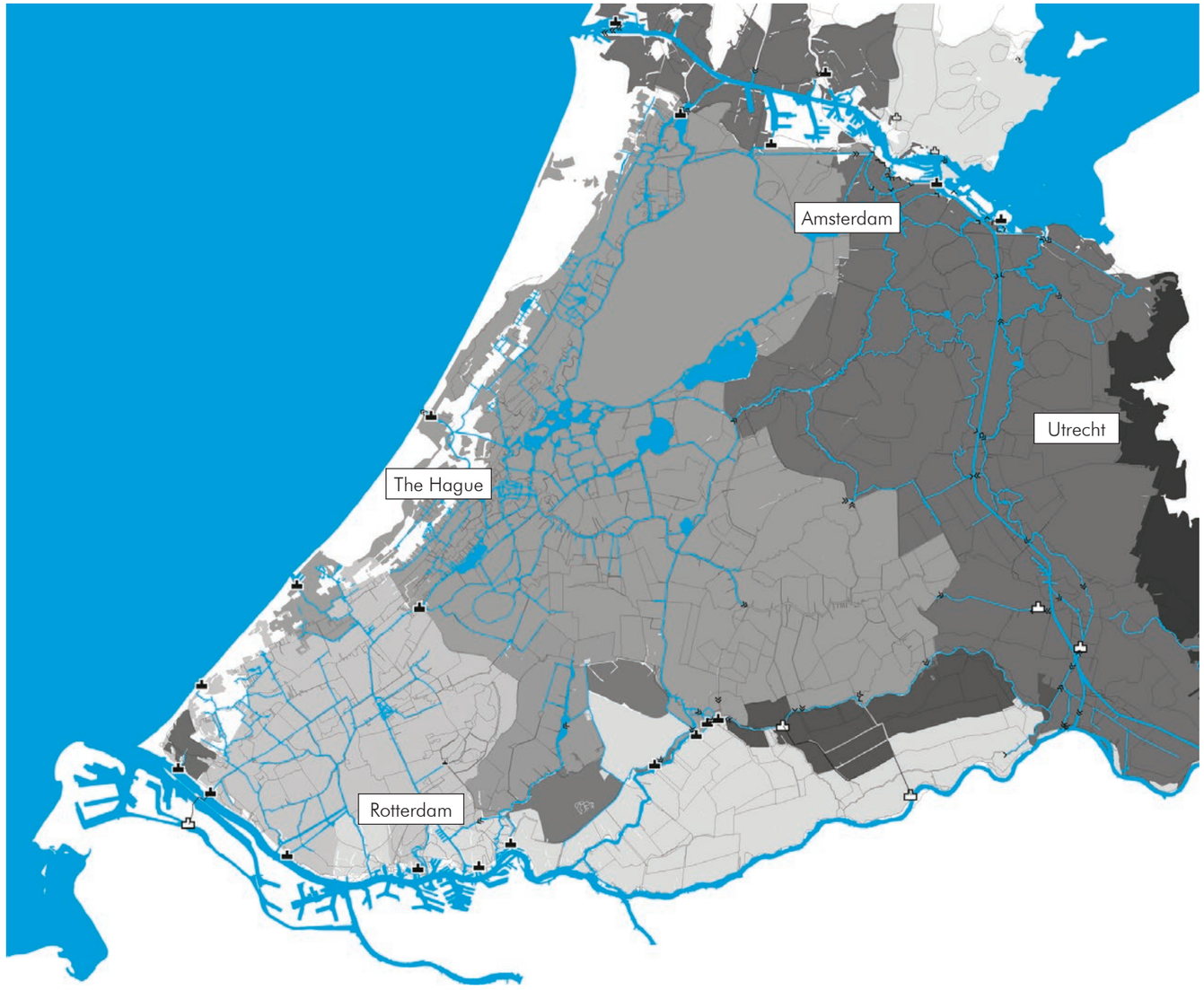


✶ *Bobbink, I., & Loen, S. (2013). Water inSight: An exploration into landscape architectonic transformations of polder water. TU Delft University of Technology, Architecture.*

3.4 THE POLDER-BOEZEM SYSTEM

THE BOEZEM ✴

Discharge System of De Ronde Hoep

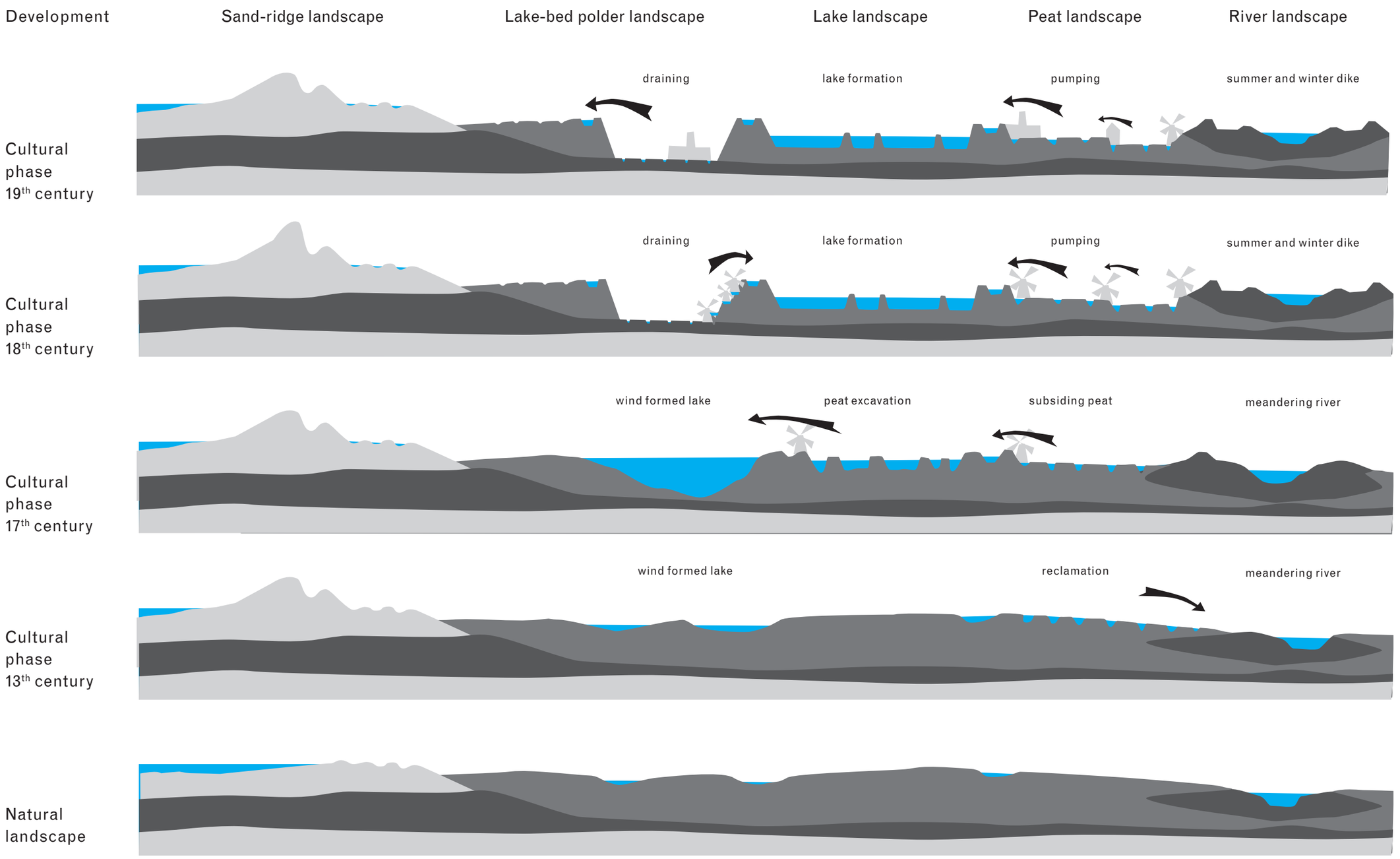


Boezem System in Randstad Area

✴ *Bobbink, I., & Loen, S. (2013). Water inSight: An exploration into landscape architectonic transformations of polder water. TU Delft University of Technology, Architecture.*

3.5 THE POLDER-BOEZEM SYSTEM

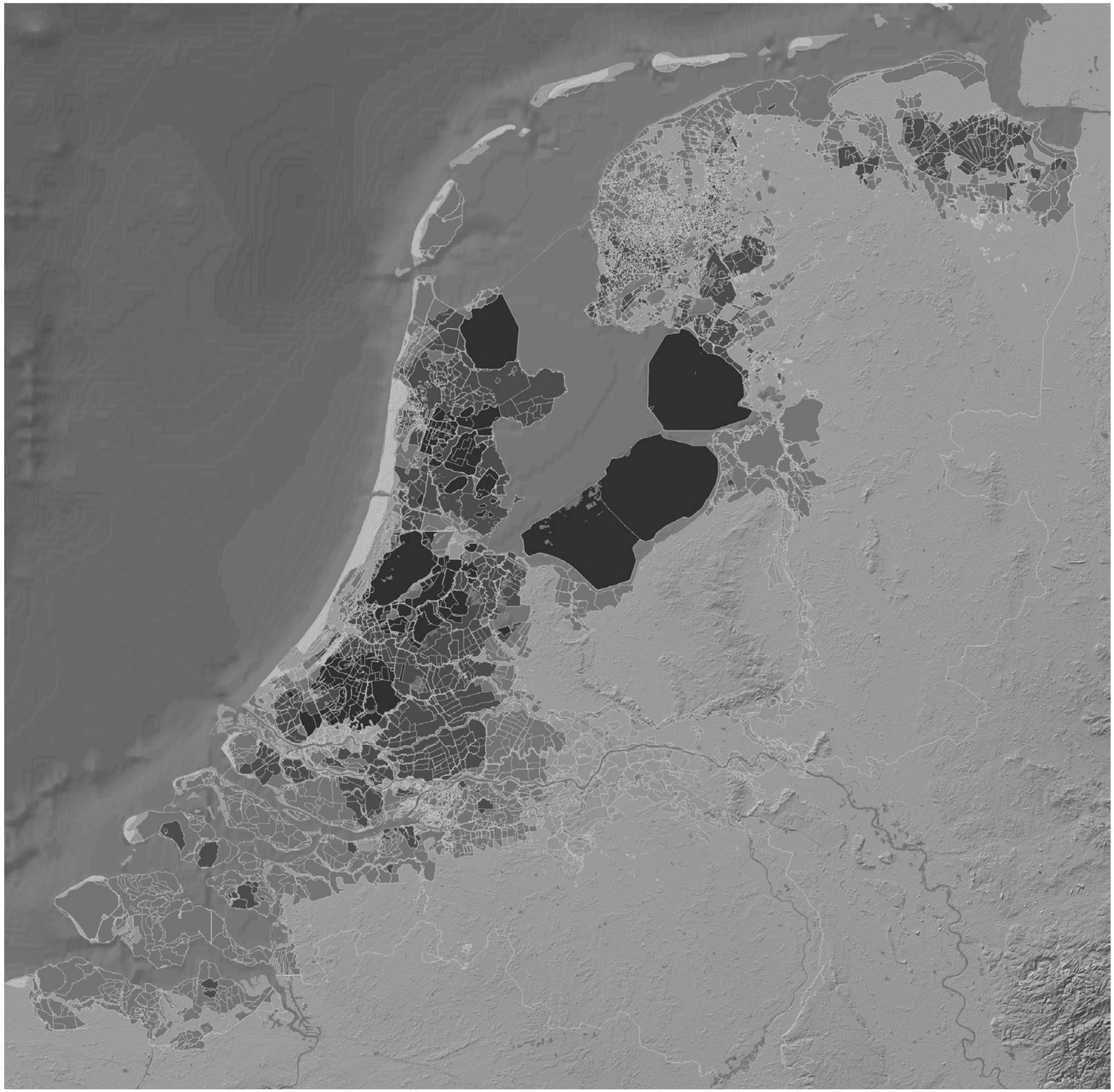
HISTORY OF LAND RECLAMATIONS & POLDERS ✶



✶ *Bobbink, I., & Loen, S. (2013). Water inSight: An exploration into landscape architectonic transformations of polder water. TU Delft University of Technology, Architecture.*

3.6 POLDER MAP OF NETHERLANDS *

In the Netherlands, there are **a total of 3891 polders.** If not drained, most of them **would fill up entirely with water**, as they lie below Amsterdam Ordnance Datum (Normaal Amsterdam Peil, NAP), the referrence level which corresponds approximately to the mean sea level.



* *Bobbink, I., & Loen, S. (2013). Water inSight: An exploration into landscape architectonic transformations of polder water. TU Delft University of Technology, Architecture.*

4

A NEW PRODUCTIVE LANDSCAPE

4. A NEW PRODUCTION LANDSCAPE

4.1 A REGENERATIVE APPROACH *

Regeneration means **"considering all dimensions of life and restoring them in parallel".**

- conventional & green designs:
  - not involved with creation of living systems
  - concerned about **efficiency.**

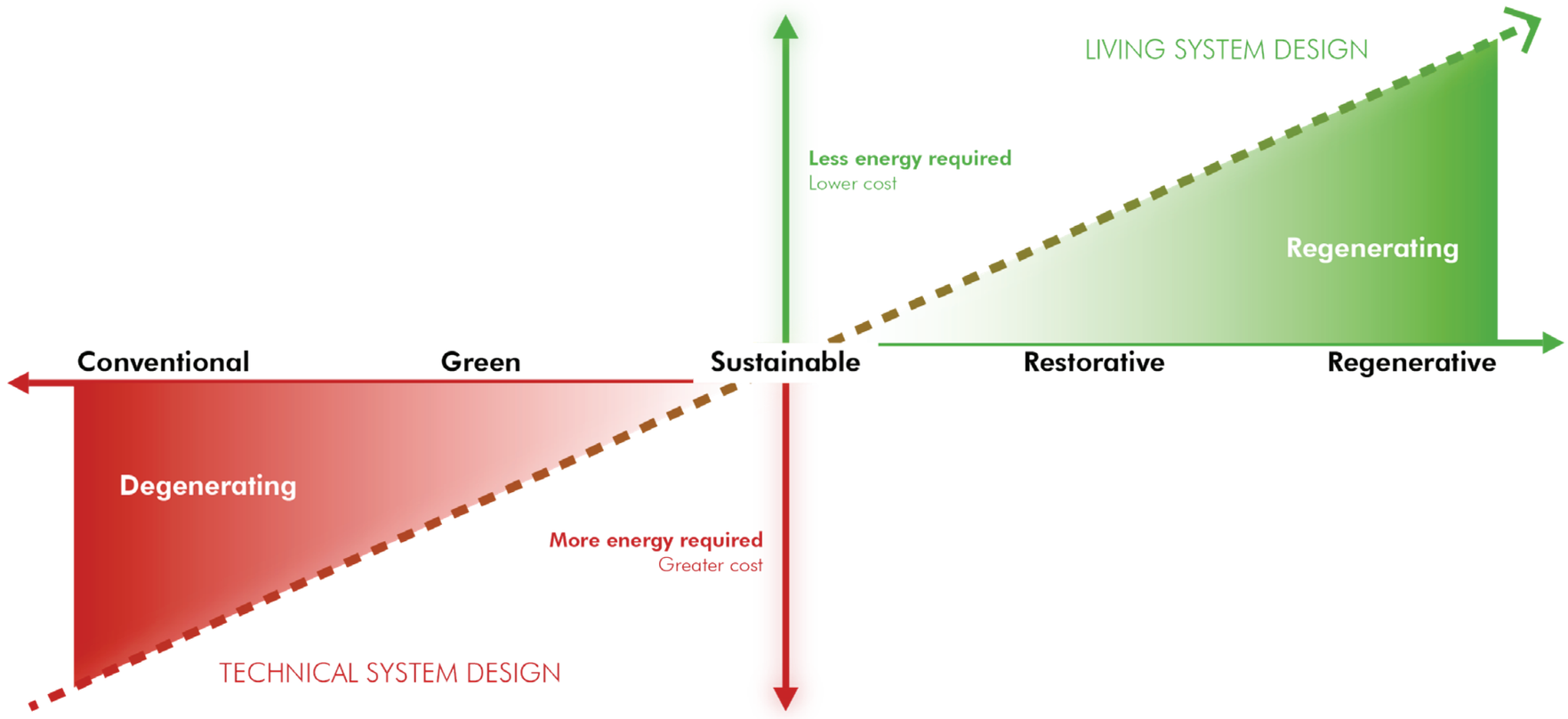
- Sustainable designs:
  - neither a positive nor a negative impact on life

- Restorative & regenerative designs
  - create living systems and therefore require
  - concerned about **effectiveness**
  - **less energy**
  - **less costs**
  - **living systems evolve on thier own.**

First, a restorative design approach is needed to restore this unique landscape and its ecosystem.

Next, is time to utilize the many possibilities within this living system to meet the upcoming environmental, social and economic challenges.

Reed, B. (2010) 'From Sustainability through Regeneration: Whole and Living System Design', in Healthy Schools conference. Pittsburgh.



* Different design approaches and their relationship

4.2 PALUDICULTURE
AS A REGENERATIVE PRACTICE

Much of agricultural practices of today are developed since the **Mesopotamian era**, where **relatively dry soils** are common.

Cereals and grains such as wheat that are cultivated in this type of agriculture require dry soils. In places like the Netherlands, this means **draining away the native swamps and bogs.**

Paludiculture is the **productive use of wet or rewetted peatlands that preserves the peat body.**

Paludiculture ⟶ Palus = Swamp, Marsh

In paludiculture, **flood tolerant species** are used that do not require lowering the water table and therefore, **sustain and preserve the peatlands** at the same time.

5

THE DESIGN

5. THE DESIGN

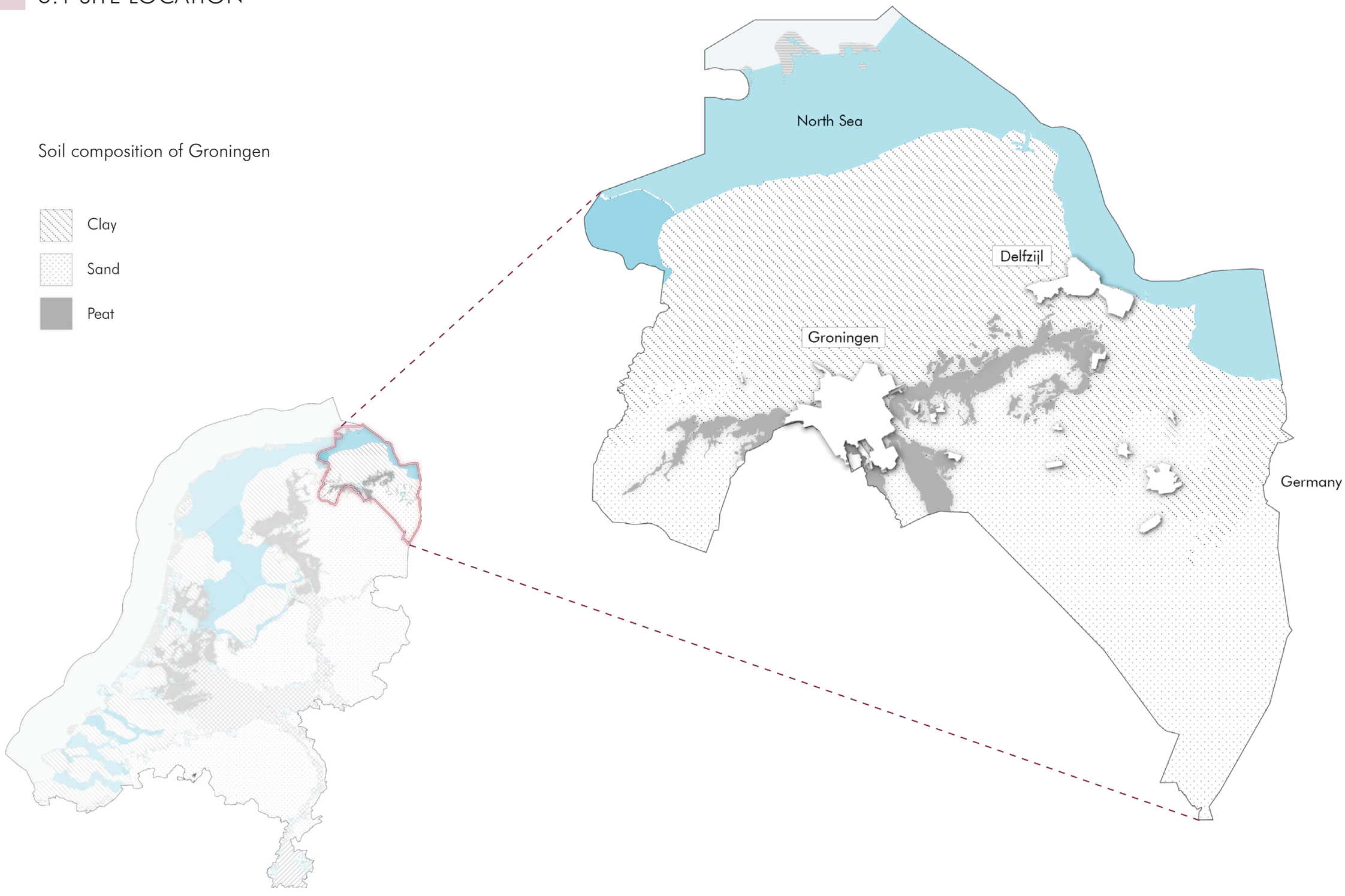
5.1 SITE LOCATION

Soil composition of Groningen

Clay

Sand

Peat



5.2 THE LANDSCAPE PALIMPSEST

1827

1850

1870

1873 - Creation of Eems Canal

1976

2015 - Nature Resrve formation

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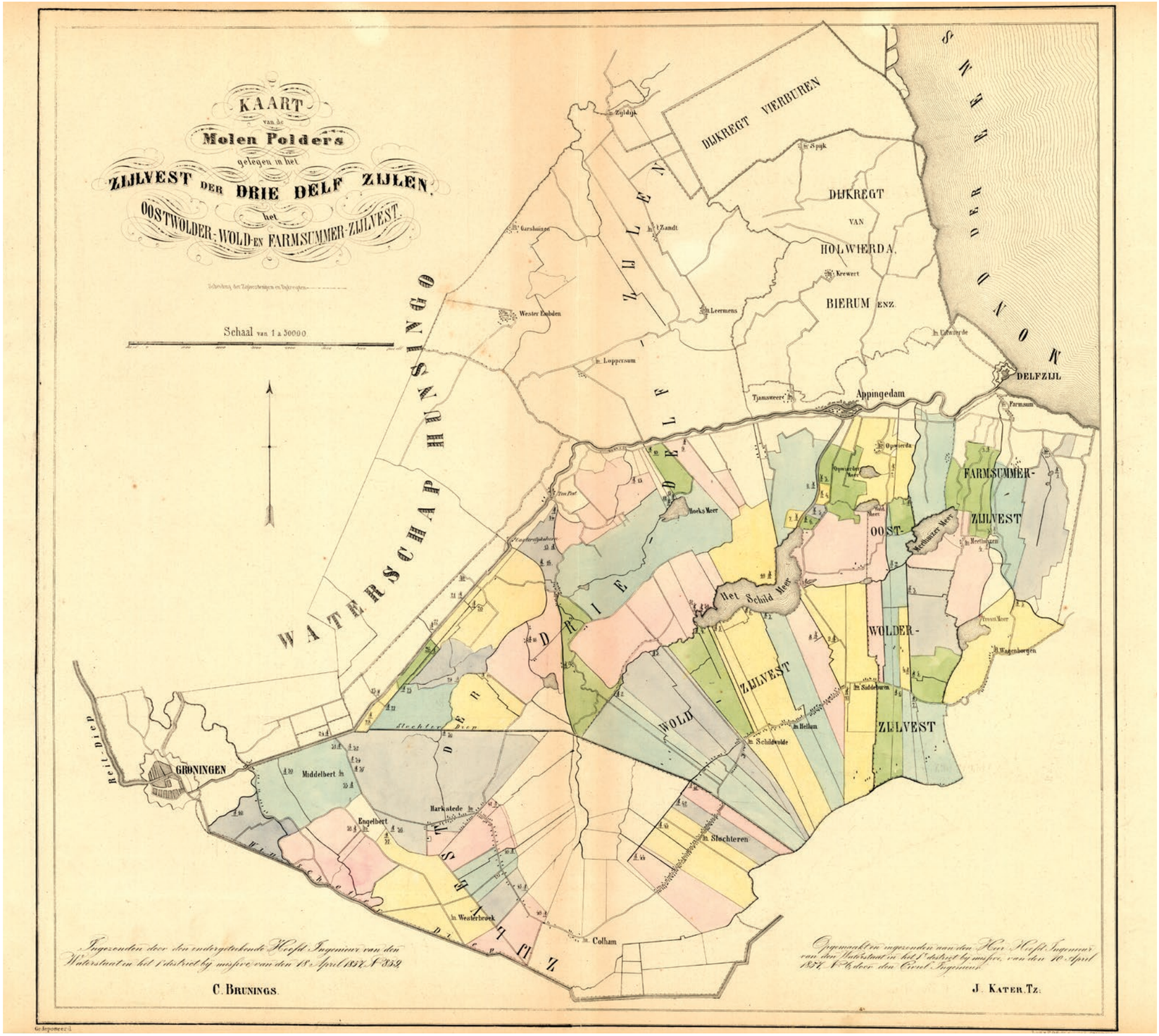
5.3 OLD POLDER STRUCTURE



Groningen Polder Map
1857

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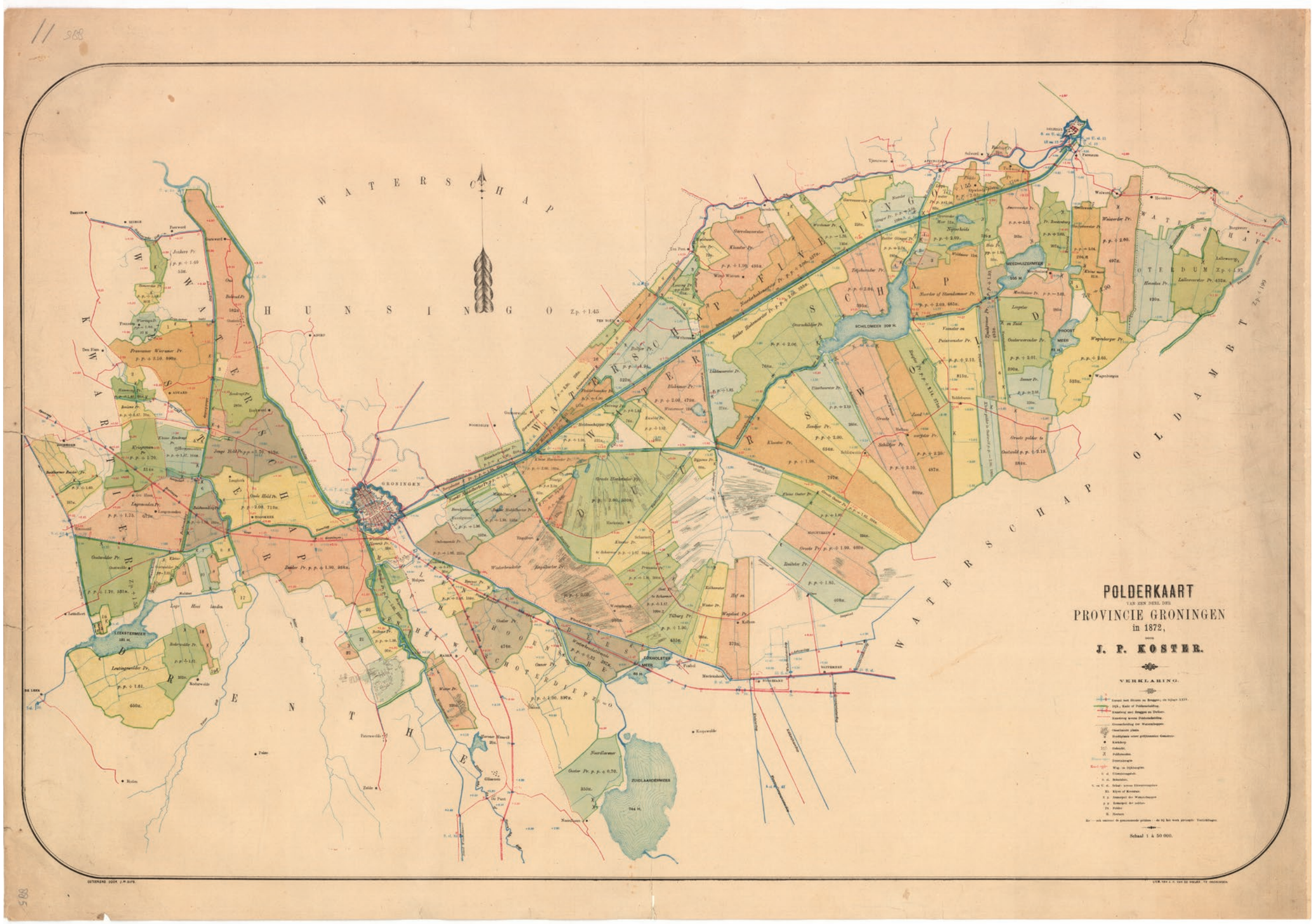
5.3 OLD POLDER STRUCTURE



Groningen Polder Map
1872

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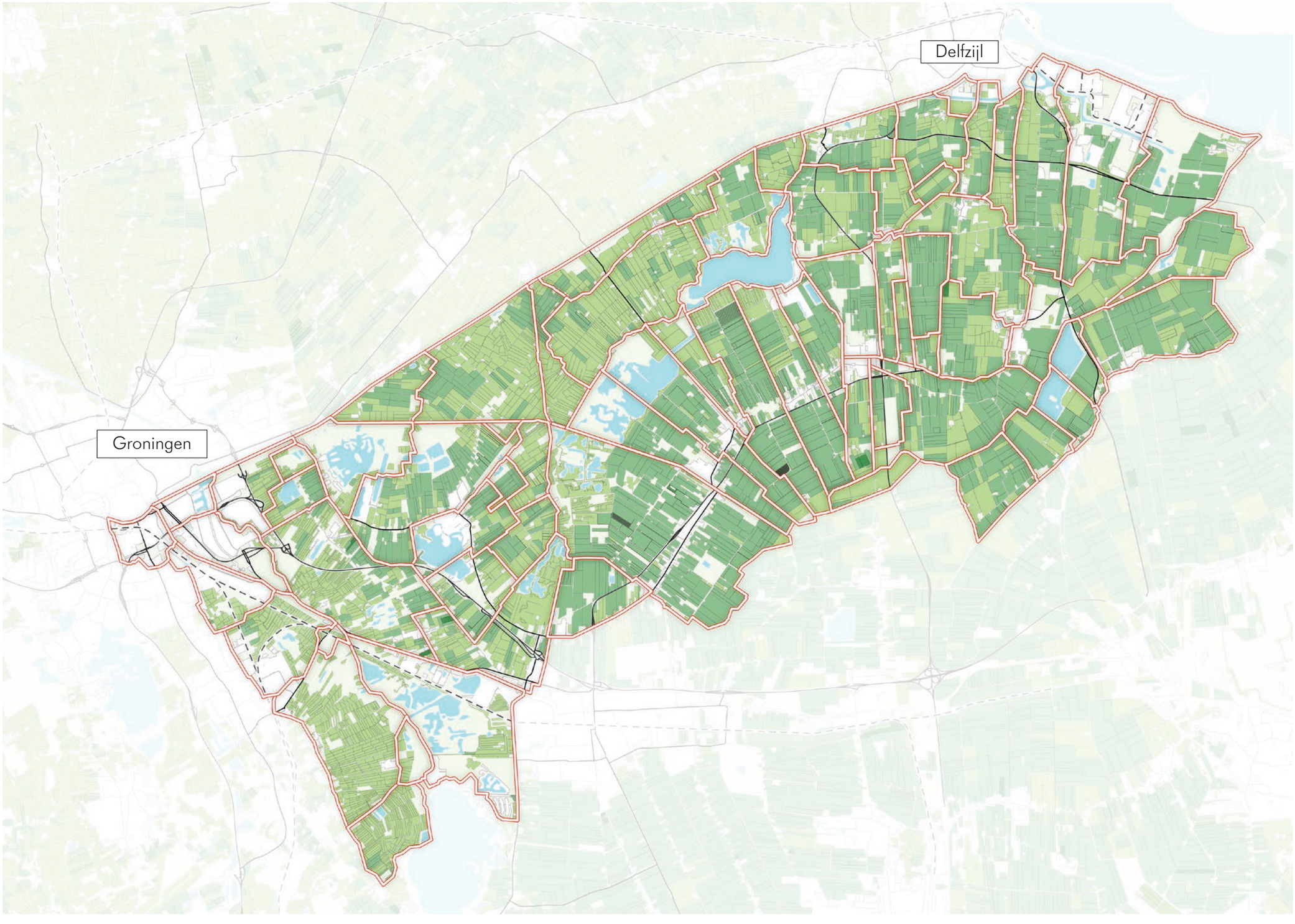
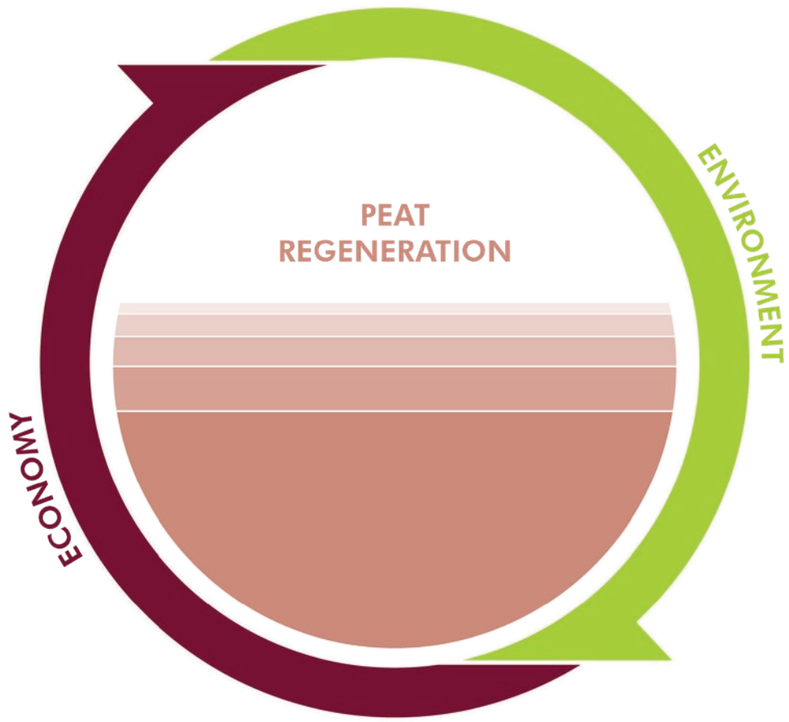
5.4 PRESENT POLDER STRUCTURE

DESIGN BUILDING BLOCKS



5.5 MAIN CHALLENGES

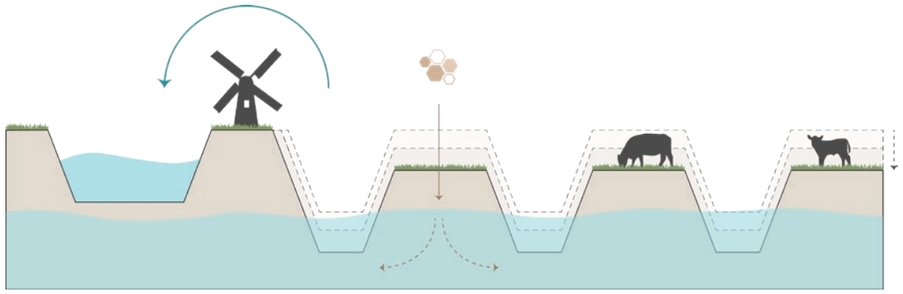
The design goal is to establish a new landscape system that **first stops the cycle of peat loss** and ultimately, **regenerates the peat in a sustainable fashion** - environmentally and economically.



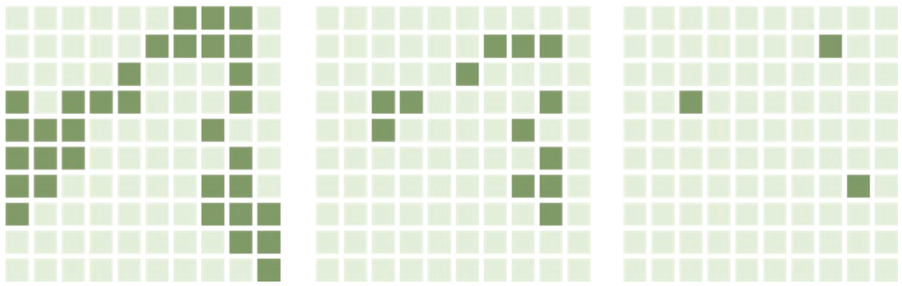
5.5 MAIN CHALLENGES

GENERAL PROBLEMS
related to peat loss

- **Constant Drainage**
- **Nutrient Overload**
- **Land Subsidence**

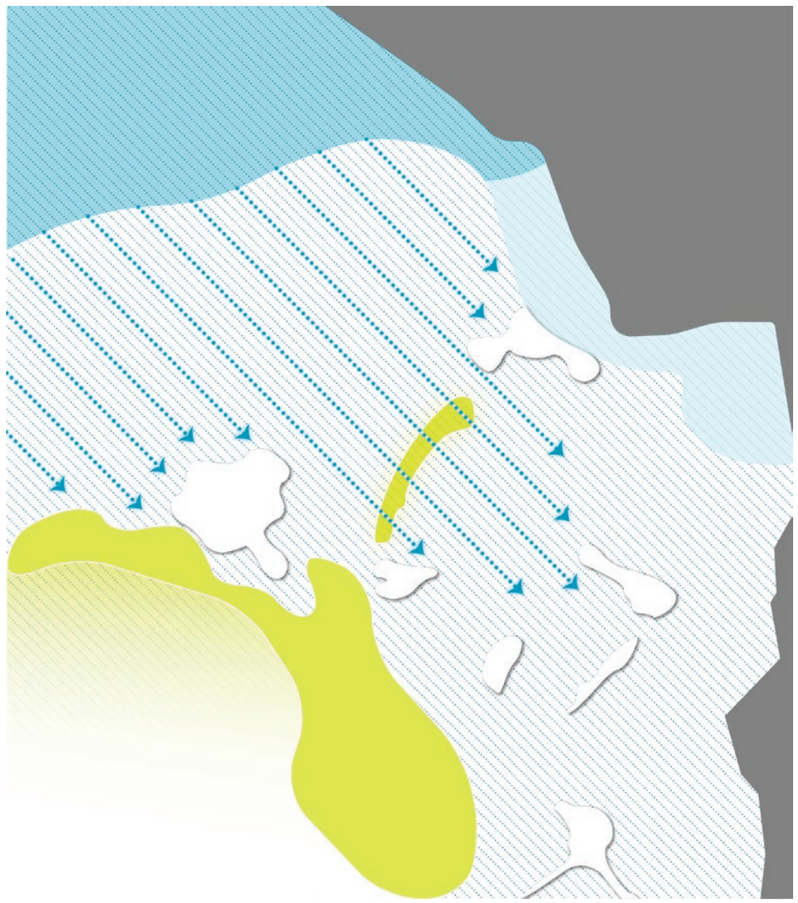


- **Becoming Too Isolated**

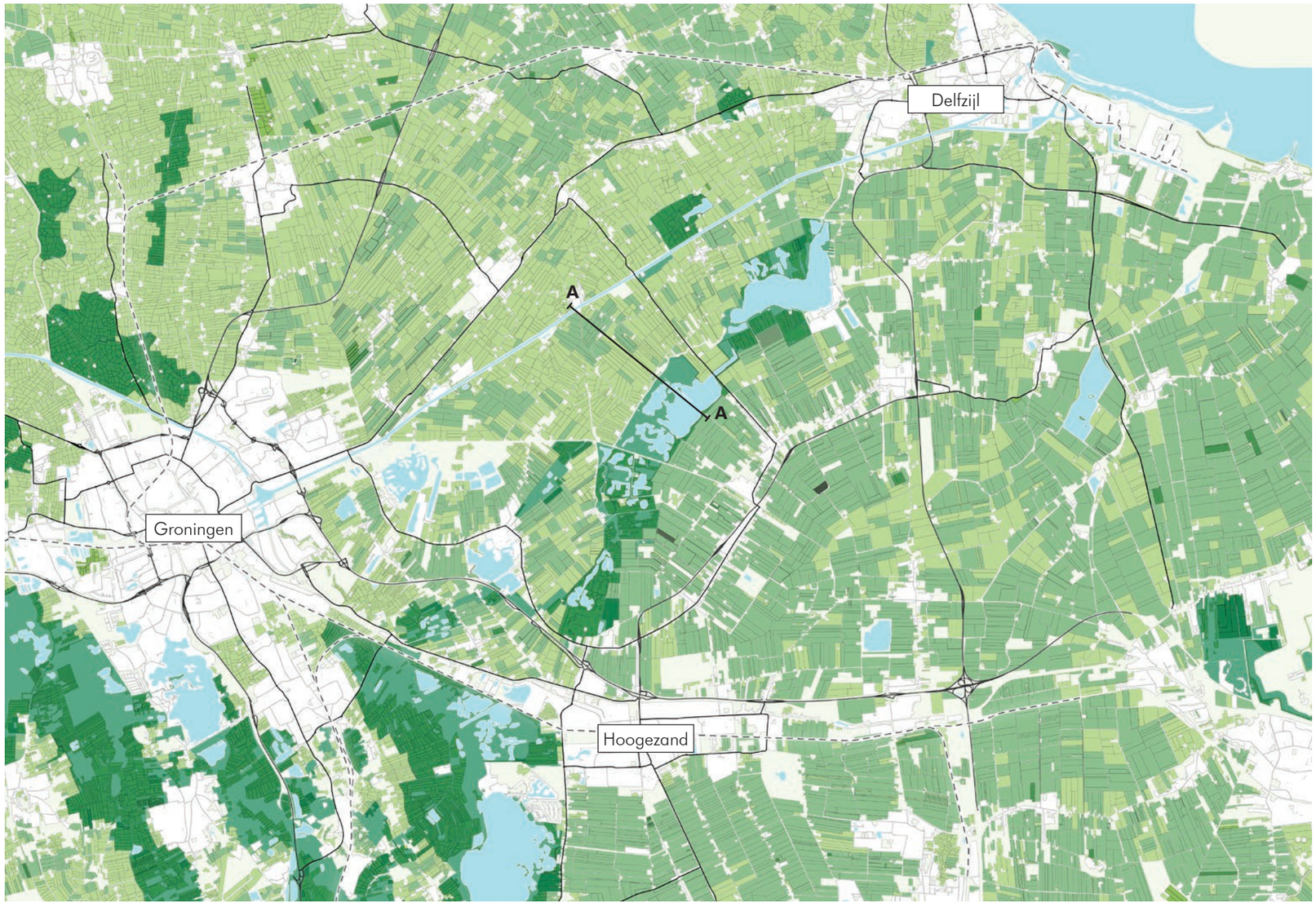


CONTEXT SPECIFIC PROBLEM
related to Groningen

- **Saline Seepage from the North Sea**



5.6 THE SALINITY PROBLEM



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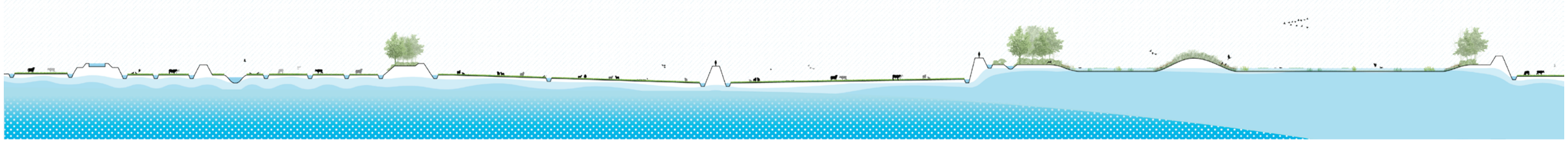

Section A - A

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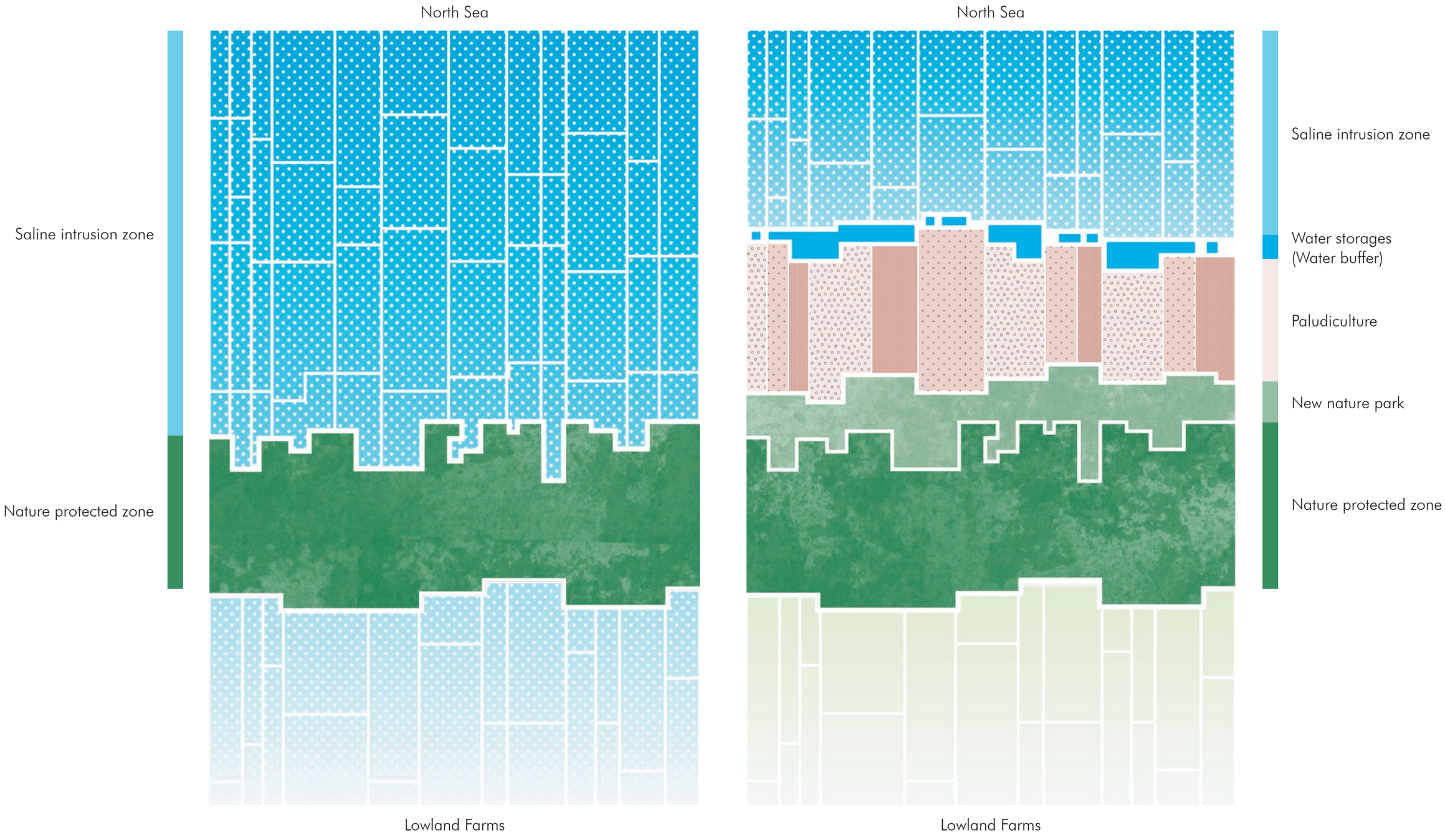
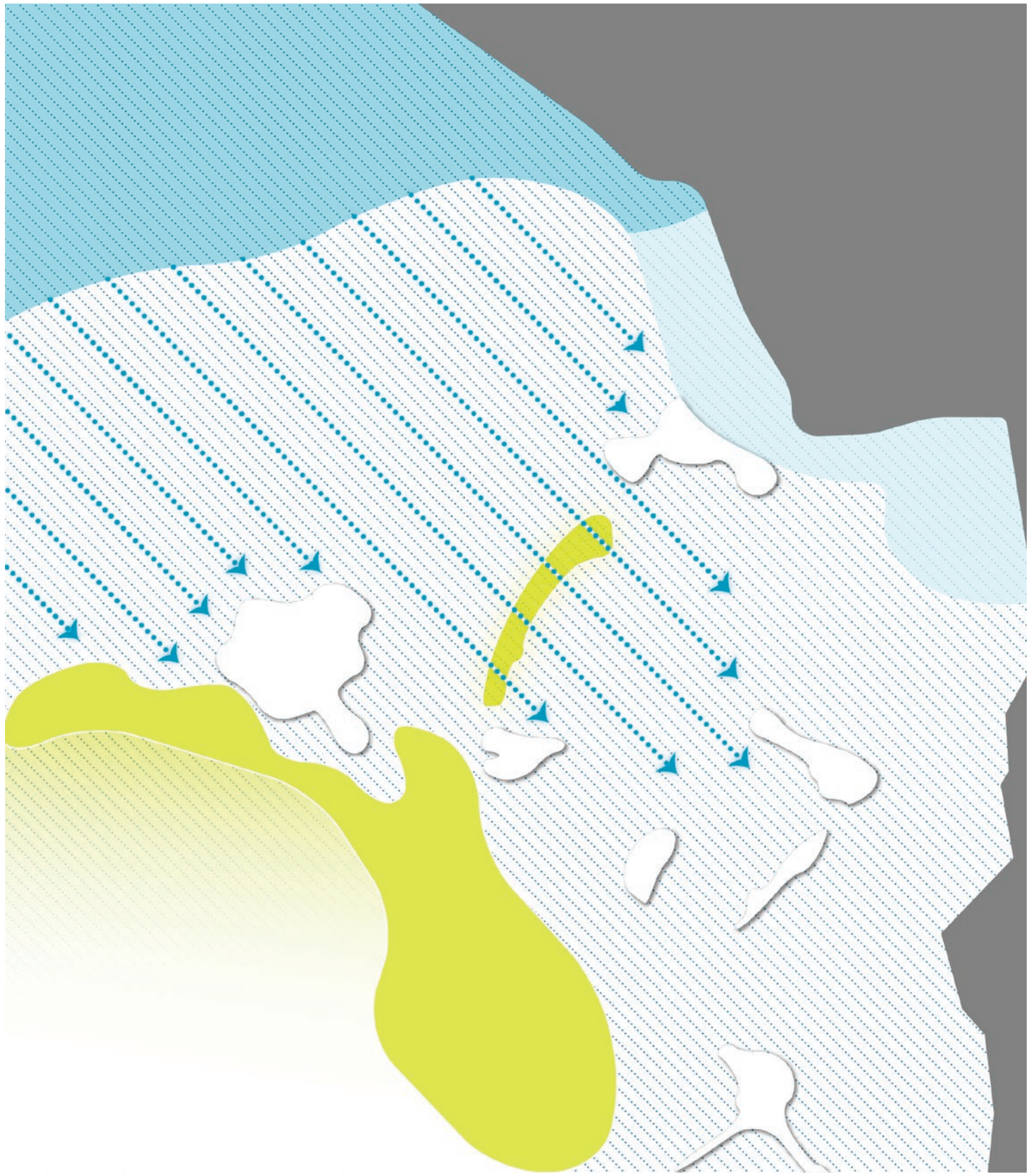
5.7 THE DESIGN CONCEPT:

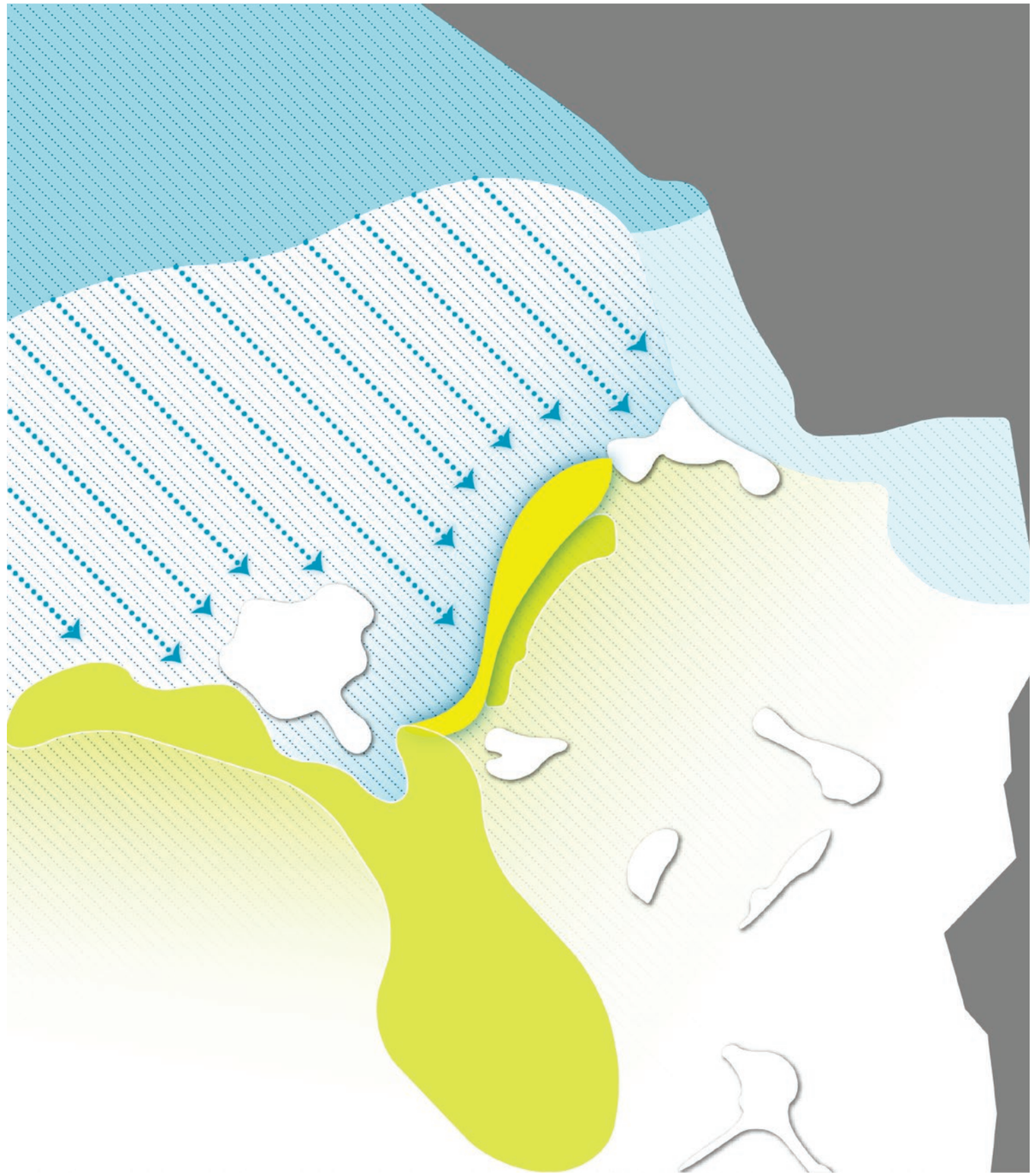
PROTECTING LOWLAND AGRICULTURE - PRODUCTIVE DEFENCE LAYERS



5.7 THE DESIGN CONCEPT:

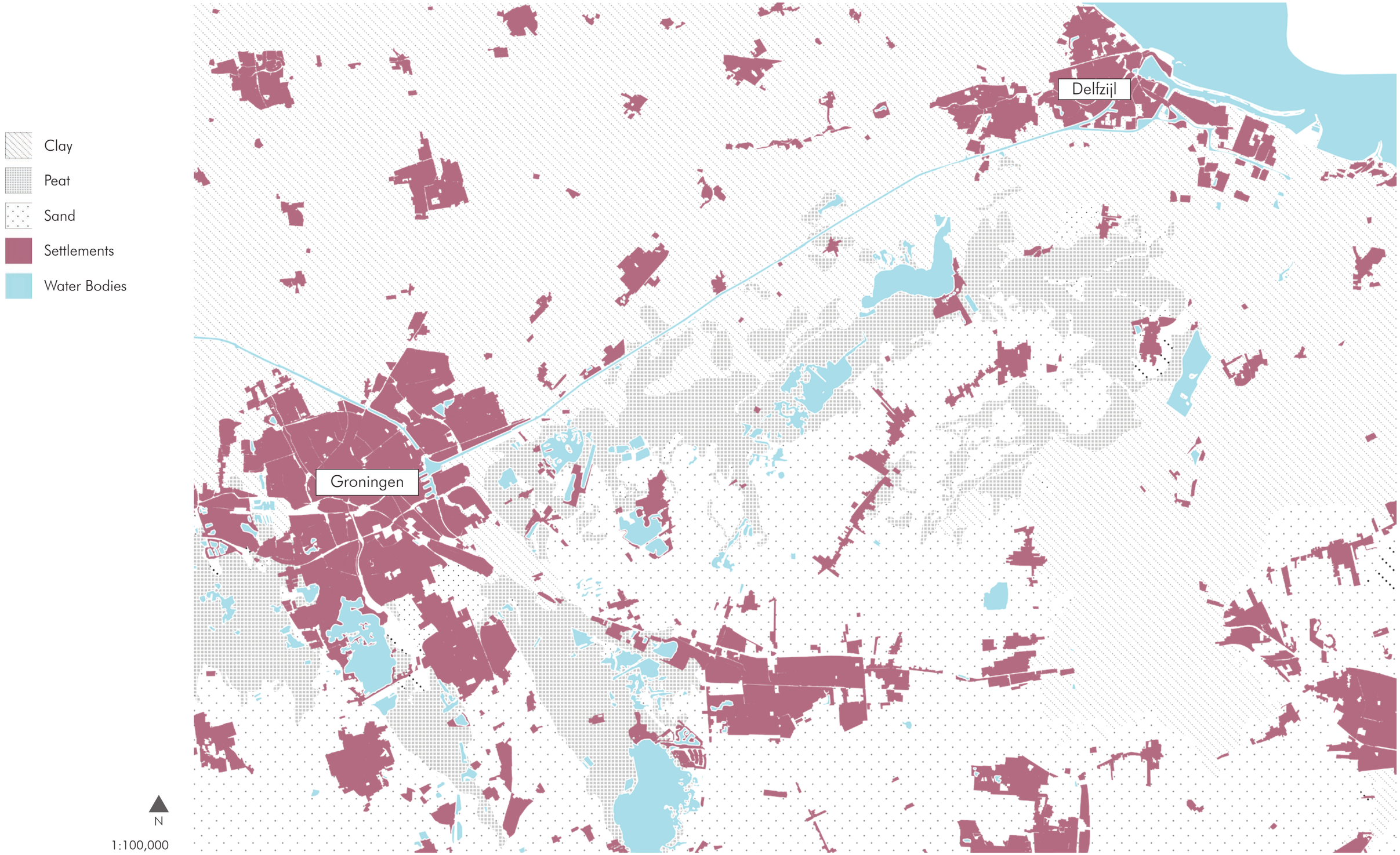
CLOSING NATURE GAPS - SALINITY SHIELD





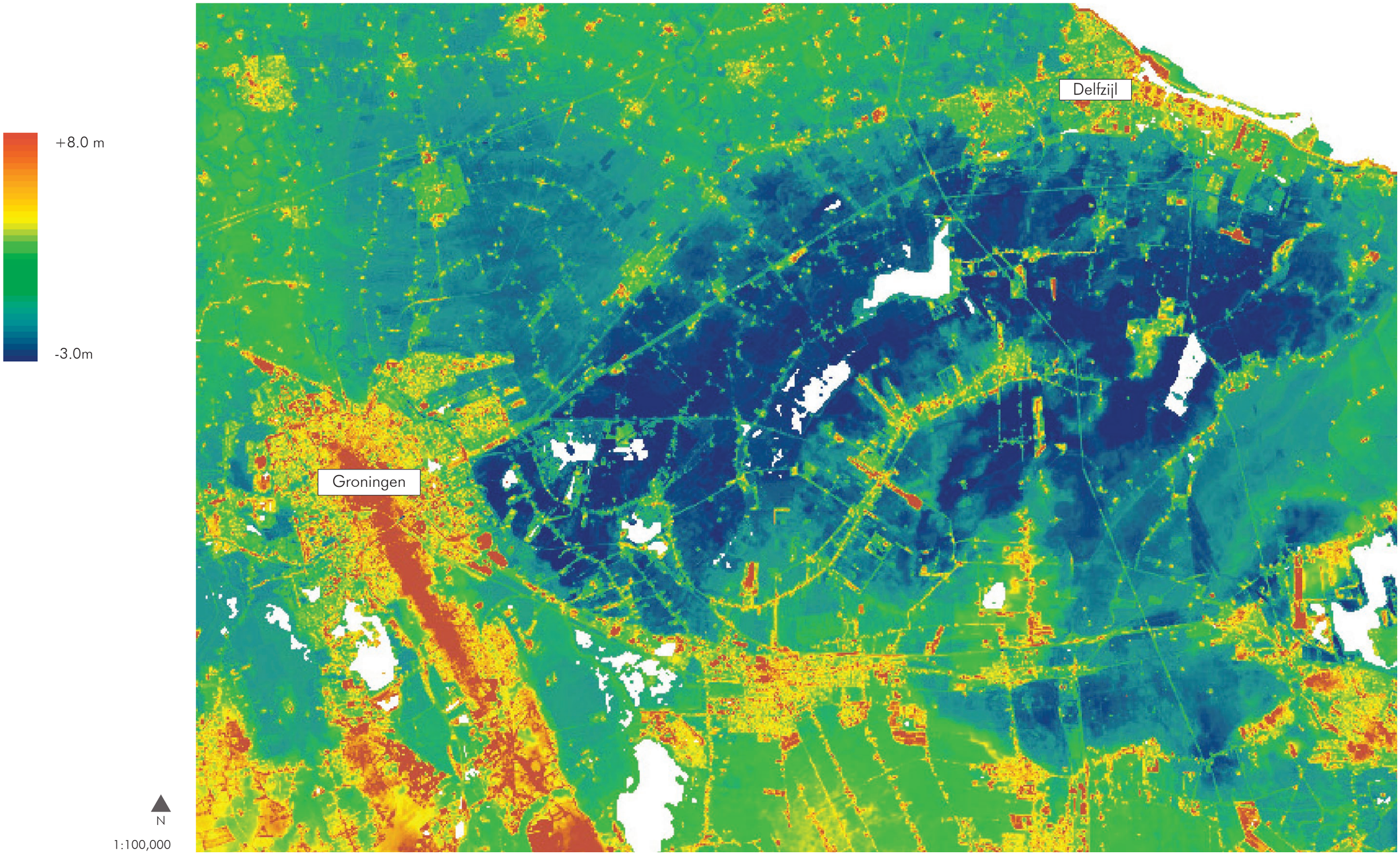
5.8 UNDERSTANDING THE LANDSCAPE

Settlements



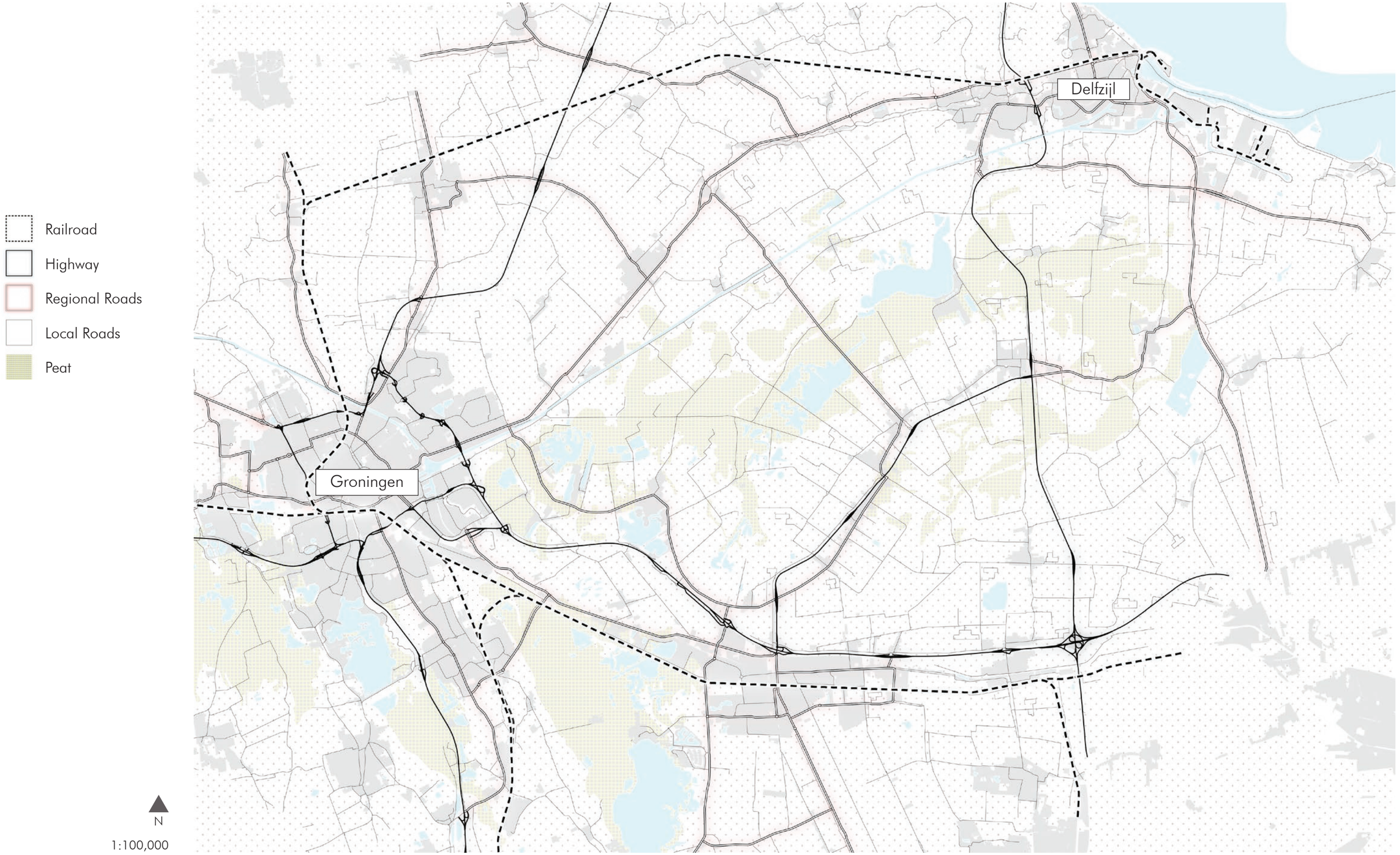
5.8 UNDERSTANDING THE LANDSCAPE

Height Map



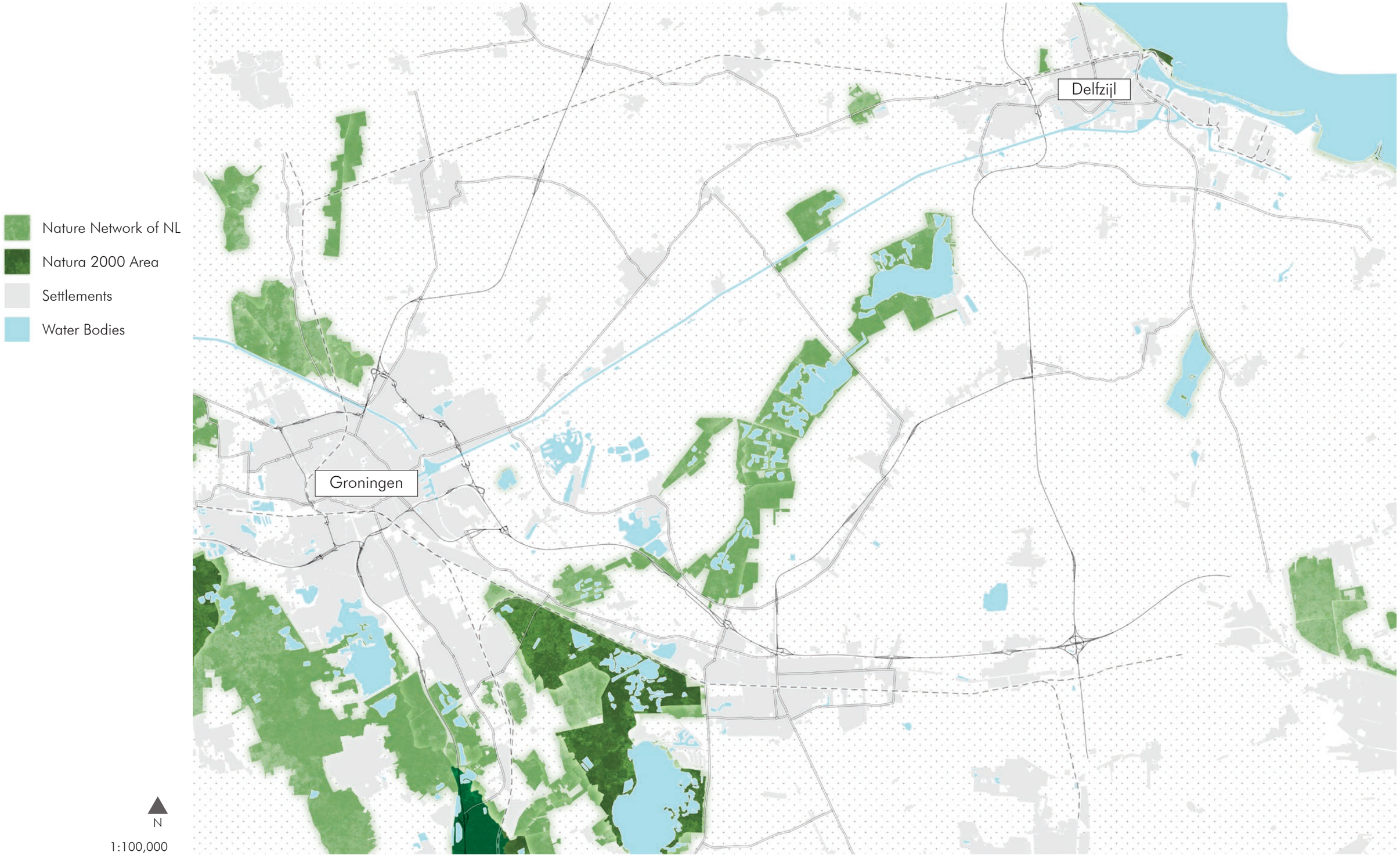
5.8 UNDERSTANDING THE LANDSCAPE

Transportation Network



5.8 UNDERSTANDING THE LANDSCAPE

Natural Network

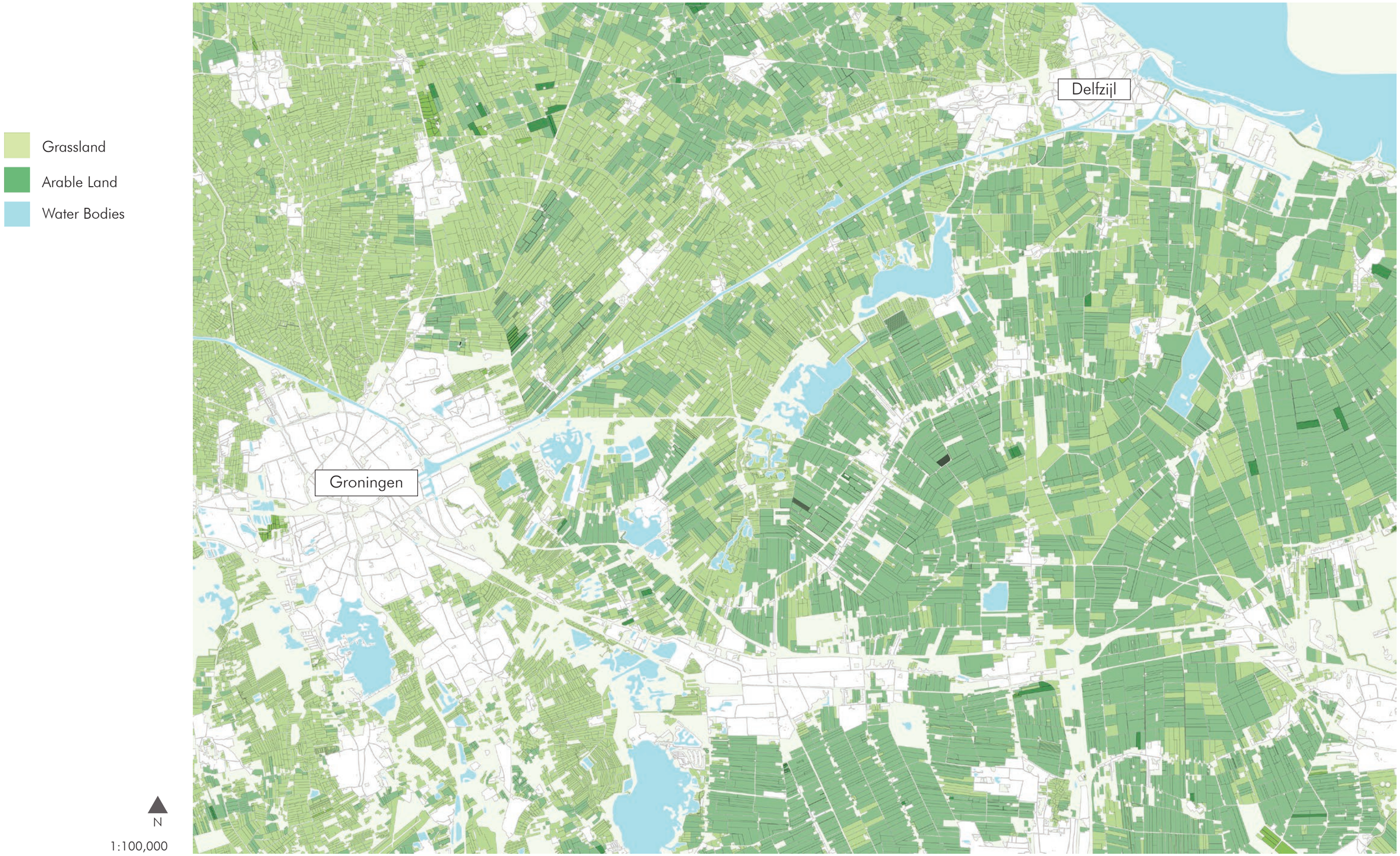


5.8 UNDERSTANDING THE LANDSCAPE

Water Network

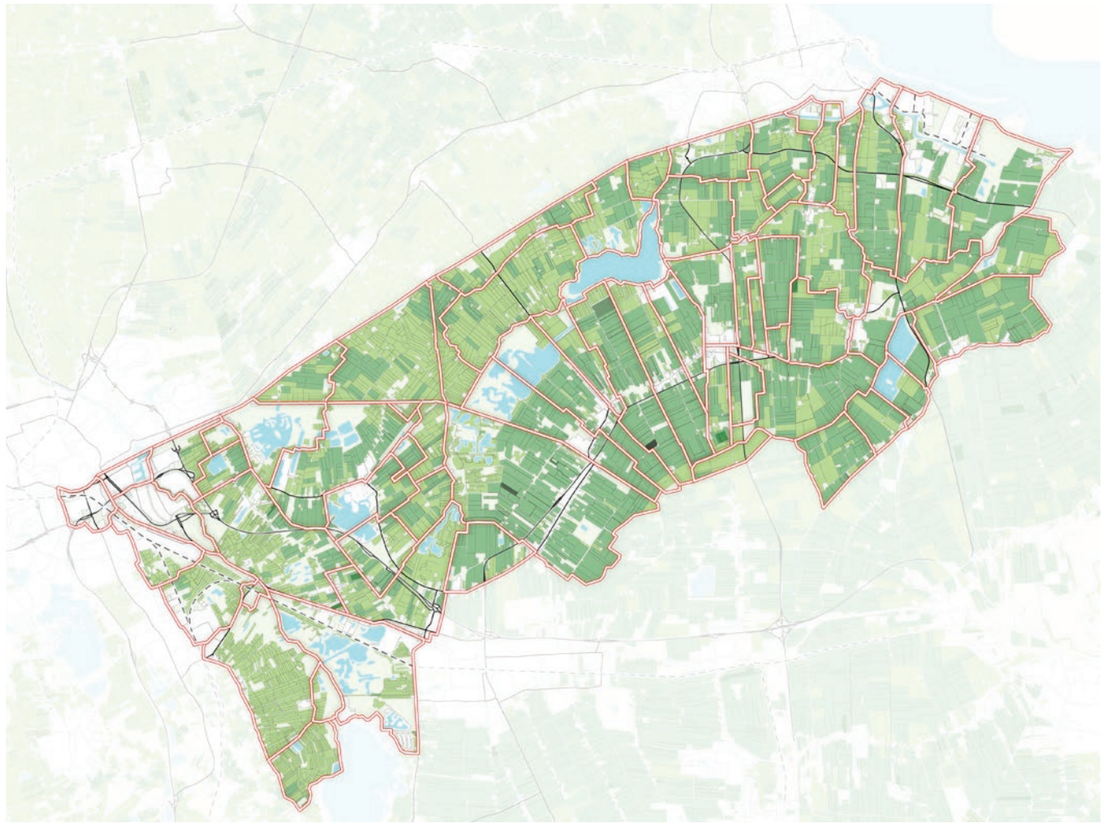
5.8 UNDERSTANDING THE LANDSCAPE

Agriculture



5.9 DEFINING PROJECT PERIMETERS

- **Building Blocks**



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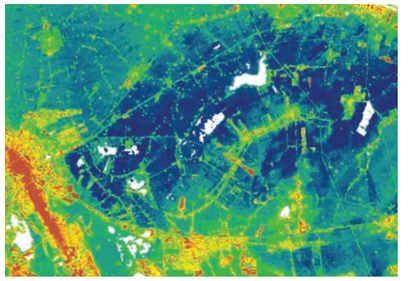
- **Peat Soil**

- **Height map**



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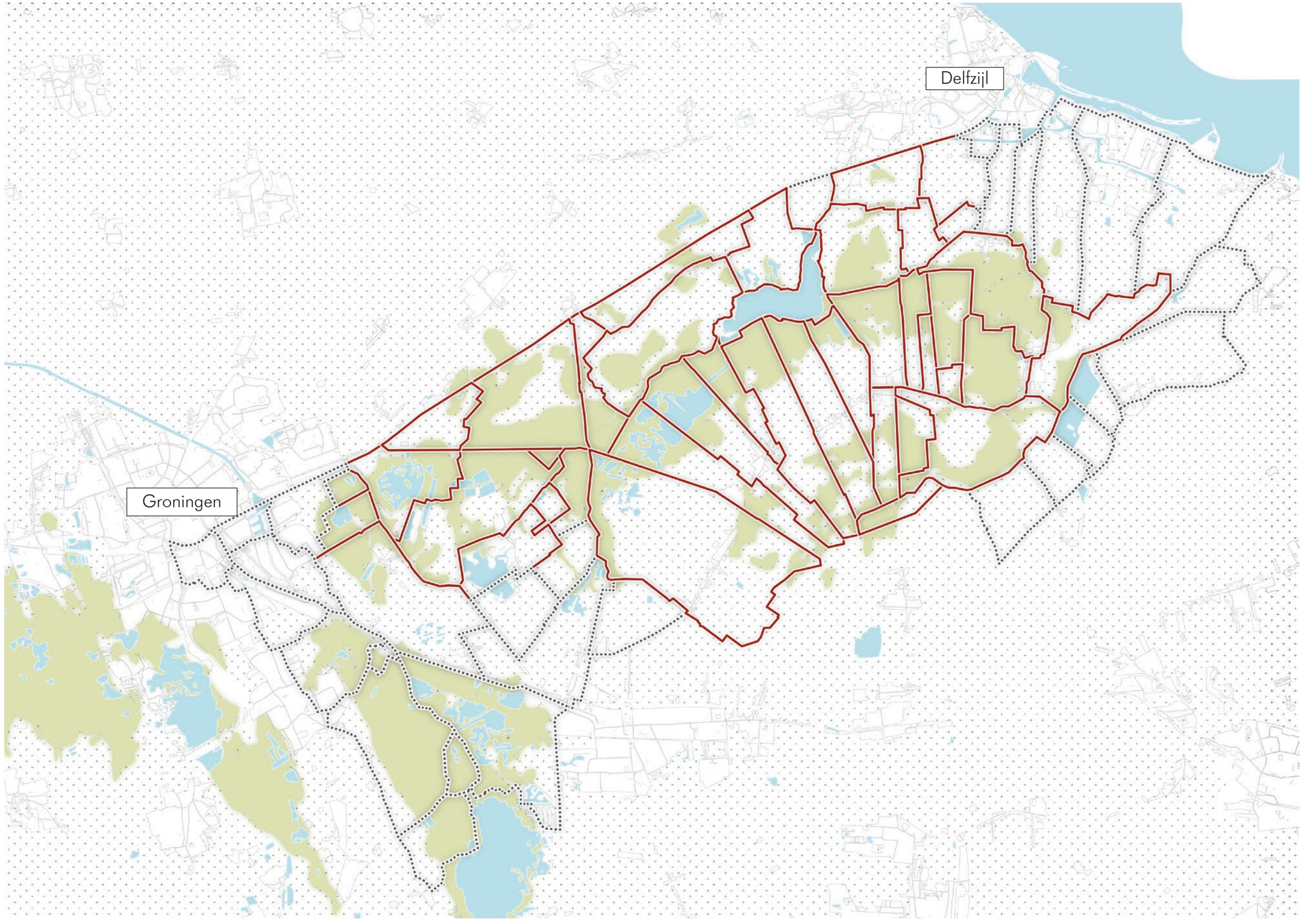
- **Nature Network**

- **Agriculture**

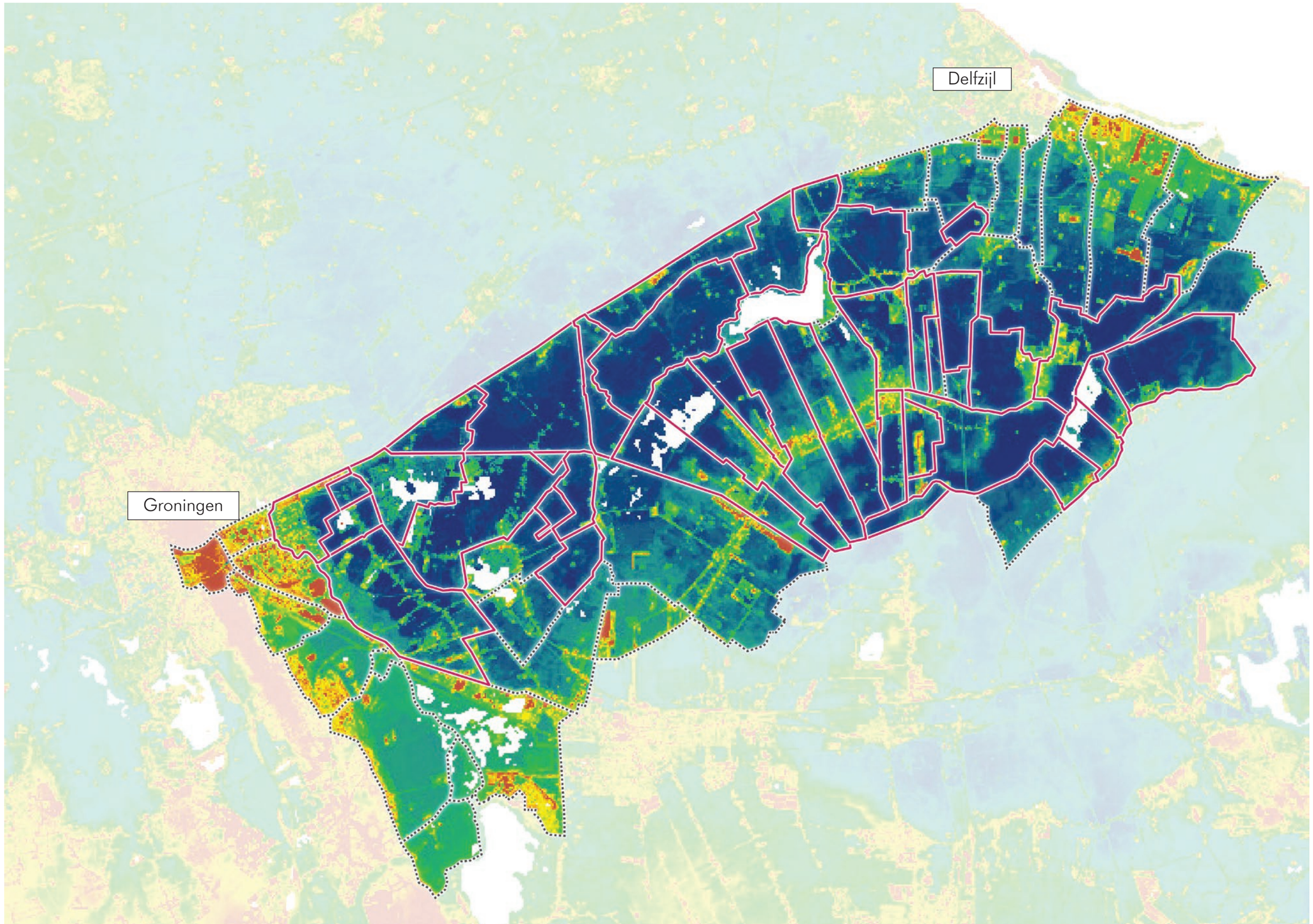
5.9 DEFINING PROJECT PERIMETERS

Polders + Peat Soil



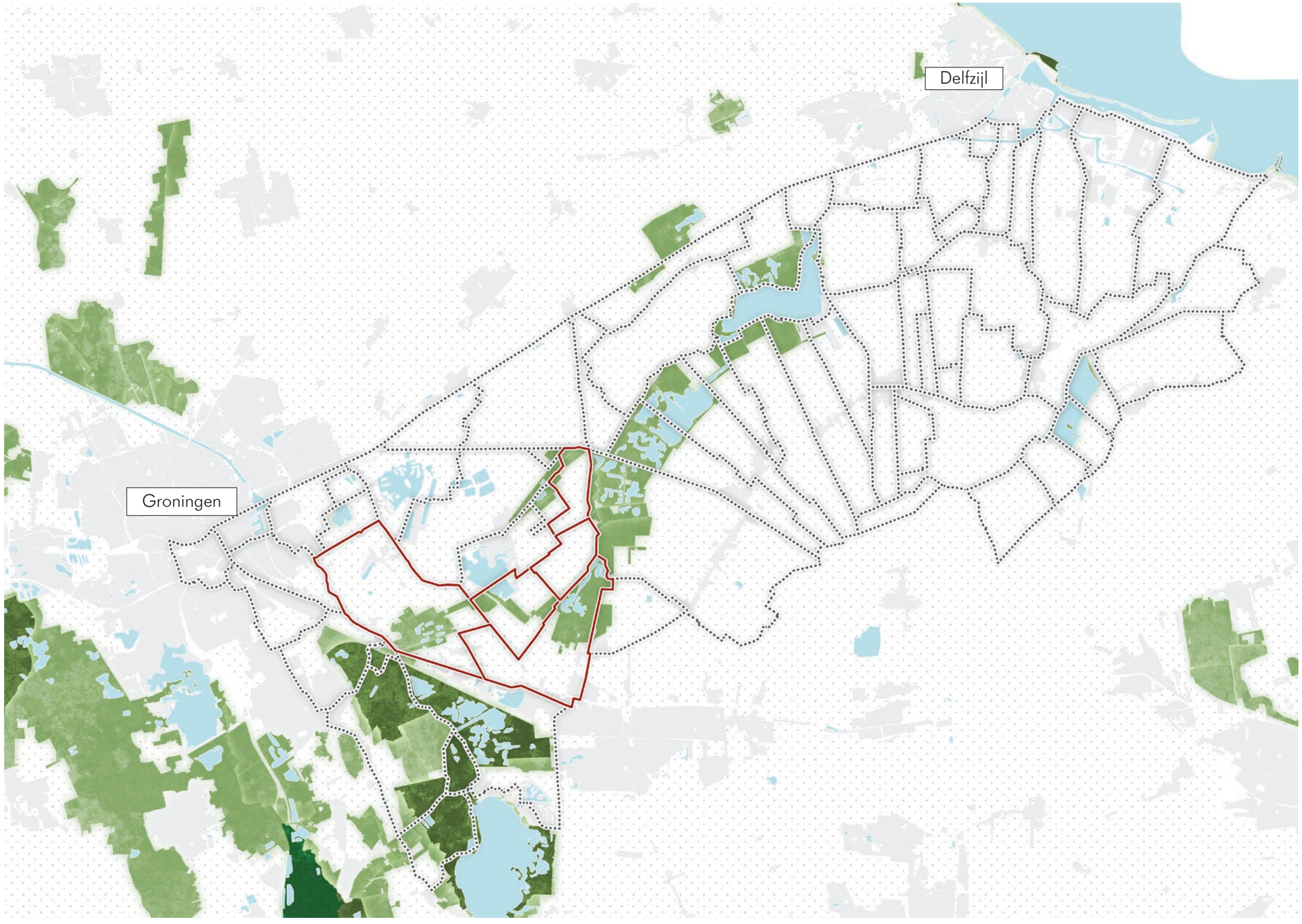
5.9 DEFINING PROJECT PERIMETERS

Polders + Heigh Map



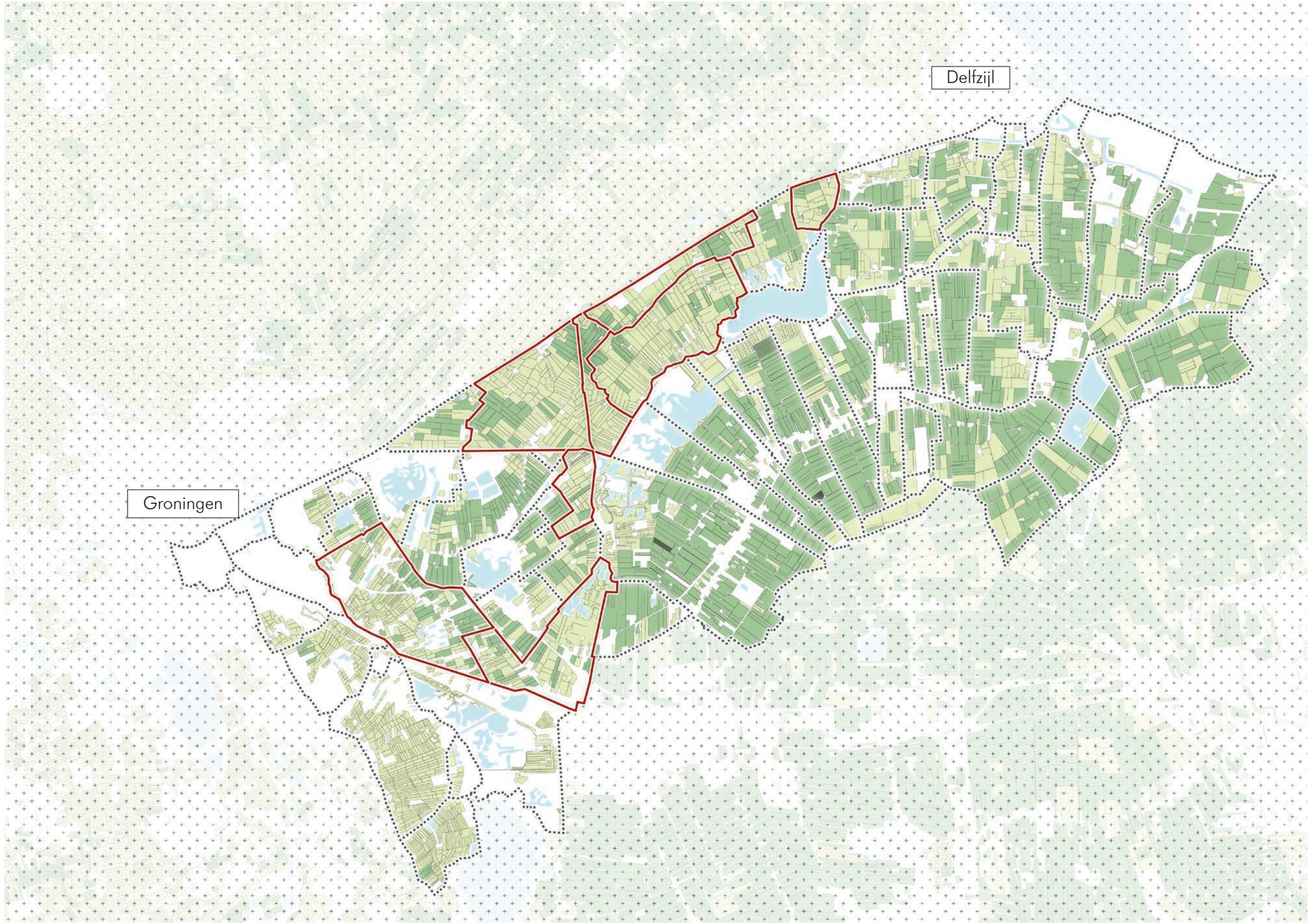
5.9 DEFINING PROJECT PERIMETERS

Polders + Nature



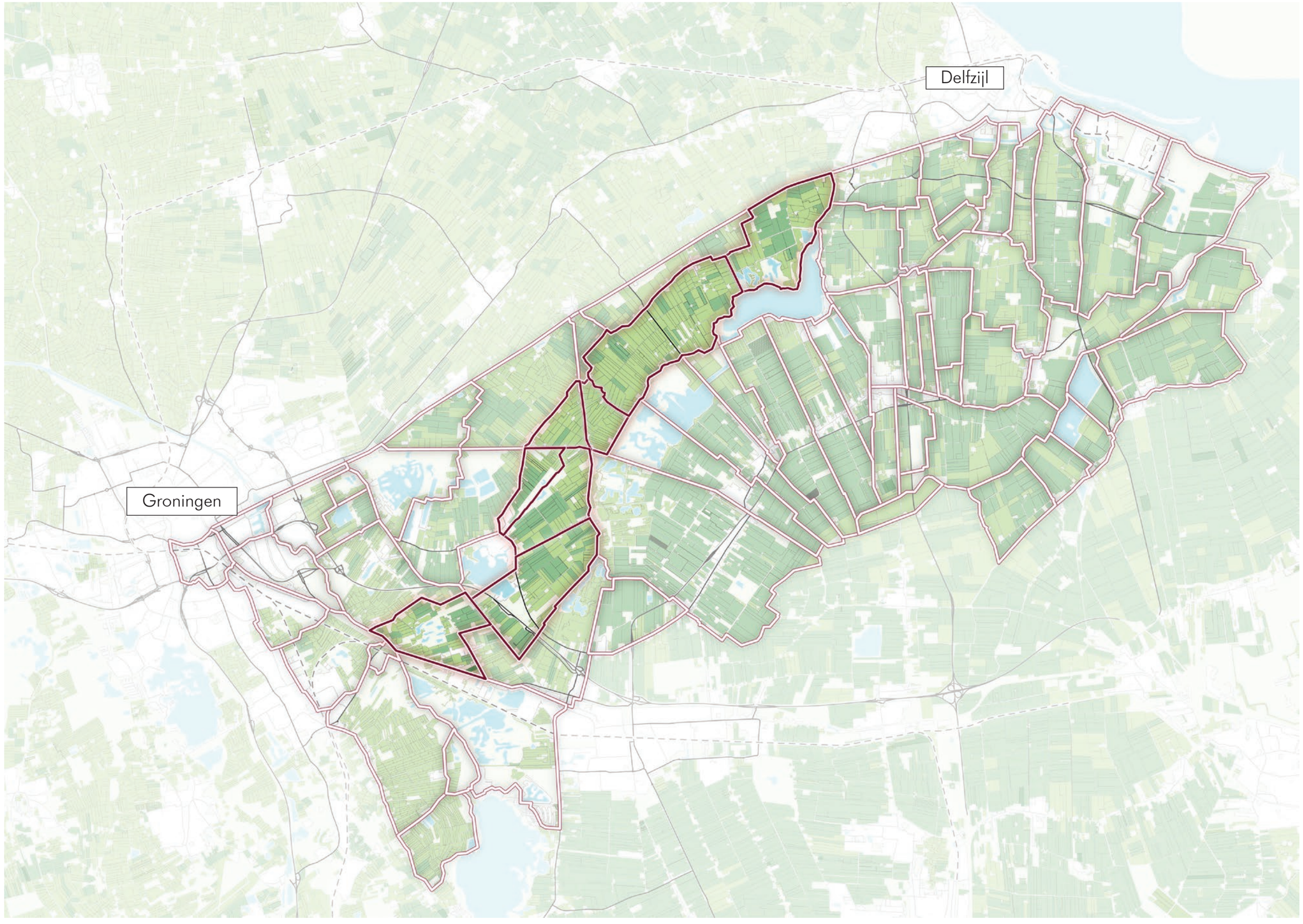
5.9 DEFINING PROJECT PERIMETERS

Polders + Agriculture

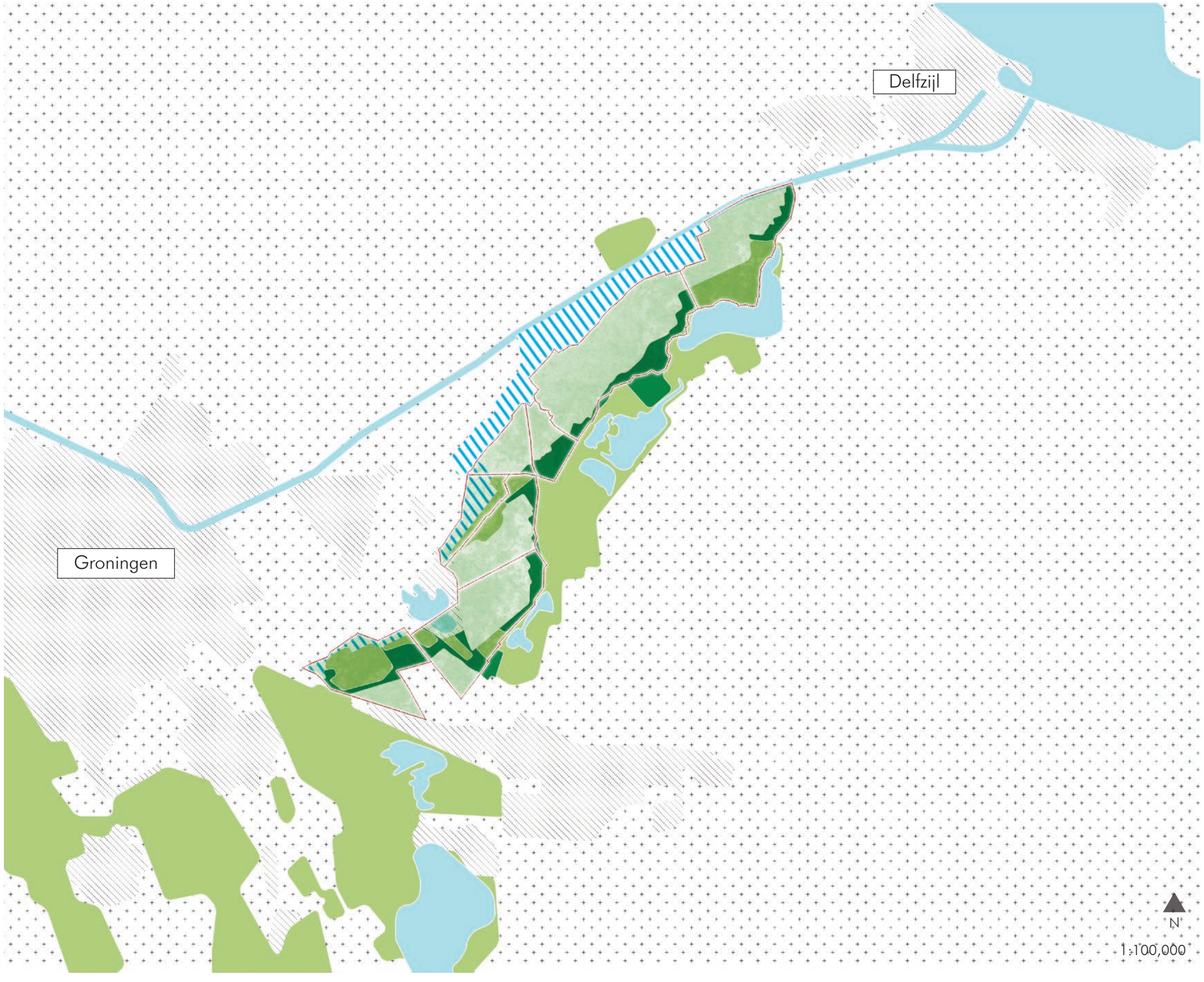


5.9 DEFINING PROJECT PERIMETERS

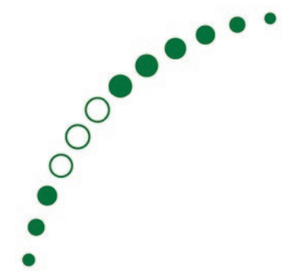
Project Perimeters



5.10 LARGE-SCALE PROGRAMMING

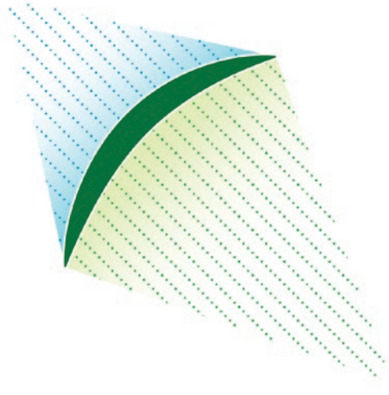


- Restoration Stage 3 Connection



- Productive Layers

- Salinity Shield



5.11 THE LANDSCAPE MASTERPLAN

5.12 NUTRIENT REMOVAL:
PALUDICULTURE

Nutrient removal is the second step in the process of peat restoration.

In this project, **nutrient removal, building up the peat soil, and economic productivity** go hand in hand in the form of paludiculture.

A set of paludiculture crops are **cultivated sequentially.** This new paludiculture system is allowed to **follow its natural course** from a nutrient rich to a nutrient poor environment, instead of fast methodes such as complete top soil removal that is harmful to the system.

The different paludiculture types provide **a diverse palette of crops** that replace the monoculture grassland. This diversification **promotes the biodiversity** and brings in **flows of revenue from a variety of markets:**

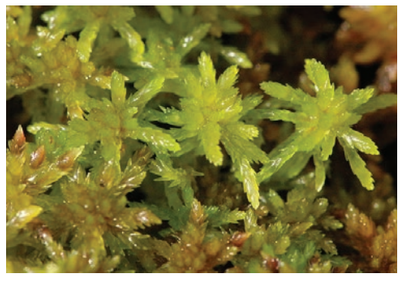
- **Building and Construction**
  Timber, Insulation



- **Energy**
  Biomass

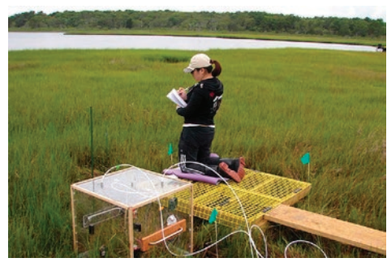

- **Agriculture**
  Haymaking


- **Medicine**
  Many species



- **Horticulture**
  Sphagnum moss as growing media


- **Research**
  Living laboratory

- **Biodiversity & Tourism**
  Agritourism, Ecotourism



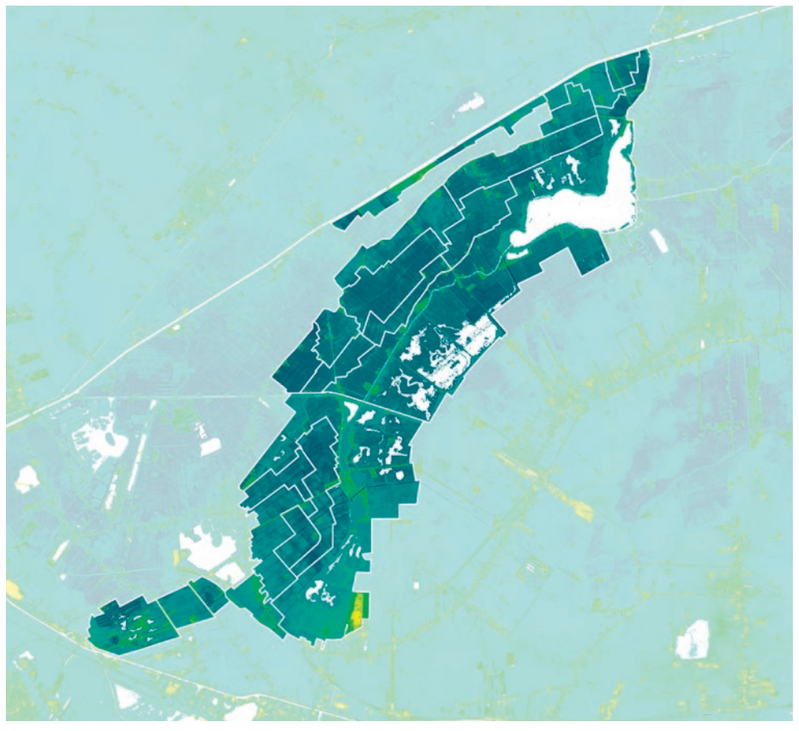

5.13 NUTRIENT REMOVAL:
PALUDICULTURE TYPES & ZONES

Nature Zone
Height not relevant for paludiculture

Deepest Areas
-2.50m to -2.20m
Paludiculture Type A

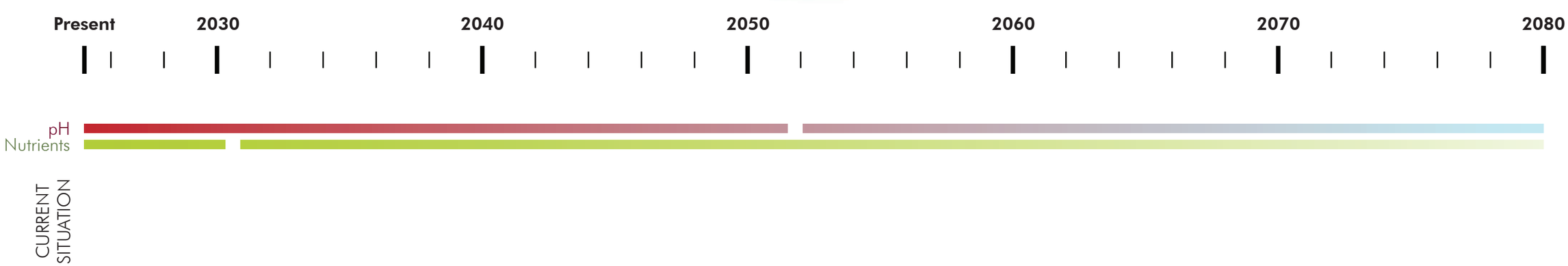
Middle Areas
-2.20m to -1.70m
Paludiculture Type B

Highest Areas
-1.70m to -1.00m
Paludiculture Type C



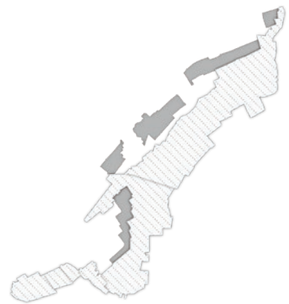
5.13 NUTRIENT REMOVAL:

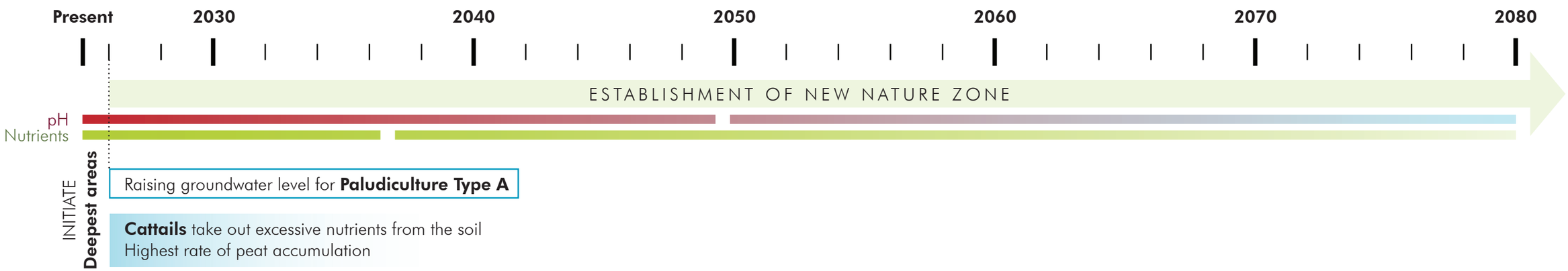
STAGE 0 - EXISTING SITUATION



5.13 NUTRIENT REMOVAL:

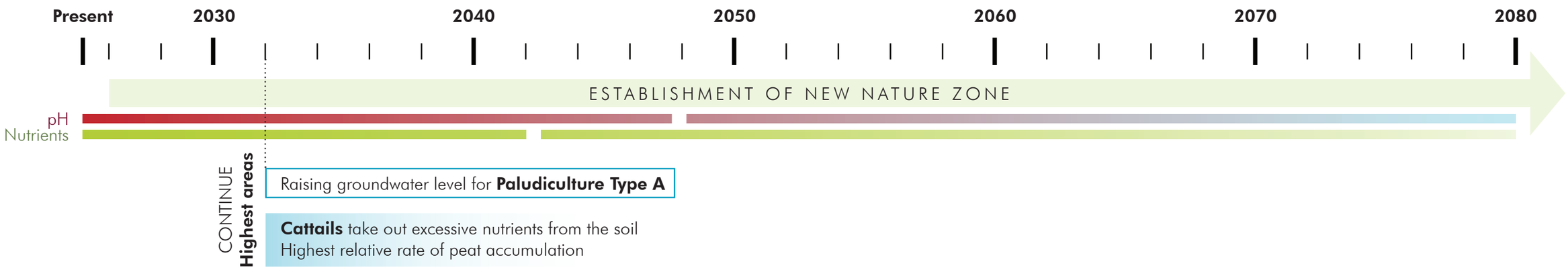
STAGE 1 - PALUDICULTURE TYPE A





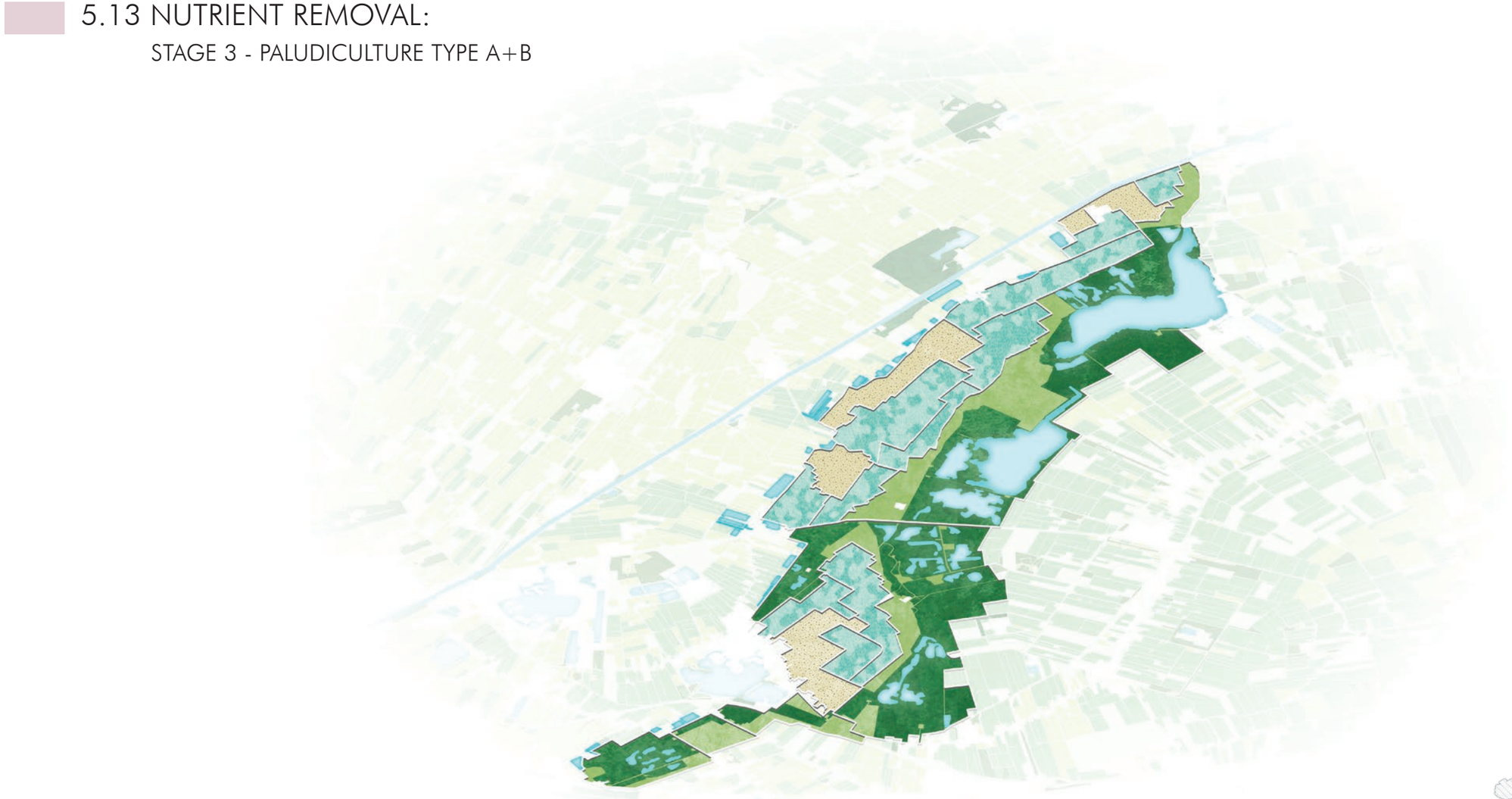
5.13 NUTRIENT REMOVAL:

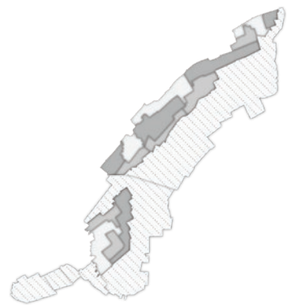
STAGE 2 - PALUDICULTURE TYPE A

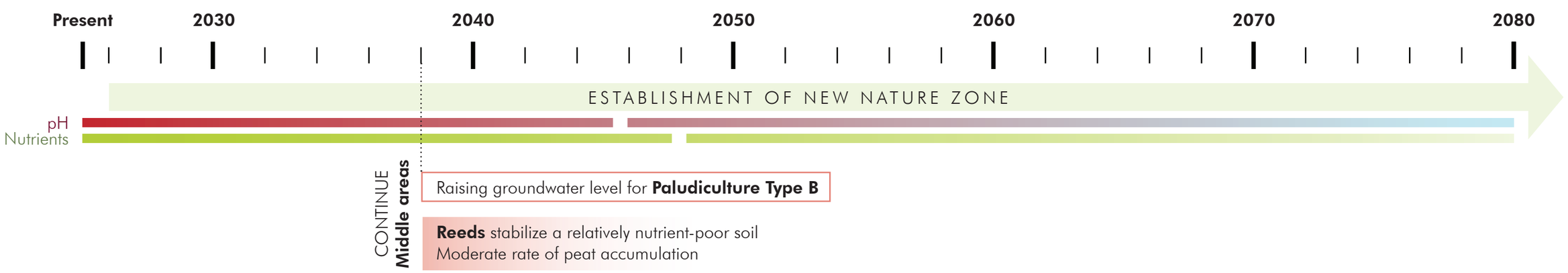


5.13 NUTRIENT REMOVAL:

STAGE 3 - PALUDICULTURE TYPE A+B

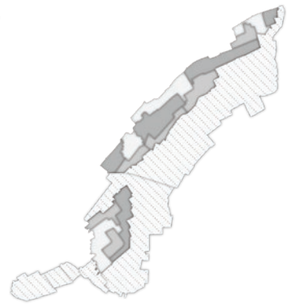






5.13 NUTRIENT REMOVAL:

STAGE 4 - PALUDICULTURE TYPE A+B



Present **2030** **2040** **2050** **2060** **2070** **2080**

ESTABLISHMENT OF NEW NATURE ZONE

pH

Nutrients

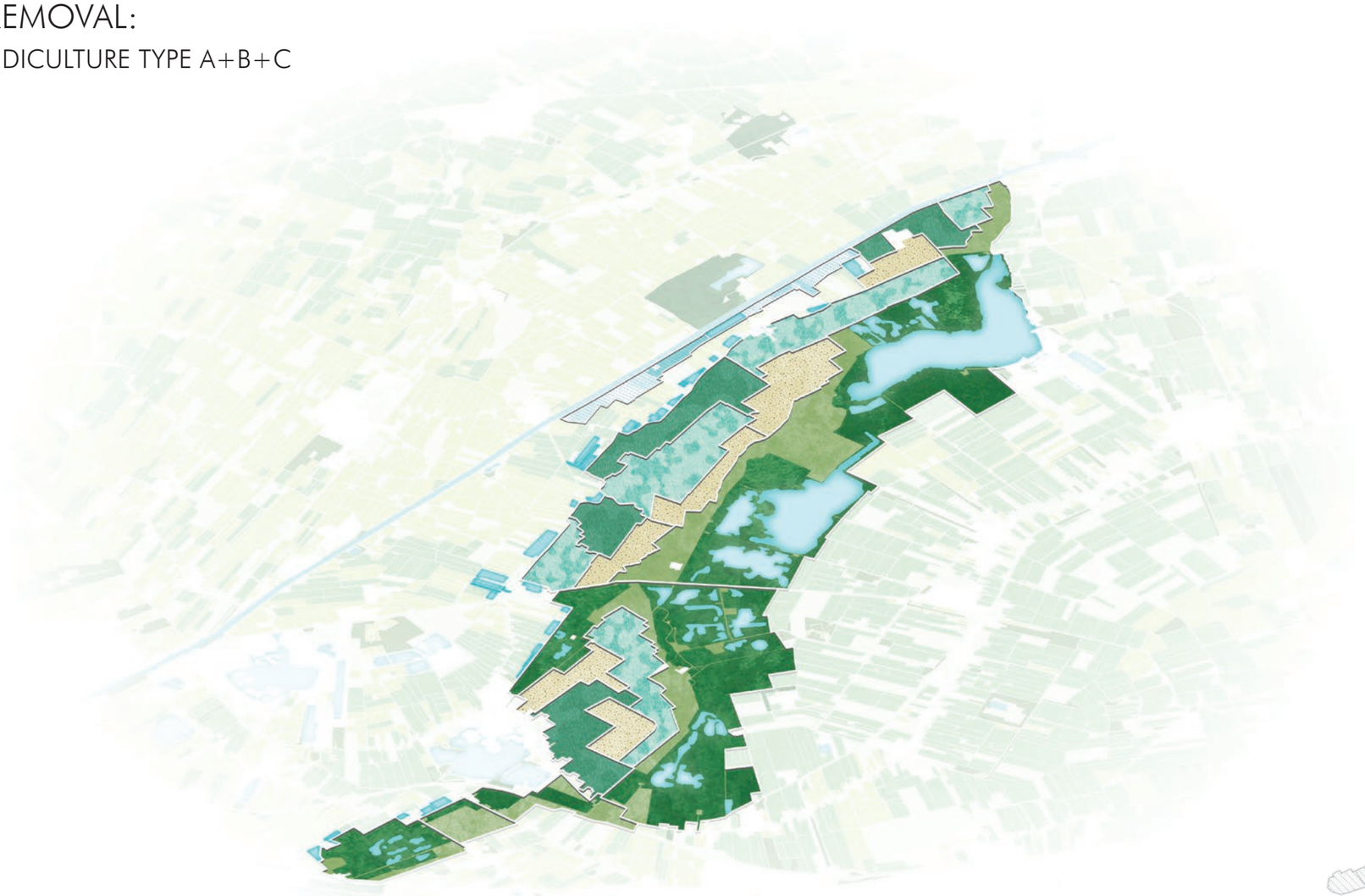
CONTINUE **Highest areas**

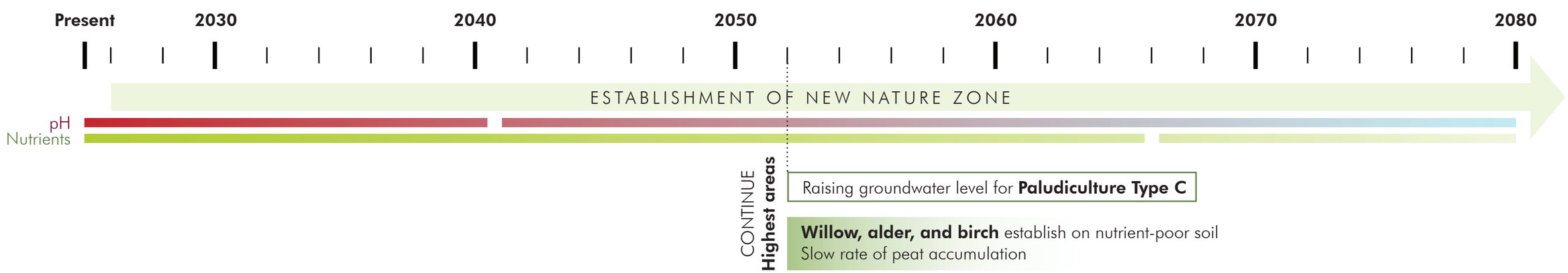
Raising groundwater level for **Paludiculture Type B**

Reeds stabilize a relatively nutrient-poor soil
Moderate rate of peat accumulation

5.13 NUTRIENT REMOVAL:

STAGE 5 - PALUDICULTURE TYPE A+B+C





5.14 HYDROLOGY:
WATER STORAGES AND WATER SOURCES

Restoring the hydrology is the first step in the process of peat restoration.

The new hydrology system **is isolated from the rest of the landscape** and is an inherently different system that:
- is supplied by **several water storages,**
- with **varying nutritional profiles.**

These water storages compose **the first defence layer** against saline intrusion, and **support all the other layers.**

5.14 HYDROLOGY:
WATER SOURCES AND FLOWS

- **Surface Water**
  feeds cattails

Nutrients

pH

5.14 HYDROLOGY:
WATER SOURCES AND FLOWS

- **Surface Water**
  feeds cattails

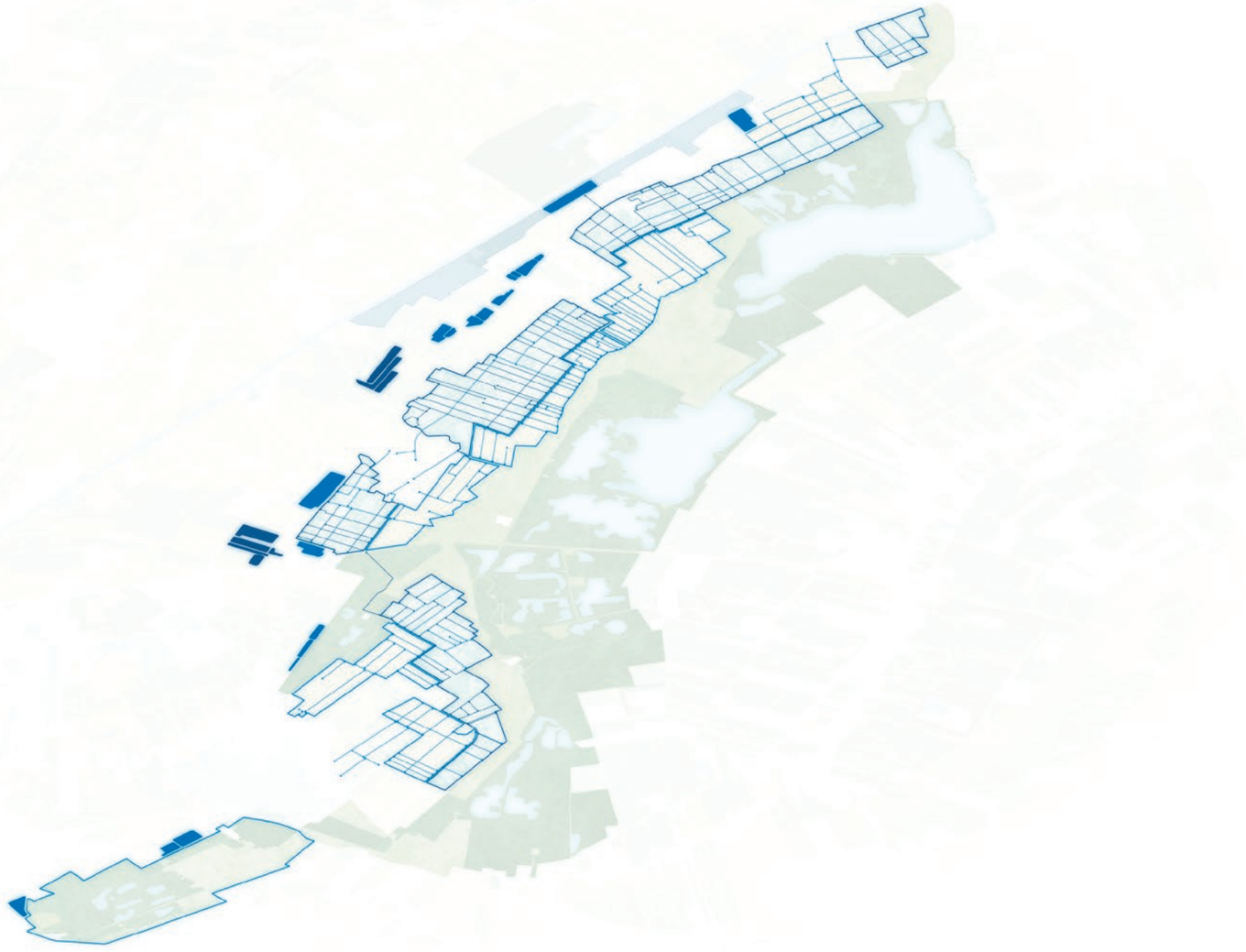
Nutrients

pH

- **Ground Water**
  feeds reeds & sedges

Nutrients

pH



5.14 HYDROLOGY:
WATER SOURCES AND FLOWS

- **Surface Water**
  feeds cattails

Nutrients

pH

- **Ground Water**
  feeds reeds & sedges

Nutrients

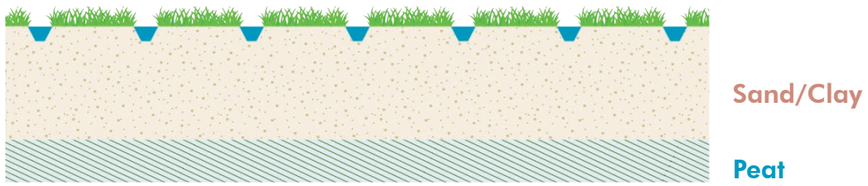
pH

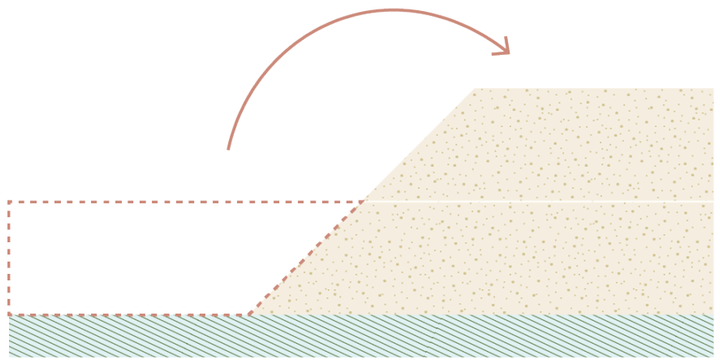
- **Rain Water**
  feeds swamp forests & bog reserve

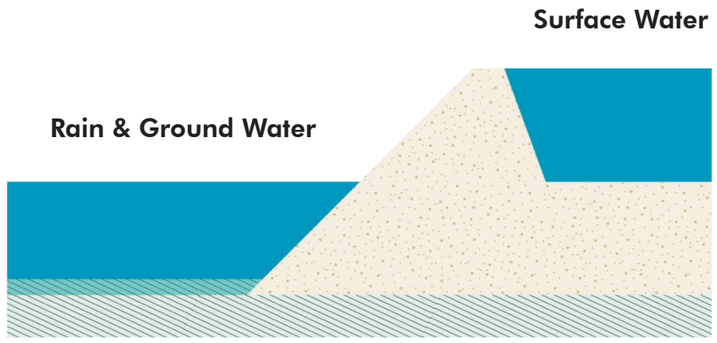
Nutrients

pH

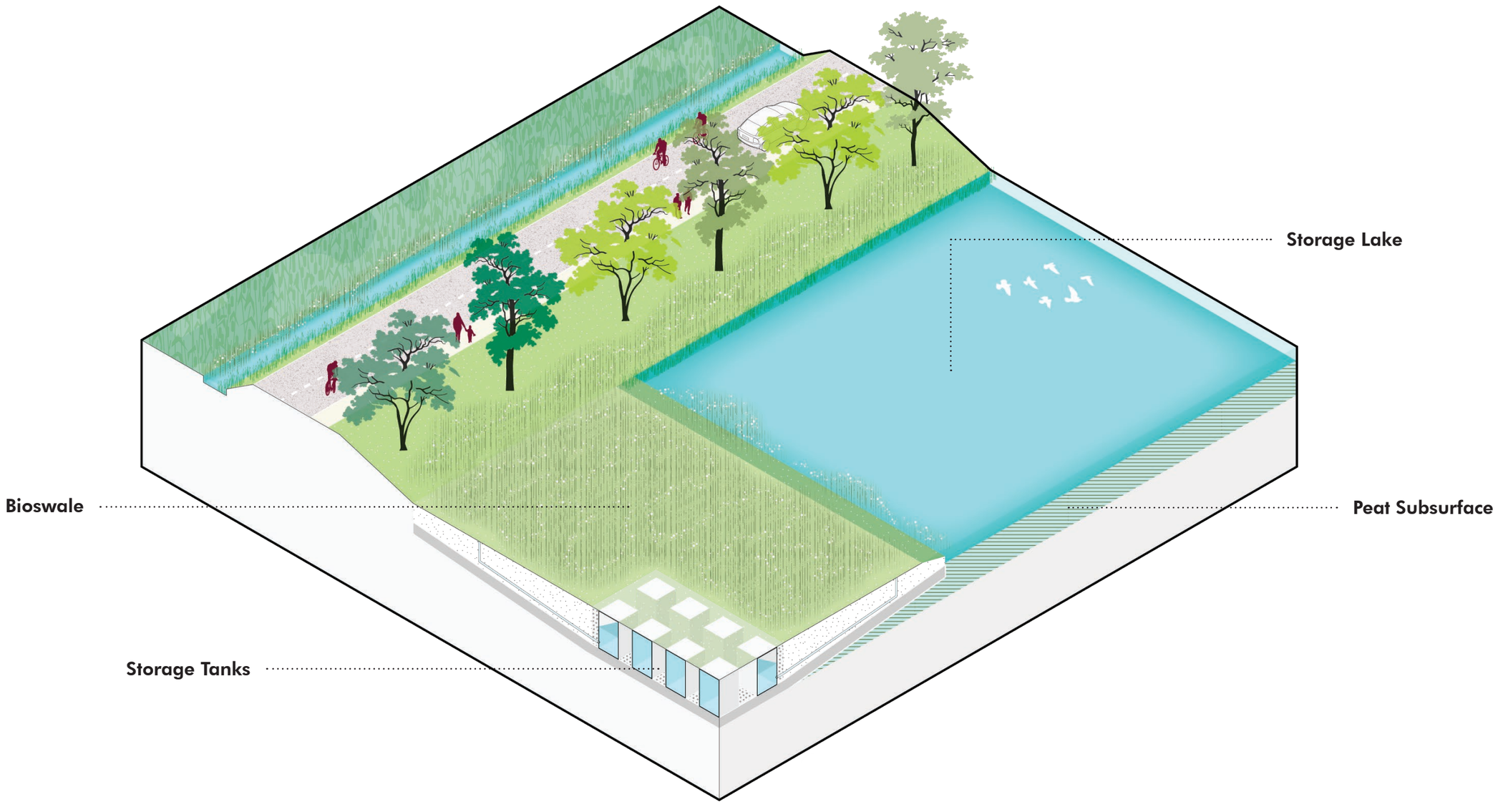
5.14 HYDROLOGY:
WATER SOURCES AND FLOWS



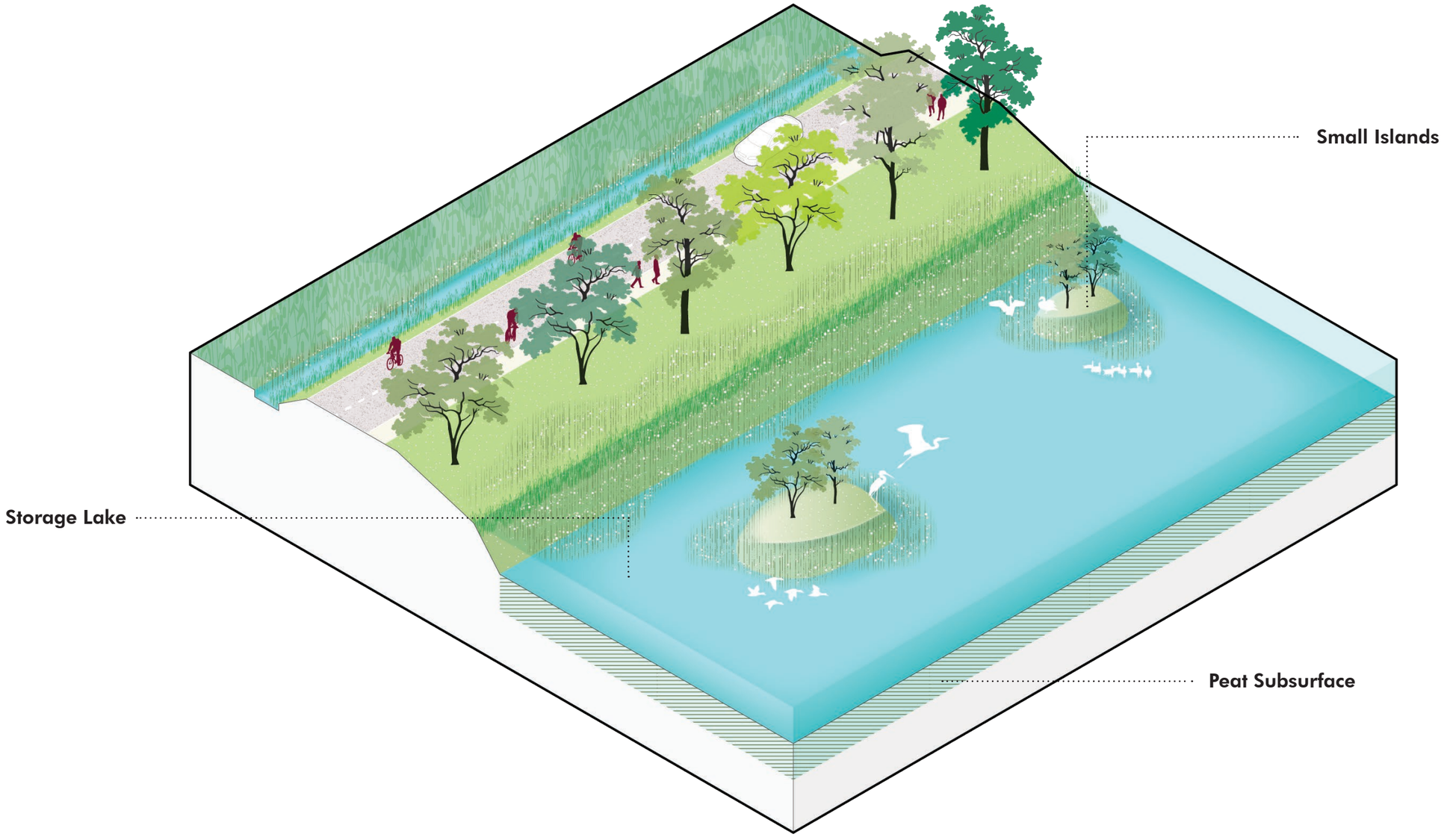




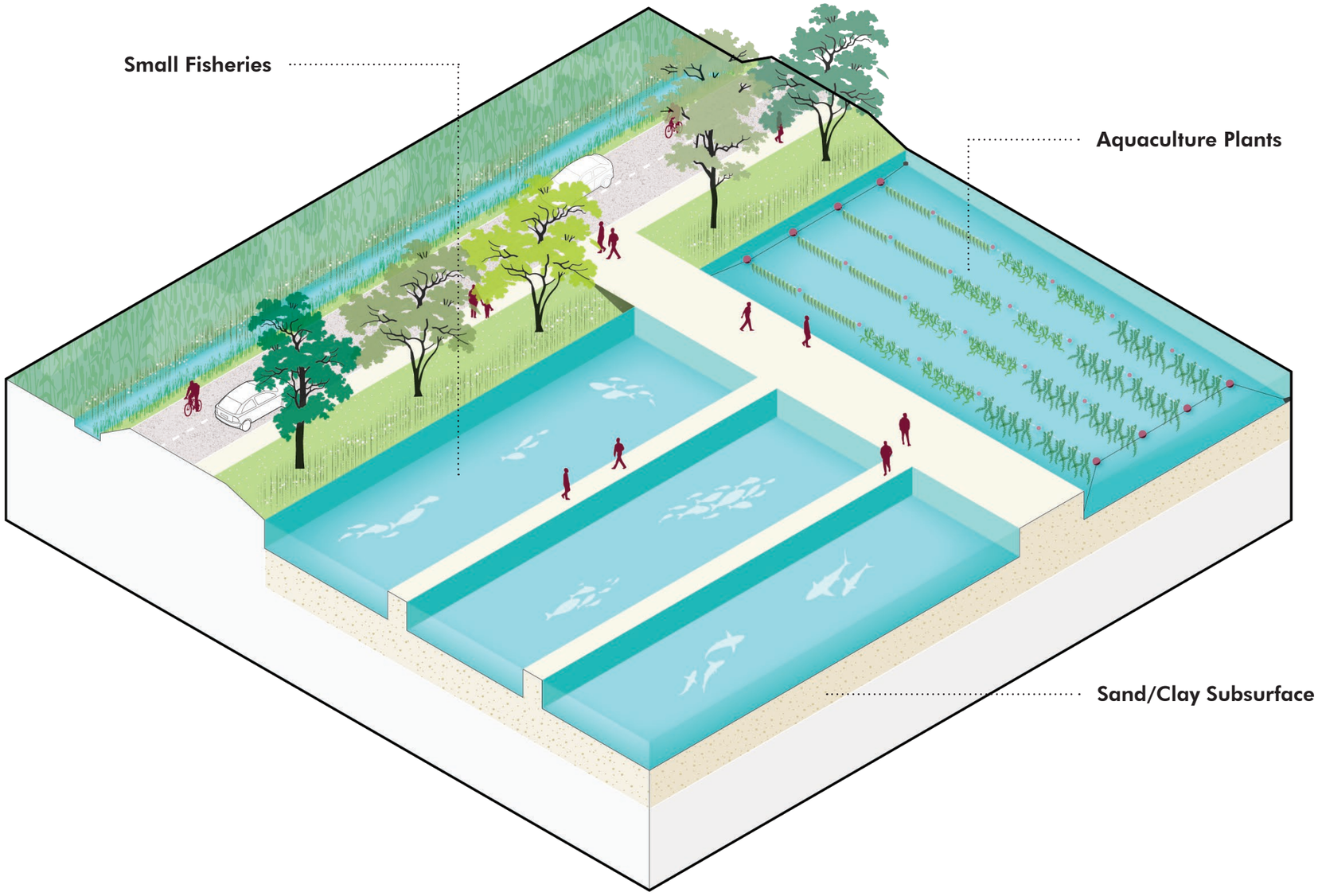
5.14 HYDROLOGY:
RAIN WATER STORAGE



5.14 HYDROLOGY:
GROUND WATER STORAGE

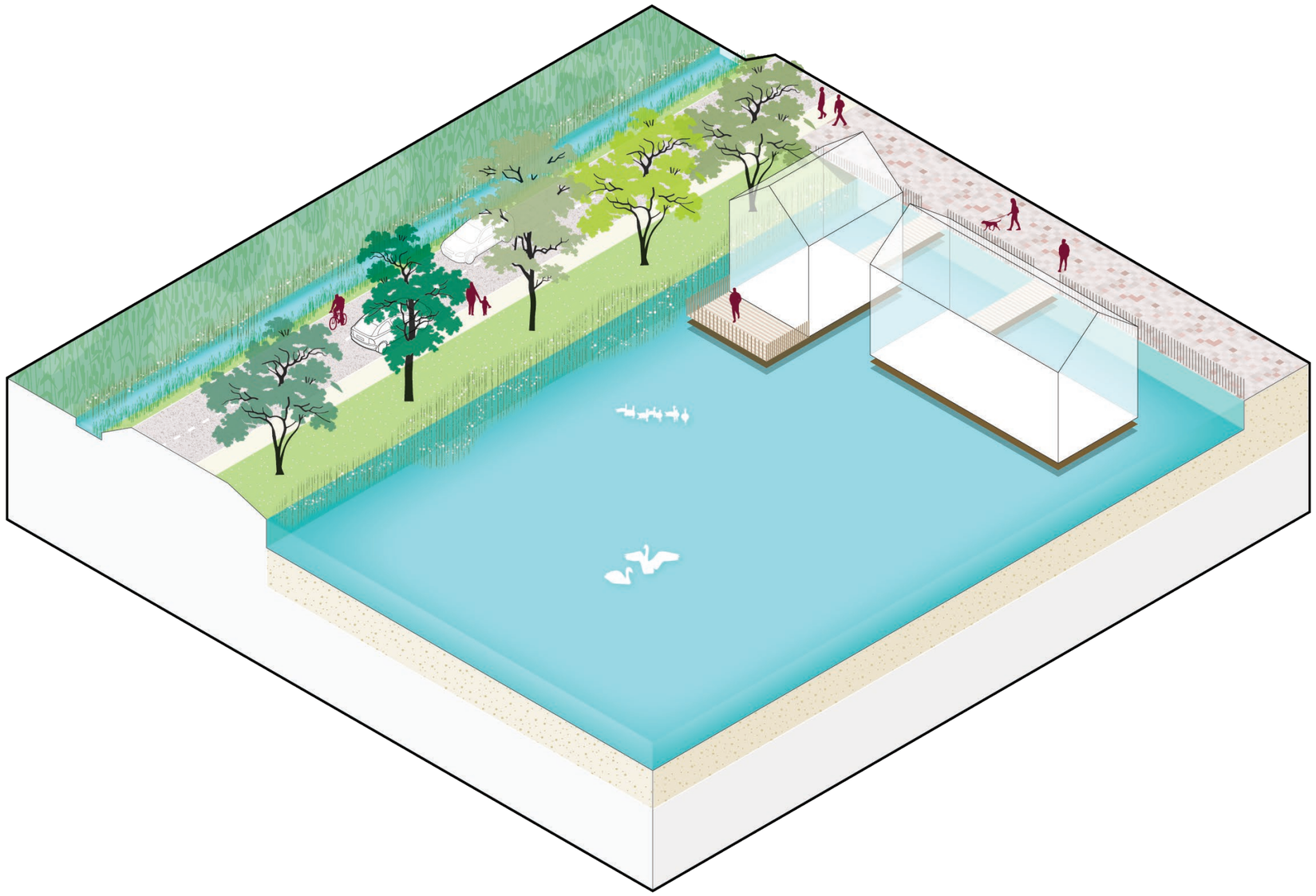


5.14 HYDROLOGY:
SURFACE WATER STORAGE

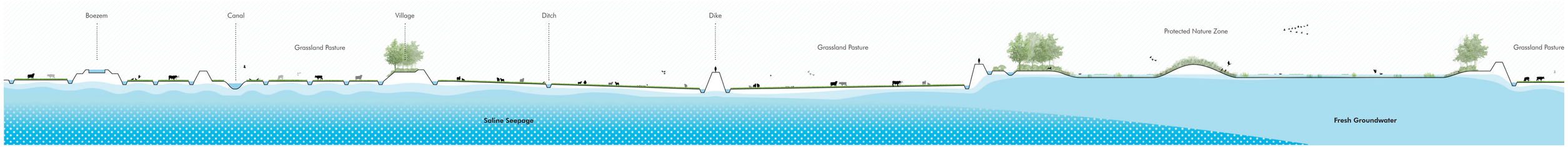


5.14 HYDROLOGY:
SURFACE WATER STORAGE

Storage Lake + Housing, Leisure, etc.



5.15 EXPANDING FRESHWATER THRESHOLD



Section A - A
Existing situation

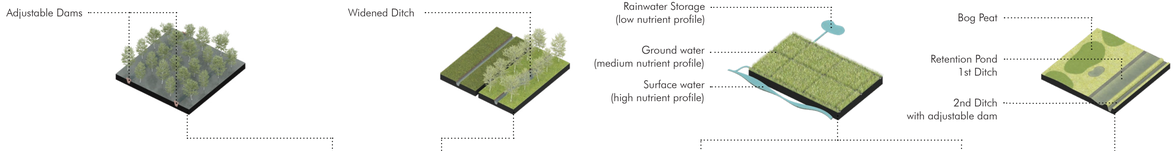
1:5,000

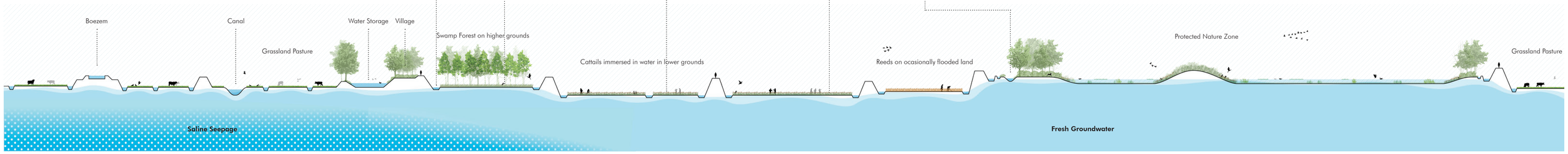
ADJUSTABLE DAM FOR TEMPORARY FLOODING

WIDENING THE DITCHES

ALL NUTRIENT PROFILES FOR CATTAILS

THE DOUBLE DITCH SYSTEM



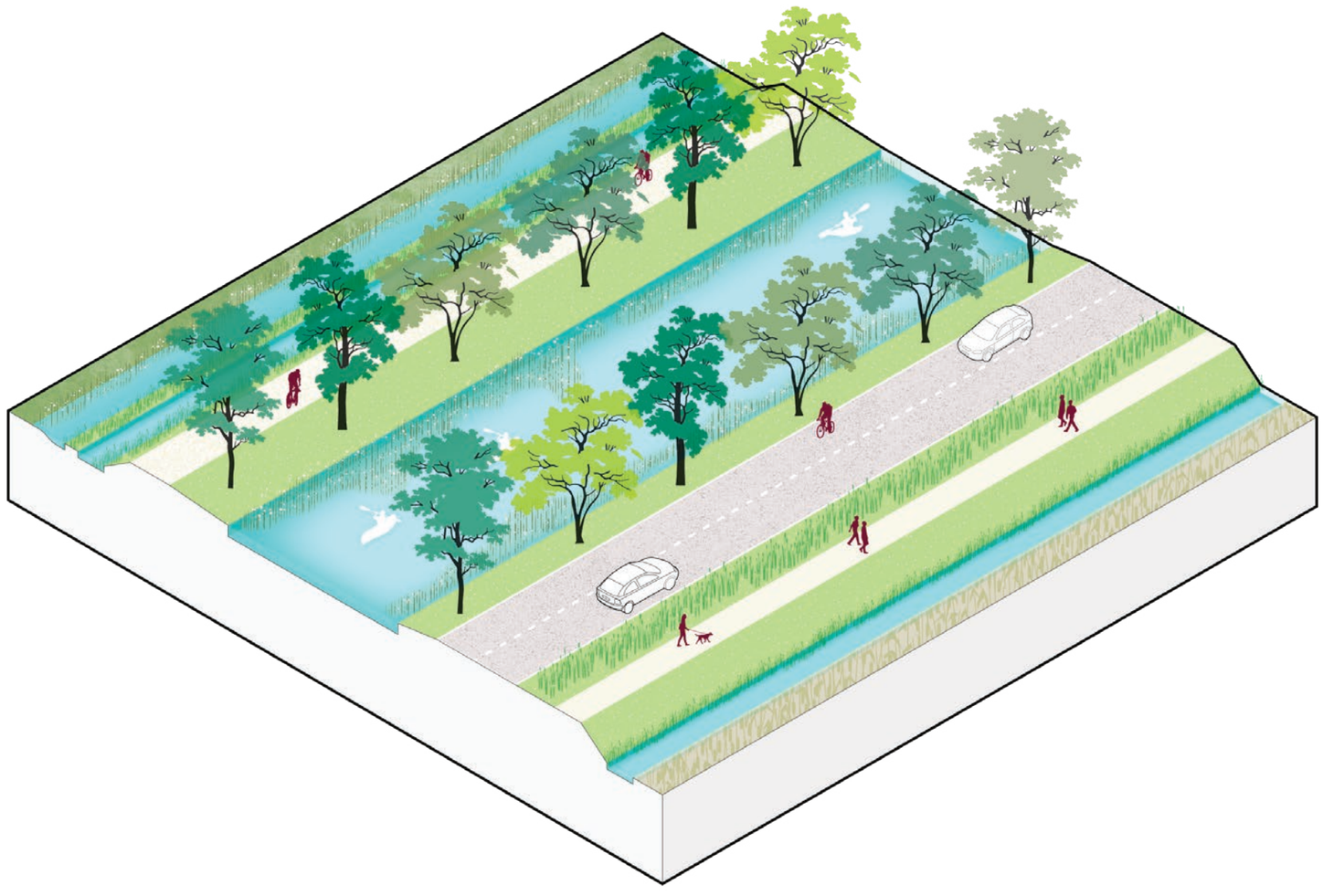


Section A - A
Design Proposal

1:5,000

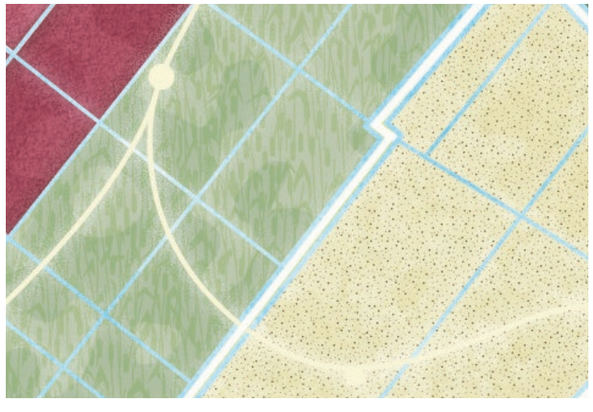
5.16 DIKE TYPOLOGIES:

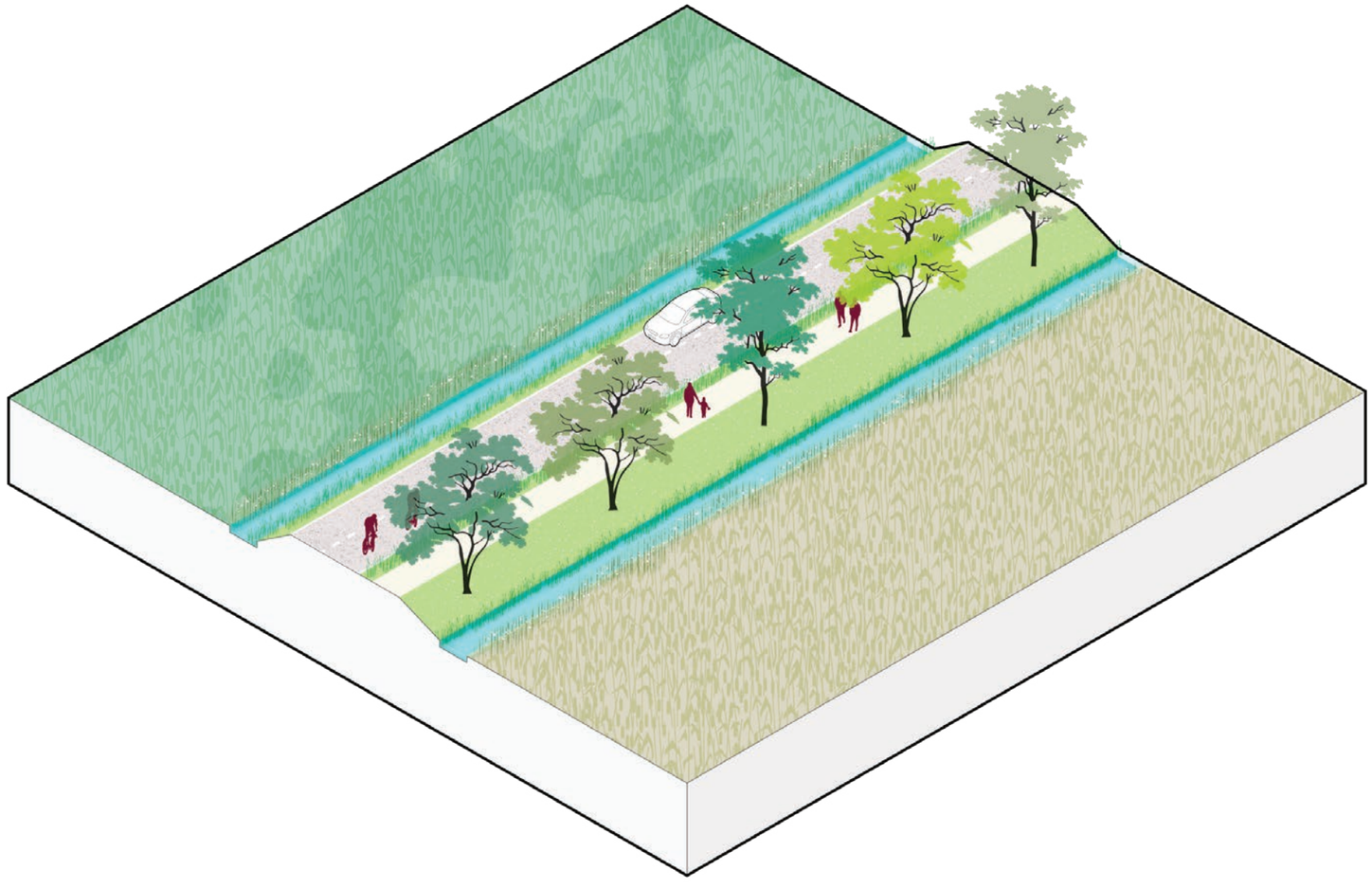
TYPE 1 - ALONG THE BOEZEM



5.16 DIKE TYPOLOGIES:

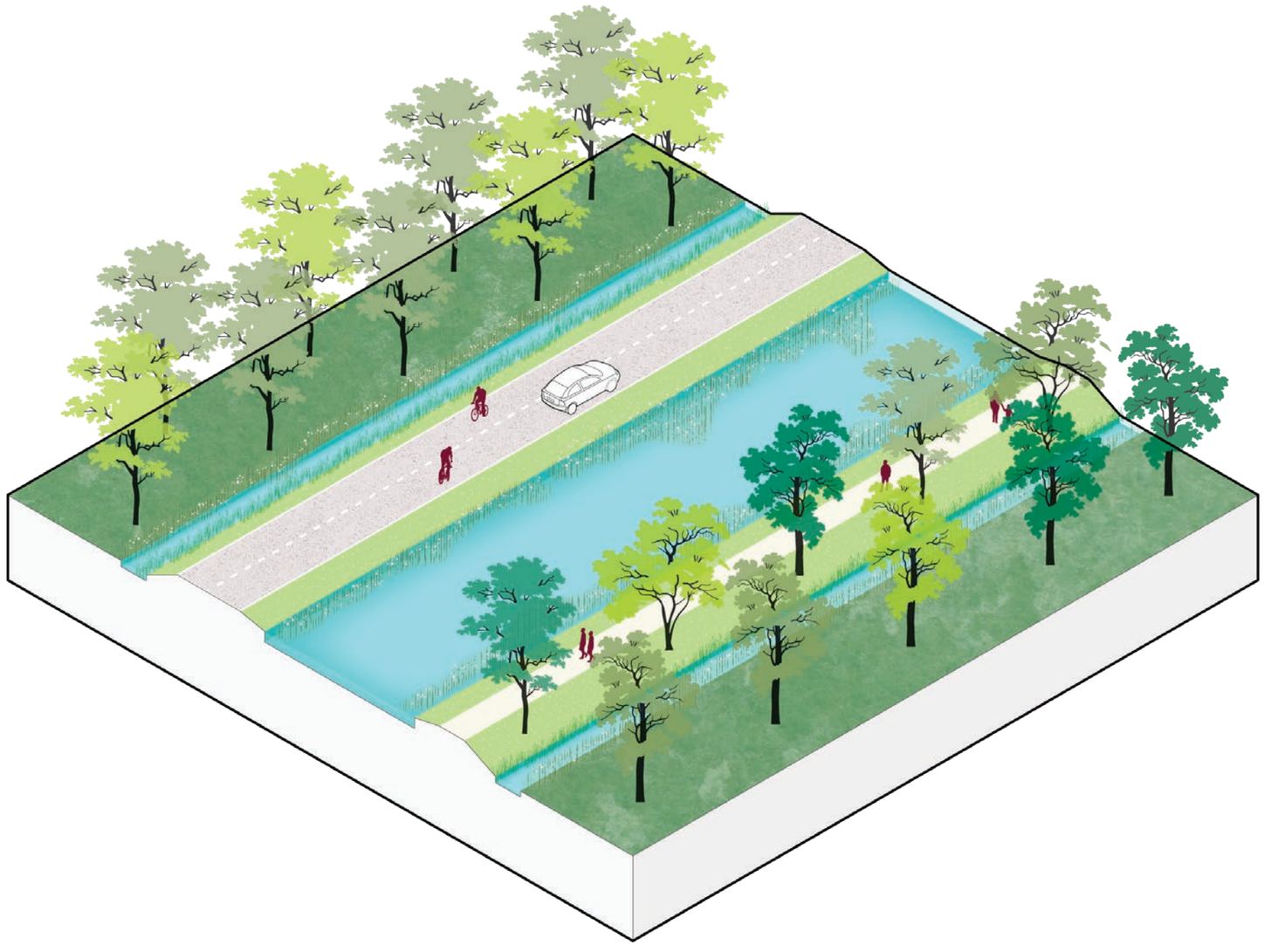
TYPE 2 - REGULAR DIKES





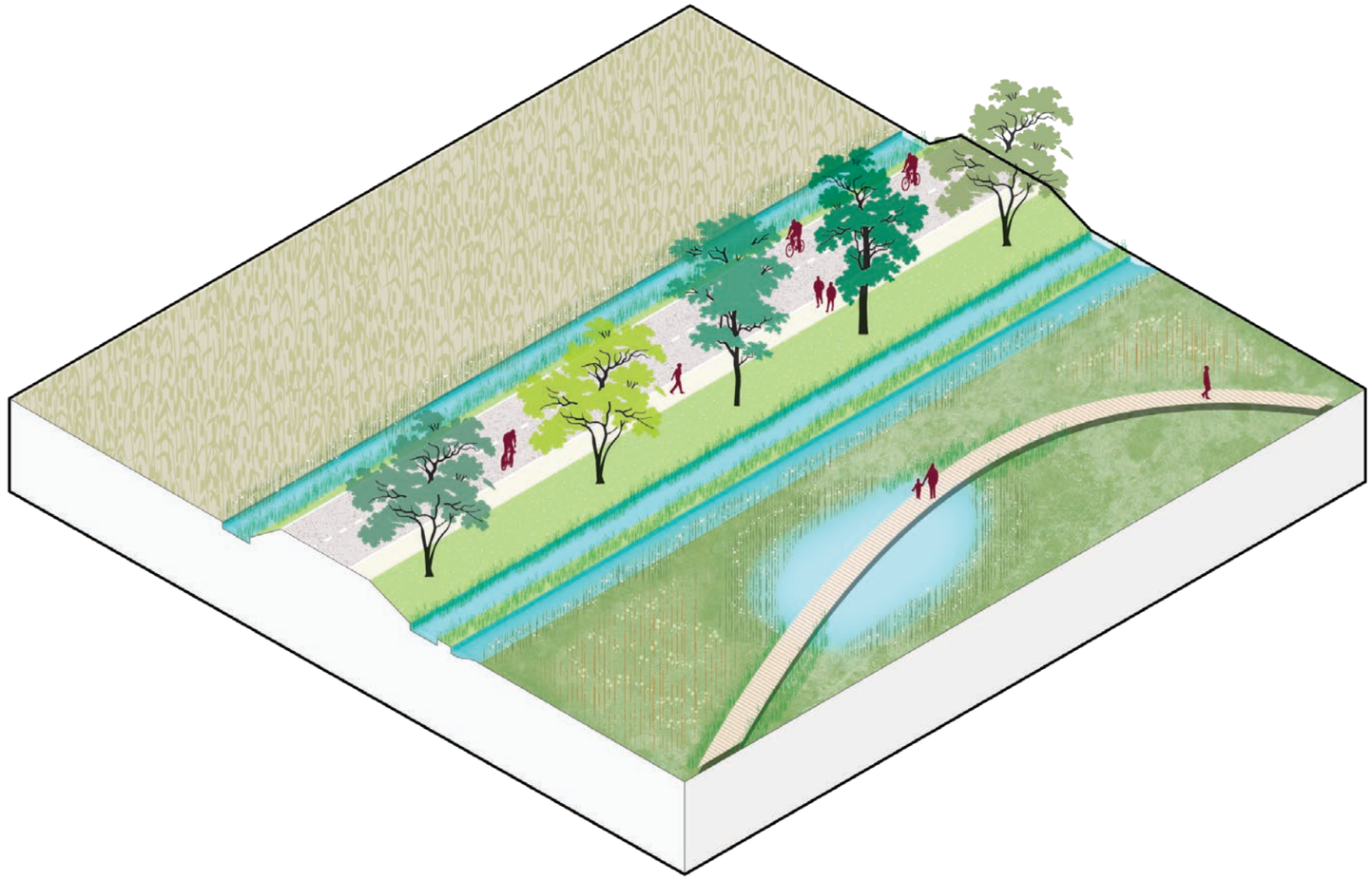
5.16 DIKE TYPOLOGIES:

TYPE 3 - WITH A MIDDLE CANAL



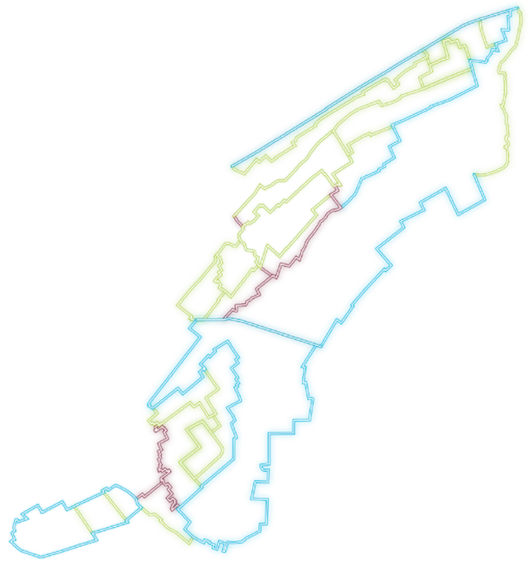
5.16 DIKE TYPOLOGIES:

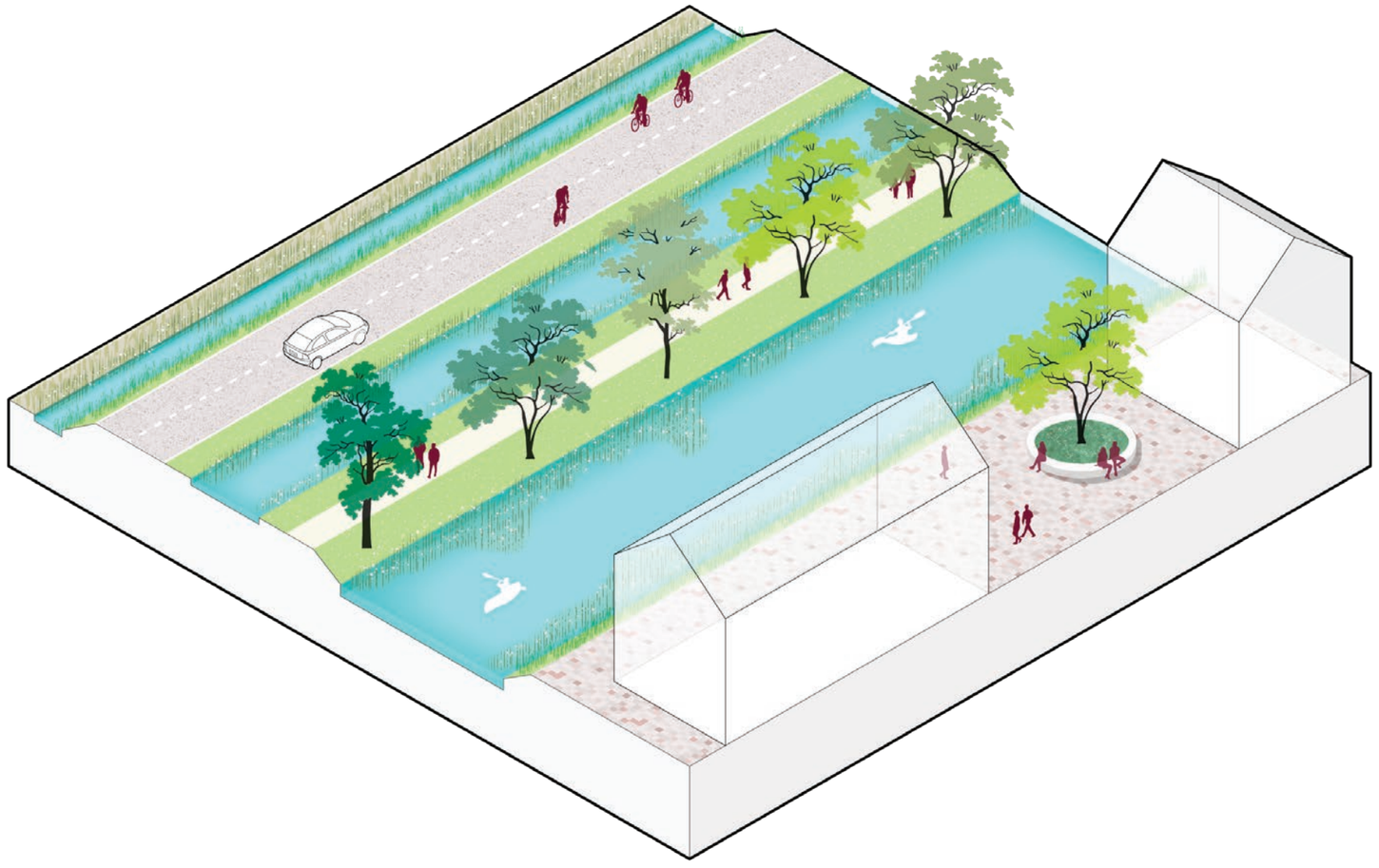
TYPE 4 - ON THE NATURE RESERVE BORDER



5.16 DIKE TYPOLOGIES:

TYPE 5 - ON THE SETTLEMENTS BORDER





5.17 SUCCESSION IN THE NEW NATURE

The new nature zone **reinforces** the existing protected raised bog area and **closes the gap between two main natural patches.**

This new zone focuses on **restoring the peat ecosystem.** However, unlike the existing protected area, it **offers a diverse palette of habitats of the lowland and highland peat meadow.**

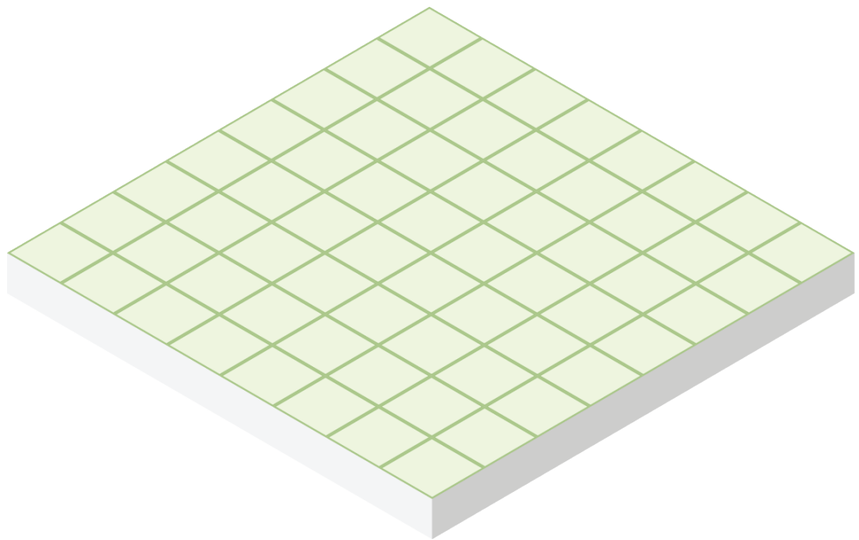
This is a shifting, **dynamic landscape** in which **sucession can be resetted** and experienced in all its stages. **It is a living labratory to be explored.**

Grazors (cows, sheep, and goats) are introduced from time to time to **maintain this dynamic.** Therefore, this land parcel maintains to some level its **agricultural productivity.**

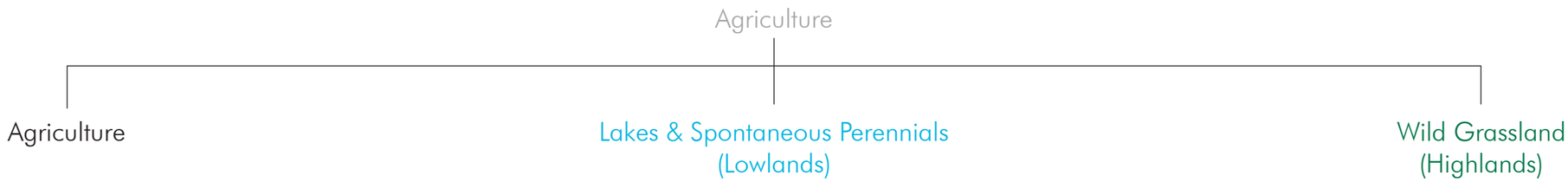
5.17 Ssuccession in the new nature

Agriculture

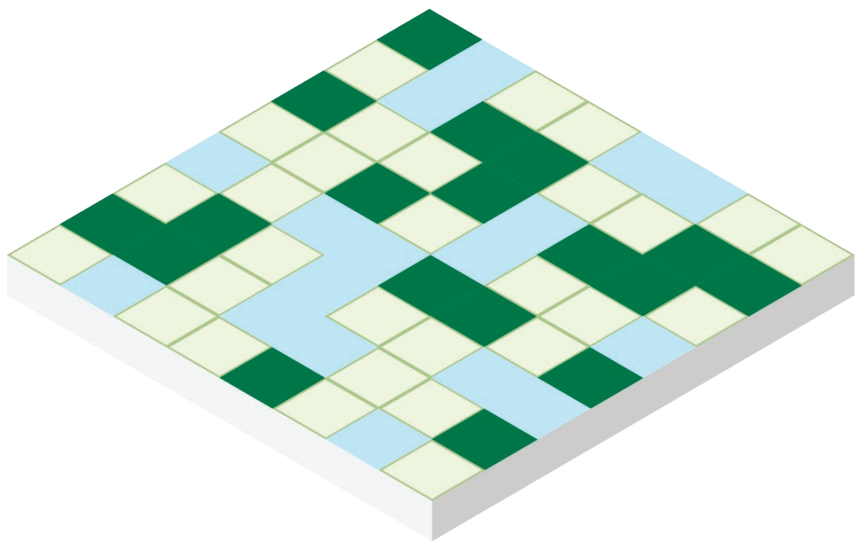
Parcel Diversity:
monoculture grass



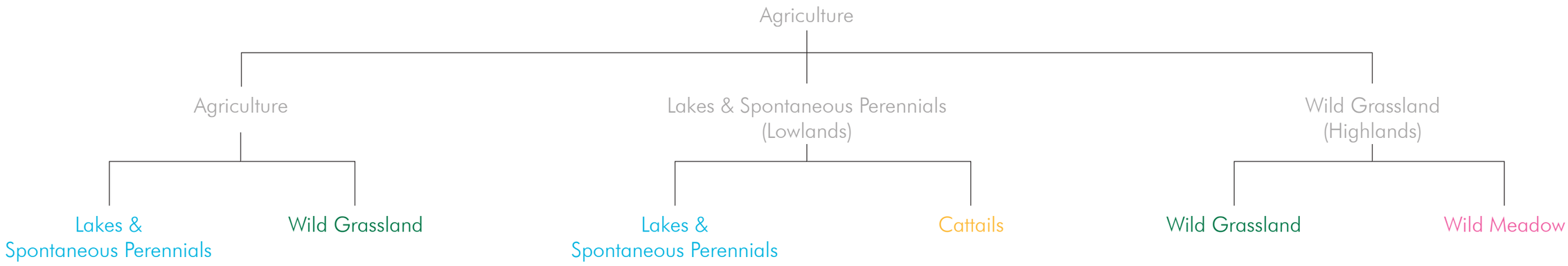
5.17 SUCCESSION IN THE NEW NATURE



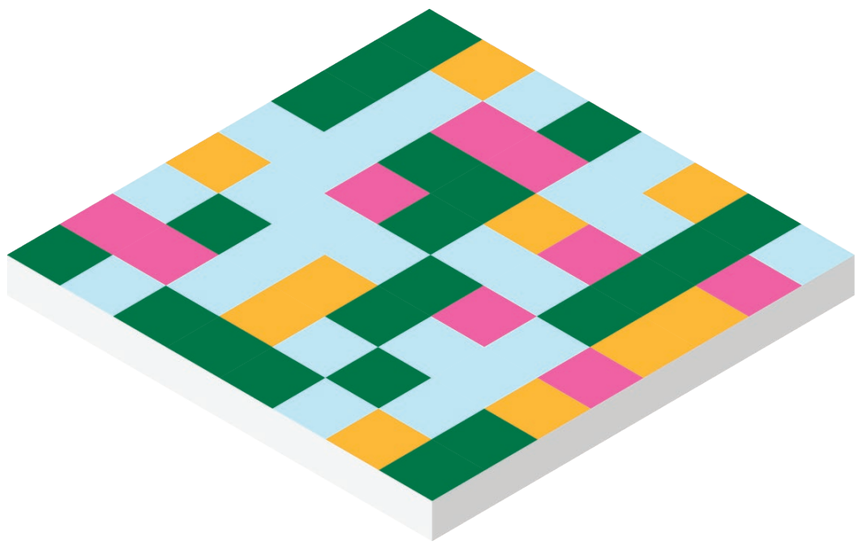
Parcel Diversity: 3



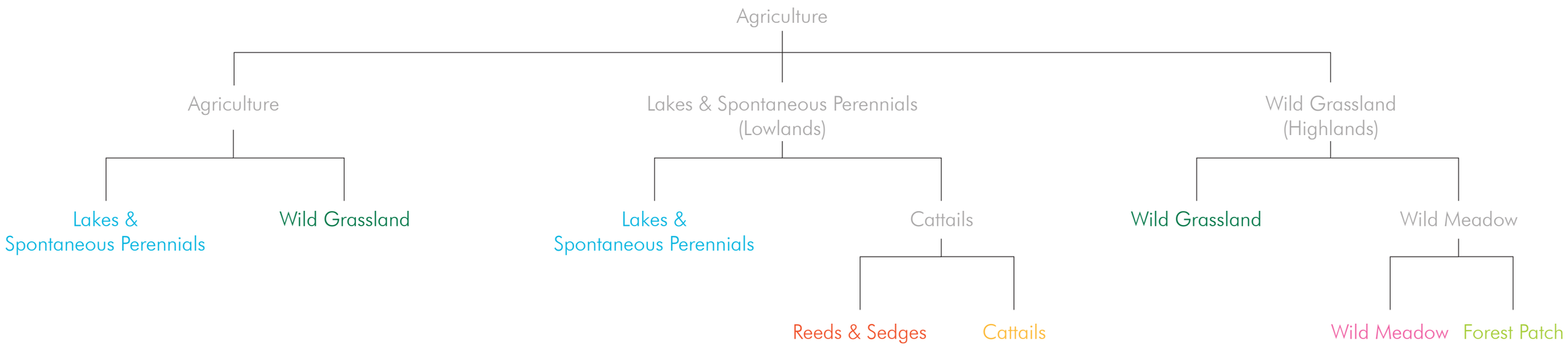
5.17 SUCCESSION IN THE NEW NATURE



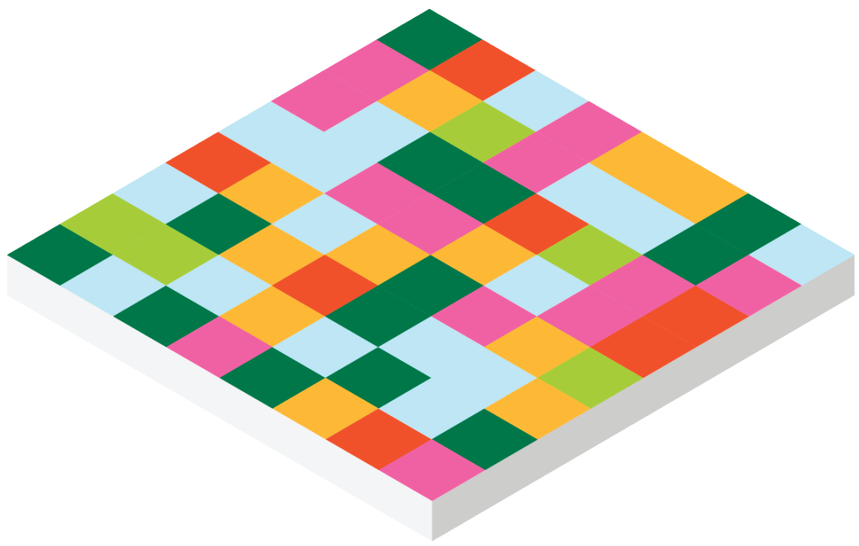
Parcel Diversity: 4



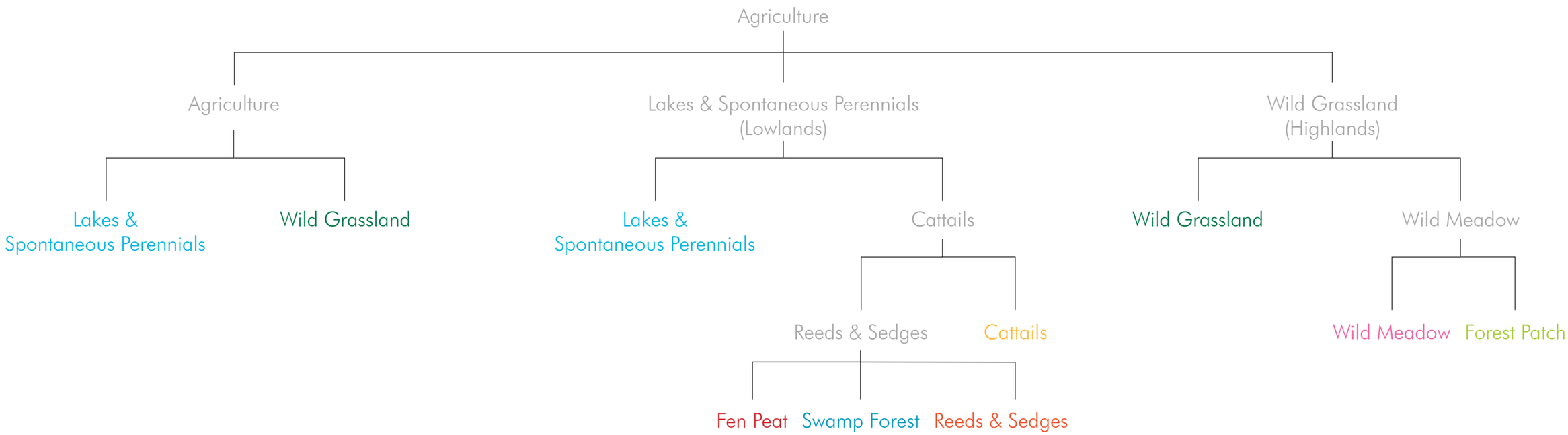
5.17 SUCCESSION IN THE NEW NATURE



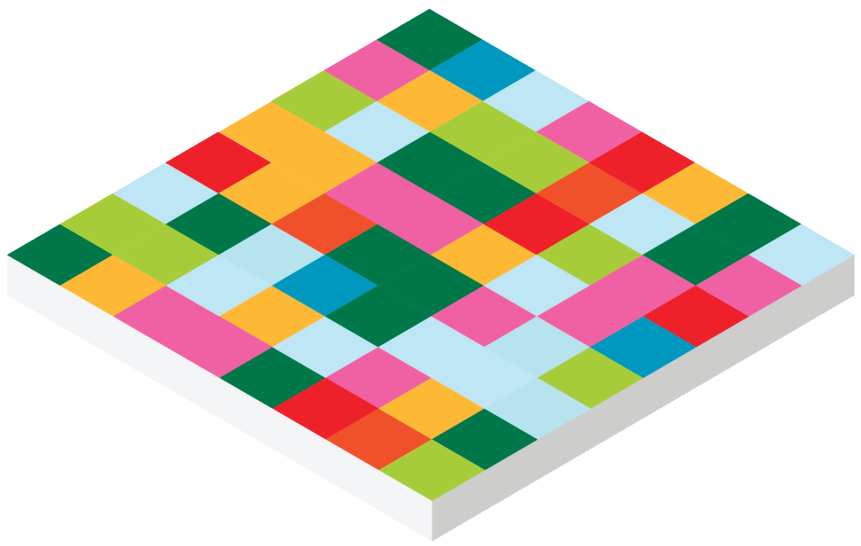
Parcel Diversity: 6



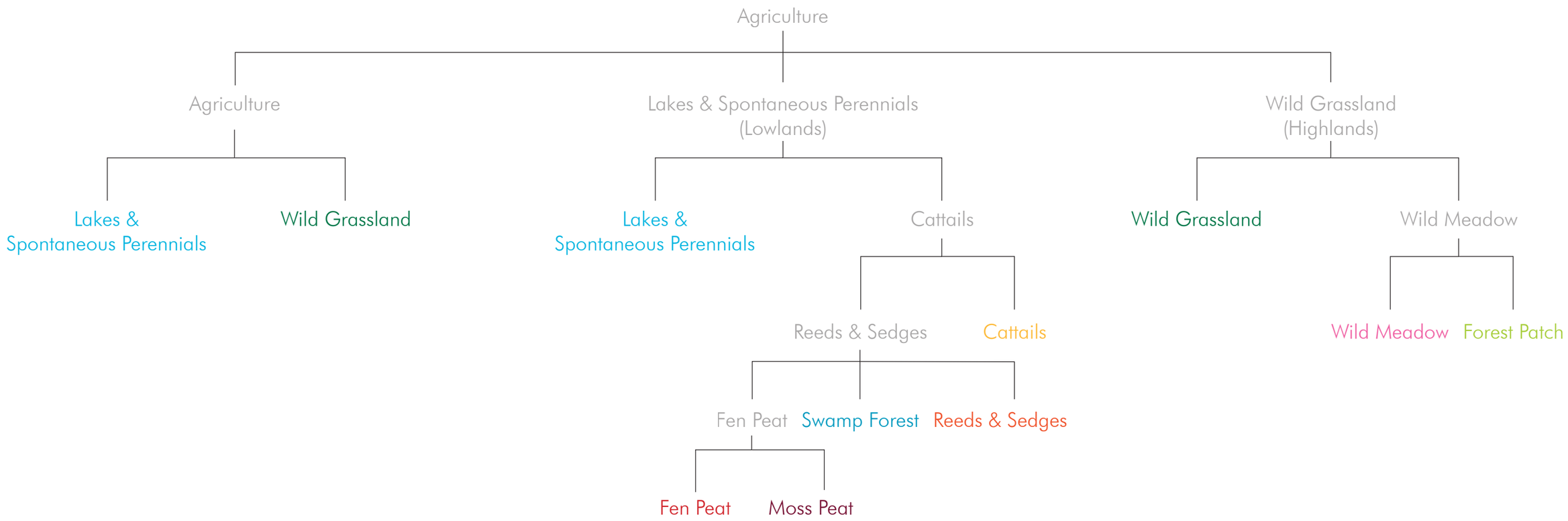
5.17 SUCCESSION IN THE NEW NATURE



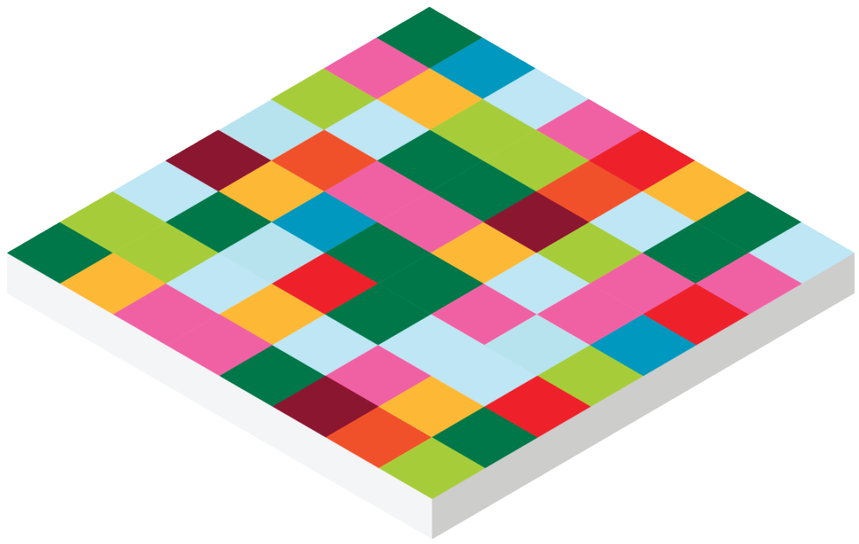
Parcel Diversity: 8



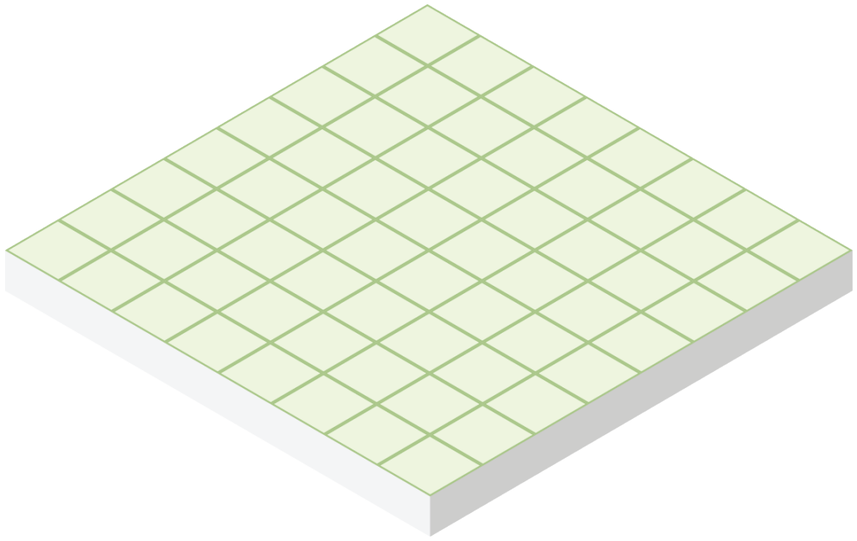
5.17 SUCCESSION IN THE NEW NATURE



Parcel Diversity: 9

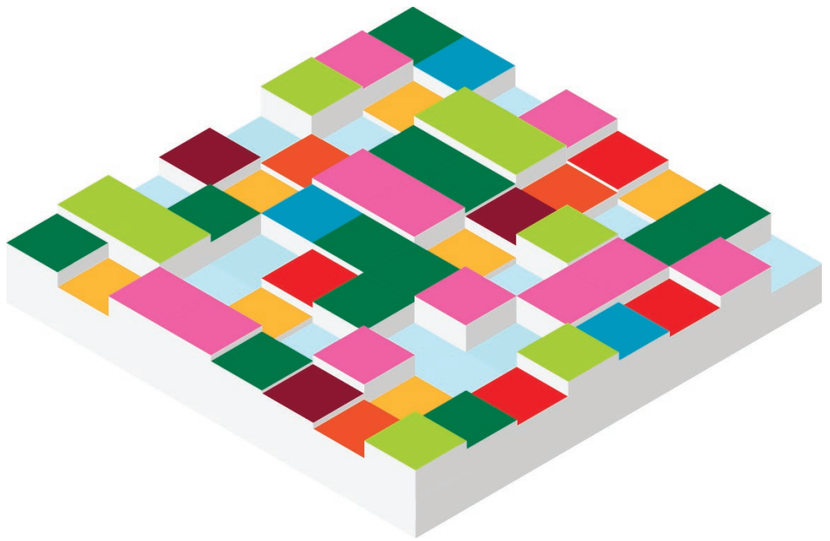


5.17 SUCCESSION IN THE NEW NATURE



Grassland Pasture

Monoculture
Mono-functional
Flat



Nature Zone & Natural Succession

Diverse Patches
Multi-functional
Changing Topography

5.18 A DETAILED FRAME

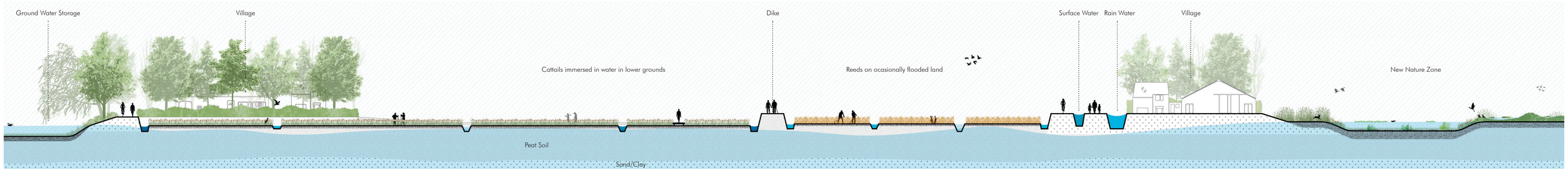
LEGEND

- Cattails, Bluegrass
- Cranberries
- Reeds, Sedges
- Willow, Alder, Birch Trees
- New Nature Zone
- Protected Nature Area
- Water Storages
- Wooden Field Paths & Platforms

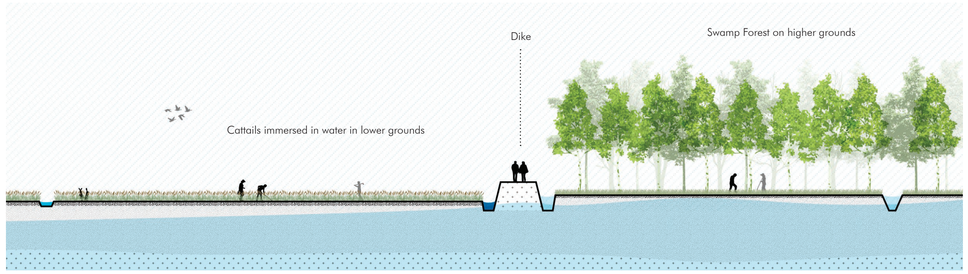
N

1:15,000

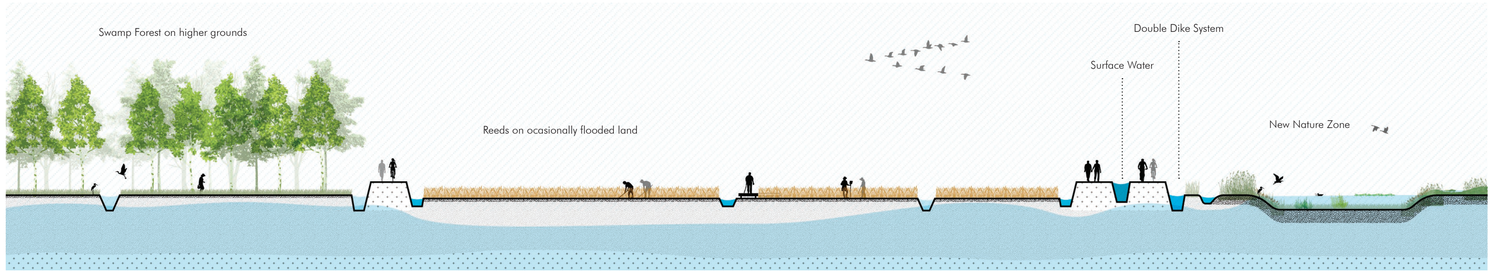
5.19 SECTIONS



Section B - B **1:2,000**



Section B - B **1:2,000**



Section C - C **1:2,000**

5.20 IMPRESSIONS

Kids wandering throuh the wooden path and platform

5.20 IMPRESSIONS

A farmer harvesting the reeds

5.20 IMPRESSIONS

Exploring the new nature park

5.20 IMPRESSIONS

Harvesting the cranberries,
swamp forest on the horizon

Thank you.