POLITECNICO
MILANO 1863

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THE GREEN HEART OF GRONINGEN

Regeneration of Groningen's Peat Landscape
With a Focus on Water Management and Agriculture

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1.1 ABOUT PEAT AND PEAT LANDSCAPES

Peat soil is made up of **partially decomposed organic matter,** mostly dead plants, under waterlogged conditions. **Oxygen and nutrient deficiency, high acidity, and constant waterlogged conditions** are necessary for formation of peat.

The term "peatland" refers to the peat soil and the wetland habitats growing on the surface. **Peatlands mitigate flooding and drought, reduce the risk of fire, ensure clean drinking water, and host an astonishing biodiversity.**

Peatlands are significant archaeological and paleo-environmental archives as well. They hold records of past vegetation, climate, and artefacts from previous human societies.

Sphagnum Plant or Peat Moss

1.2 PEAT FORMATION

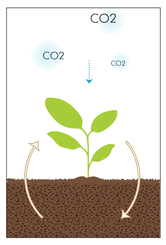
Peat froms through **terrestrialisation: a form of succession which means infilling of water by plants.**

In the terrestrialization process, **the system goes from a relatively nutrient rich environment with low pH, to a nutrient poor environment with higher pH**, which host specialized species.

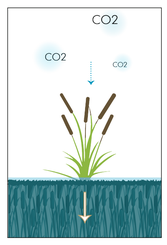
Peat bogs regulate their own hydrology and are called **ecosystem engineers**. They act like **sponges** and **retain water** from cell level to plant level to ecosystem level, **some times up to 30 to 40 times of their own weight.**

Peat is a major **carbon sink** in its natural state and has **no closed nutrient cycle** under permanent waterlogged conditions. Therefore, peatlands have a unique capacity for **long-term carbon sequestration.**

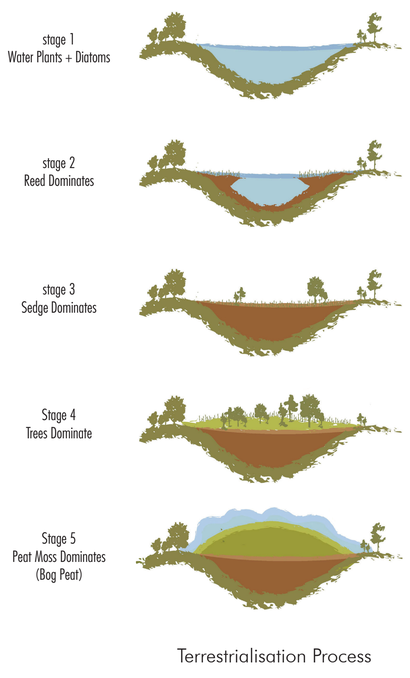
However, **extracting, burning, and draining** the peat turn it into a huge **carbon emitter**, as the stored carbon is released.



Closed Nutrient Cycle



Open Nutrient Cycle
of Peat (Carbon Sink)



Terrestrialisation Process

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

1.3 LAND RECLAMATION & PEAT POLDERS

In the Netherlands peat was used for two main reasons:
1. Peat excavation for burning as fuel
2. Draining the peat for agriculture

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.**

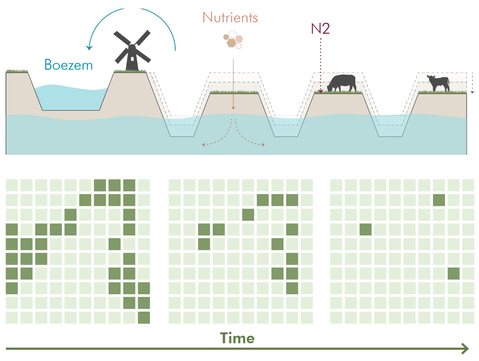
The distinguished polder landscapes of Netherlands are formed as a result of peat extraction. A **polder** is:
- an enclosed land
- with controlled water levels
- in which the ratio between wet and dry can be decided

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

1.4 MAIN PROBLEMS IN THE SITE

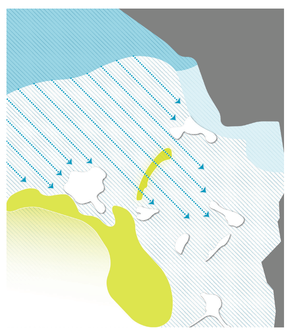
GENERAL PROBLEMS RELATED TO PEAT:

1. Land subsidence as a result of constant drainage
2. Nutrient overloading of the soil (N2, fertilizers)
3. Becoming too isolated



SITE-SPECIFIC PROBLEMS:

4. Saline water seepage from the North Sea

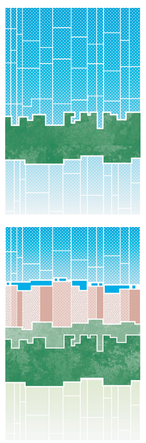


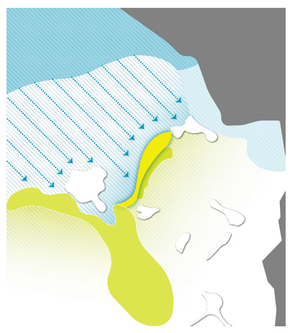
1.5 THE CONCEPT AND AIMS

According to the main challenge of soil salinity in Groningen under the influence of the North Sea, the concept is to create **defence layers to push back the saline water** by utilizing the potentials of paludiculture (wet agriculture).

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.

this approach **maintains the productivity of the landscape** and preserves the integrity of **polders**, by using them as the **main building blocks** in the design to form the salinity shield.





Salinity Shield
(Closing the Nature/Peat Gap)

Existing Situation vs.
Productive Defence Layers

1.6 PEAT; THE SHRINKING GOLD

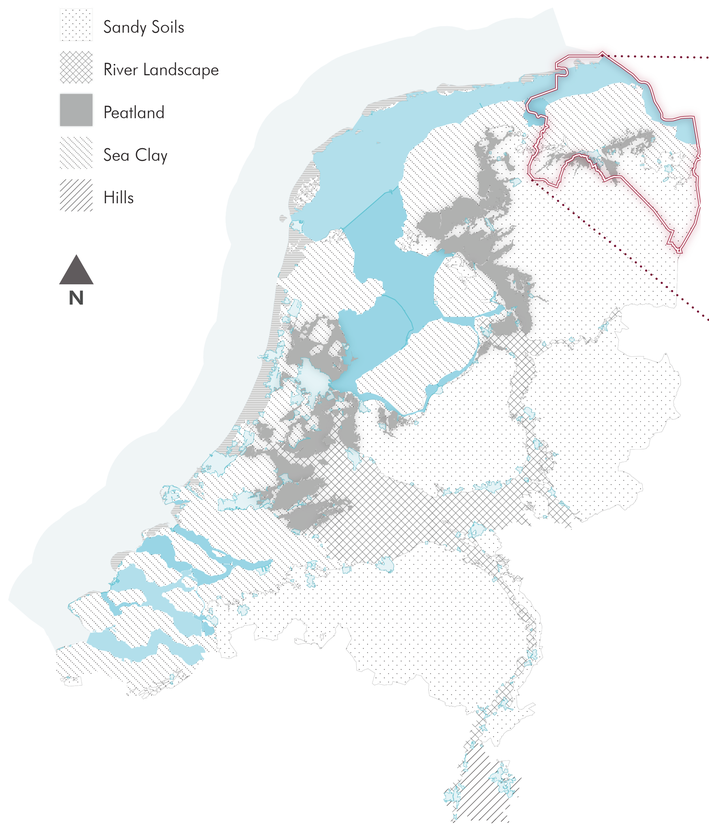
LEGEND

- North Sea
- Tidal Area
- Enclosed Estuaries
- Inland Water Bodies
- Sand Dunes
- Sandy Soils
- River Landscape
- Peatland
- Sea Clay
- Hills

N

This map shows all the landscape types that make up the Netherlands.

The dark grey region shows the peat soil. **An estimated 90% of the original raised bogs have now dissapeared as the reult of drainage for farming and peat extraction.**



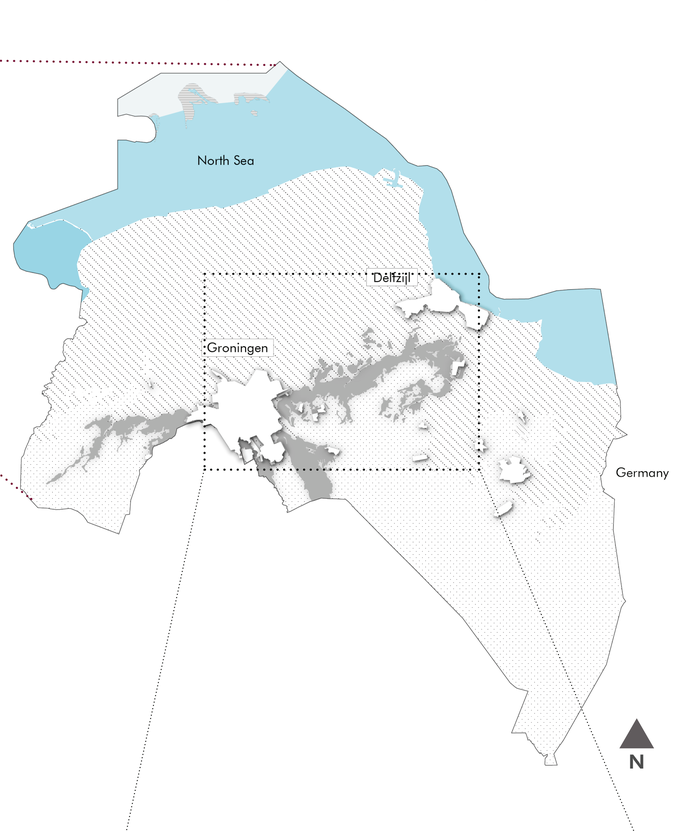
1.7 PEAT; THE SHRINKING GOLD

The landscape composition of the province of groningen is made of:

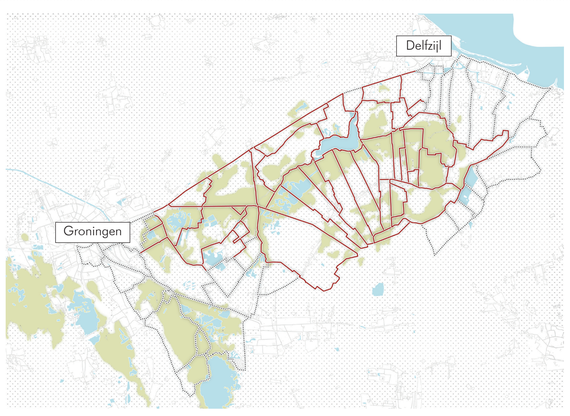
- Marine clay deposits in the north
- Sandy soils to the south
- Peat soil in the middle, particularly in the distance between Groningen and Delfzijl.

This strech of peat soil is the last remnant of a vast peat landscape.
In fact, nowadays most of Groningen lies under sea level and facing major challenges from the rising waters, wheres in the past it used to be several meters higher than the sea level most of it was covered in bogs.

This design seeks to take advantage of the immense water retaining capability and flood resistency of the peat to solve the saline intrusion, and preserve and regenerate the peat in an economically feasible way.

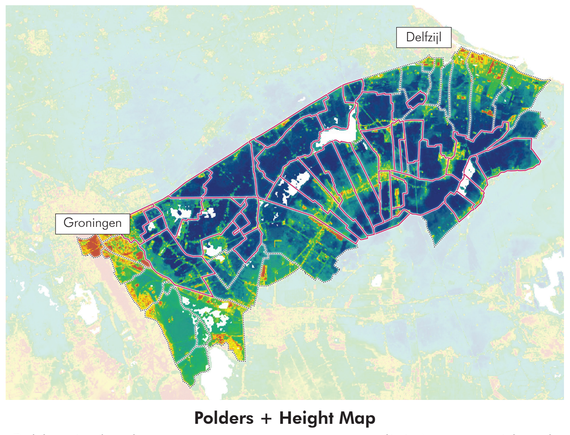


1.8 DEFINING PROJECT PERIMETERS

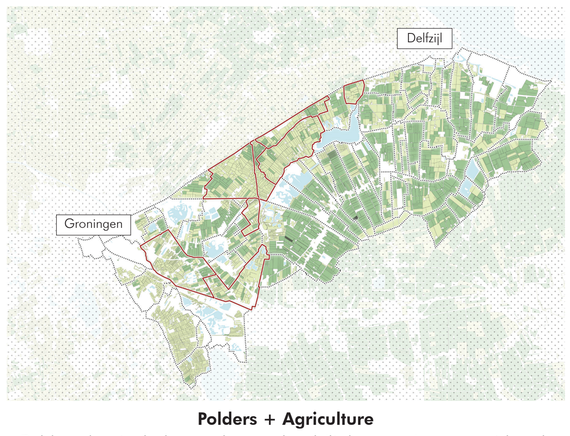


Polders + Peat Soil
Polders that include the existing peat soil are considered.

Polders + Nature Network
Polders that can close the gap between nature areas are considered.



Polders + Height Map
Polders in the deepest areas (most prone to salinity) are considered.



Polders + Agriculture
Polders that include mostly grassland (light green) are considered.

1.9 TRANSLATING THE CONCEPT TO THE LANDSCAPE

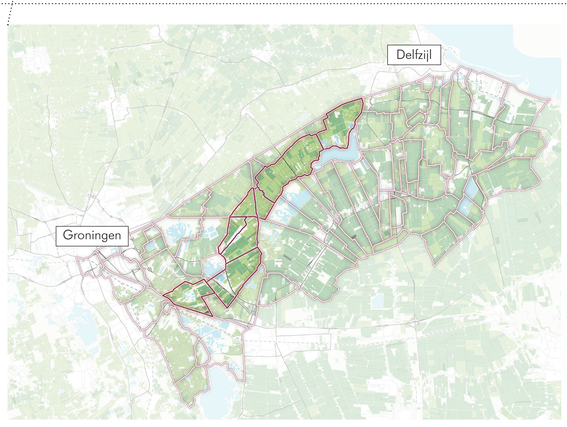
In following logical steps in this project, the site perimeters need to be defined by the many layers that constitue the landscape and affect it. **Reasonable connection needs to be found to scale down the site from the entire polder landscape on peat to several polders in total.**

The first step is to identify **polders that are on existing peat remnants**, as the aim is to utilize this peat.

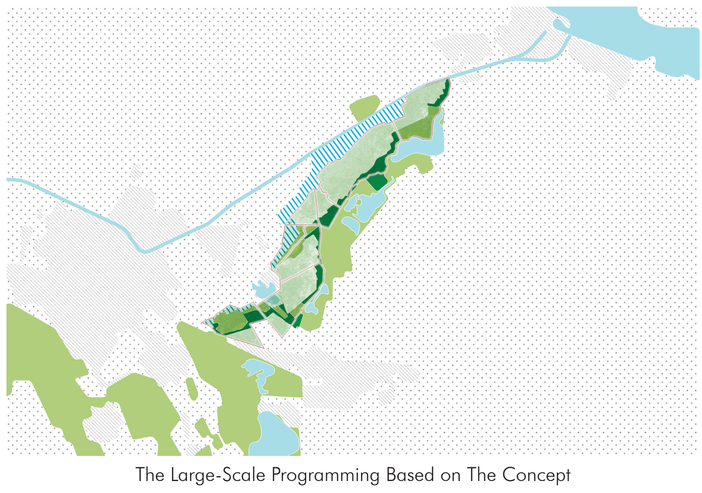
Then, it is important to **re-connect the main nature bodies** and close the gap, to **prevent salinity** and create an **ecological corridor** as well.

Next, the **most prone areas to salinity** have to be addressed, which are the **deepest zones** in the area.

Finally, maintaining land productivity means replacing the monoculture of grasslands (dairy farming), with **paludiculture - that are in fact other, more diverse and flood resilient grasses.** Therefore, the **grass is replaced with grass**, and no arable lands (dark green areas) are compromised.



Defined Project Area as the result of Synthesis



The Large-Scale Programming Based on The Concept

Connecting Nature/Peat Soils

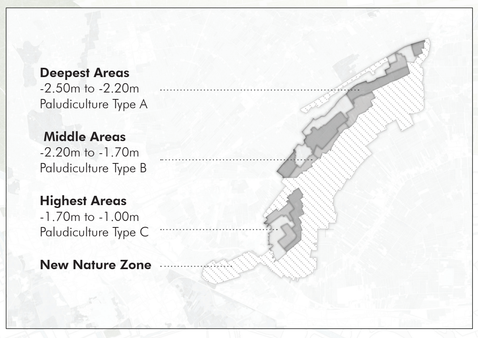
Productive Layers

Salinity Shield

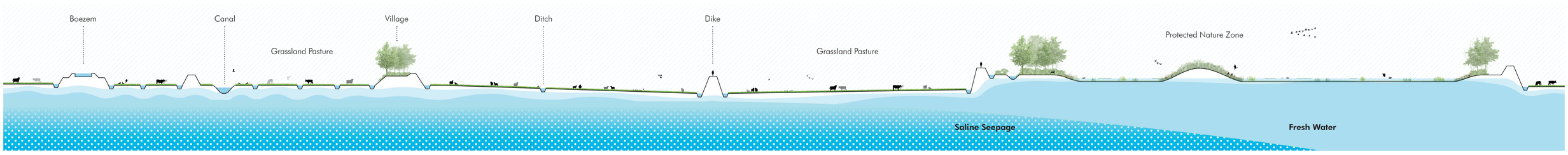
2.1 THE LANDSCAPE MASTERPLAN

In the landscape masterplan, the denfence layers of water reserves, paludiculture, and new nature zone can be seen respectively. **The many freshwater reserves on the northern edge, create a counter pressure on the saline water, pushing it more inwards to the ground.**

The second defence layer is the **paludiculture zone. This zone is divided into 3 sub-zones based on the height map.** In the lowest areas the cattail family is cultivated that has the highest rate of peat formation. In the middle areas reeds and sedges are cultivated that are exposed to occasional flooding. On the highest grounds, swamp forests emerge with willow, birch, and alder trees. This forest is flooded manually from time to time and some lower segments are filled with water permanently.



2.2 SECTIONS - EXPANDING THE FRESHWATER THRESHOLD



Section A - A
existing situation

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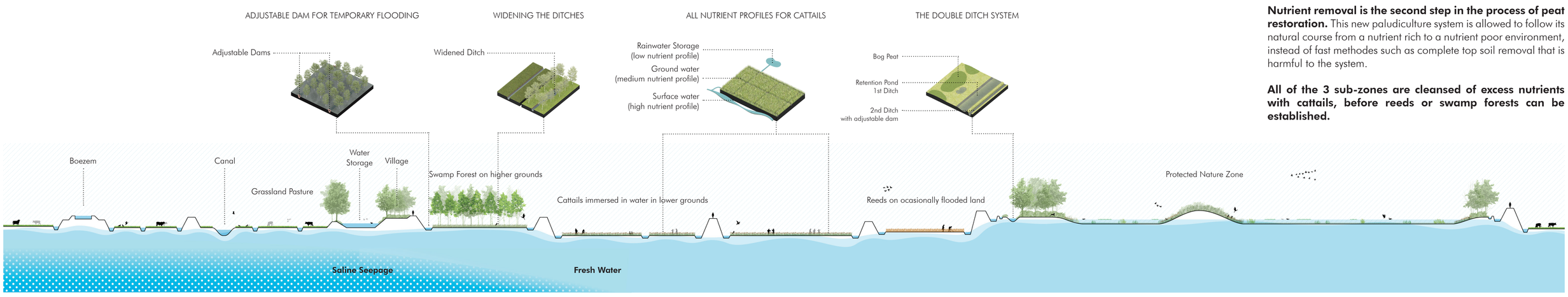

Section A - A
design proposal

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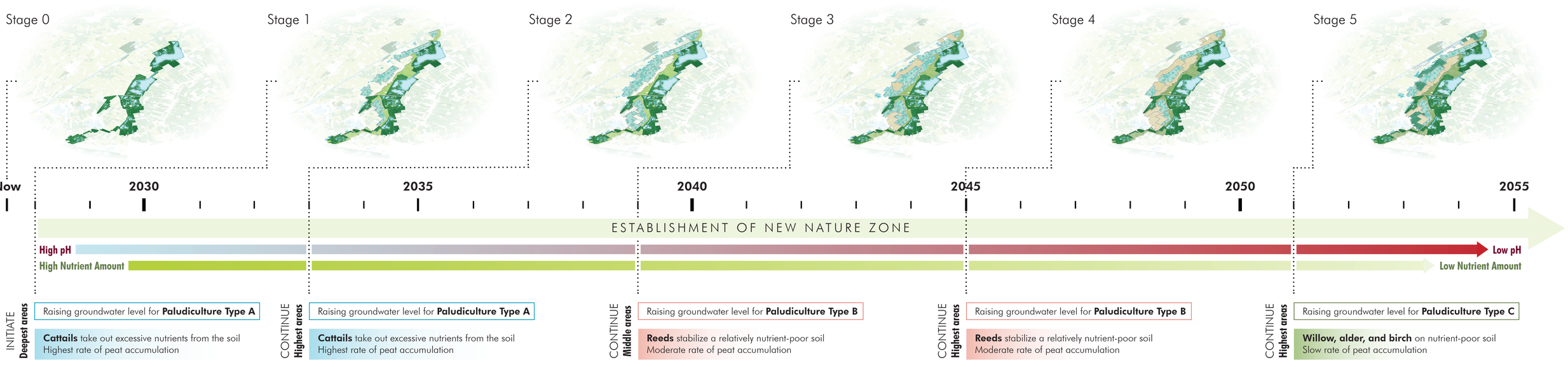
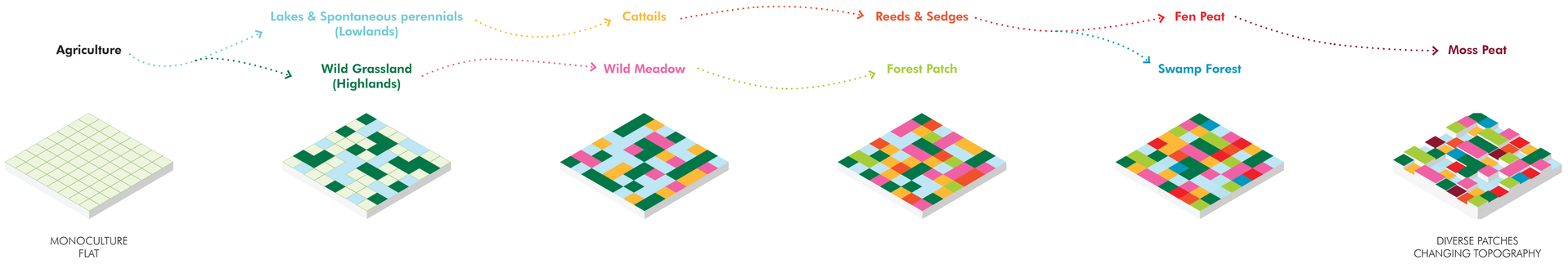
Nutrient removal is the second step in the process of peat restoration. This new paludiculture system is allowed to follow its natural course from a nutrient rich to a nutrient poor environment, instead of fast methodes such as complete top soil removal that is harmful to the system.

All of the 3 sub-zones are cleansed of excess nutrients with cattails, before reeds or swamp forests can be established.

2.3 PROJECT PHASES: DEVELOPMENT OF PALUDICULTURE



2.4 SUCCESSION IN THE NEW NATURE ZONE



In the new nature zone, a palette of various vegetation and habitats emerges. This piece of land goes **from a monoculture and flat grassland that is used only for grazing, to a land with multiple habitat types and vegetatitve cover as well as a changing topography.** This new nature promotes biodiversity and can host tourists, as well as occasional grazors that are introduced to reset succession in some areas and keep the landscape diversity.

For this area there is no definite layout or design, rather a set of possibilities and an everchanging composition that can be guided in a process.

3.1 SOME IMPRESSION FRAMES

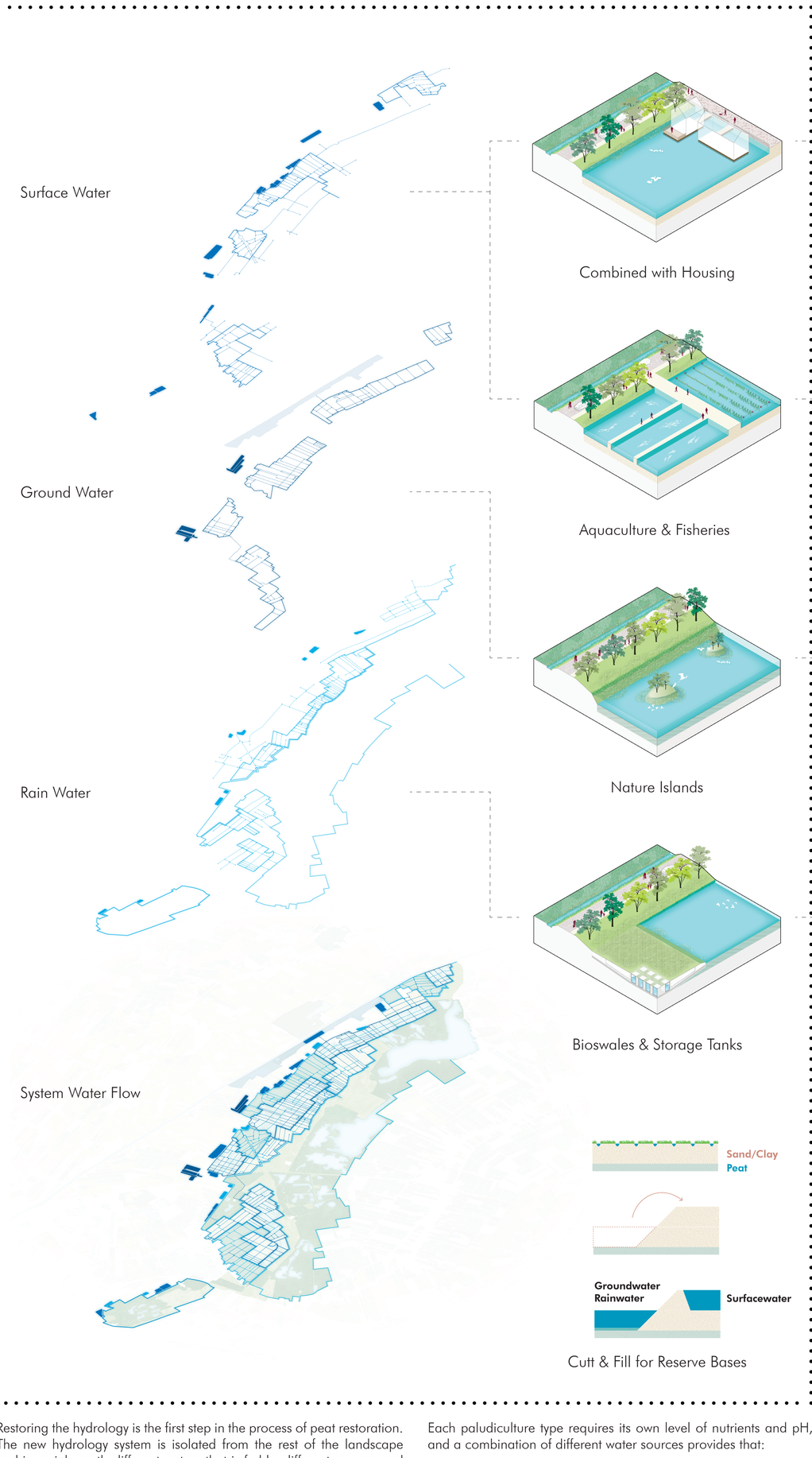
● Wooden Path and Platform in the Fields

● A Farmer Harvesting the Reeds

● Harvesting the Cranberries, Swamp Forest on the Horizon

● Exploring the New Nature Park

3.2 HYDROLOGY: WATER FLOWS & WATER RESERVES



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 fed by different sources and has different nutritional profiles and pH. These water storages compose the first defence layer against saline intrusion, and support all the other layers:

- Surface Water (Rivers, Canals): Highest nutrient amount, lowest pH **(7.4)**
- Ground Water: Medium nutrient amount, medium pH **(7.4 to 6.0)**
- Rain Water: Lowest nutrient amount, lowest pH **(5.5 to 5.0)**

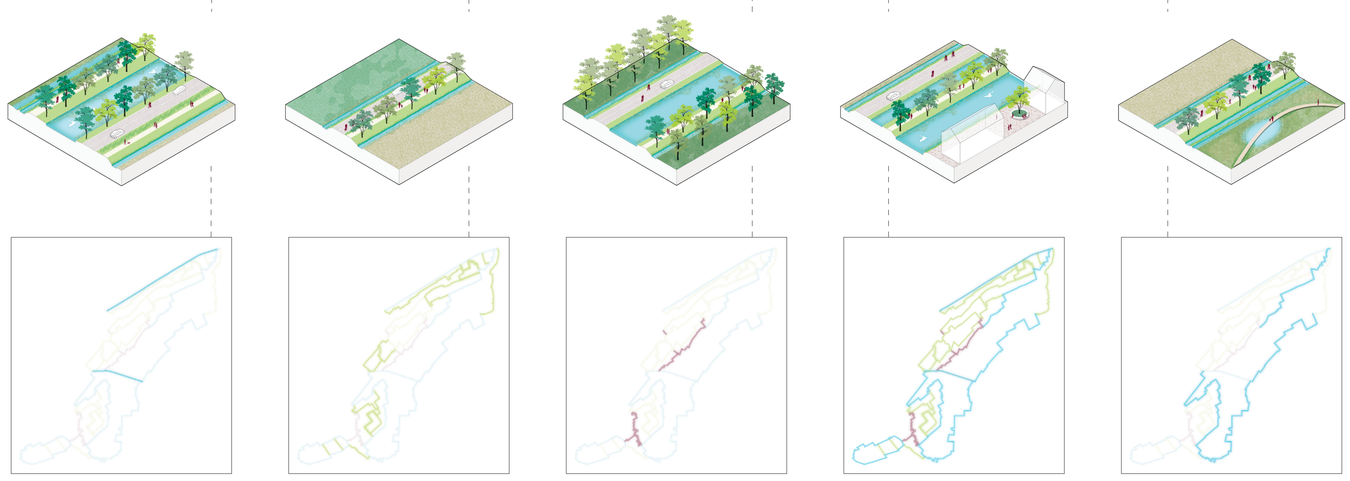
Each paludiculture type requires its own level of nutrients and pH, and a combination of different water sources provides that:

Paludiculture Type 1 (Cattails, Cranberries): Surface + Ground + Rain waters
Paludiculture Type 2 (Reeds, Sedges): Ground + Rain waters
Paludiculture Type 3 (Willows, Alder, Birch): Rain water

The existing sand and clay soils are removed to reach the peat for the base of ground and rain water, to help the peat to build up.
The removed sand and clay are used for the base of surface water.

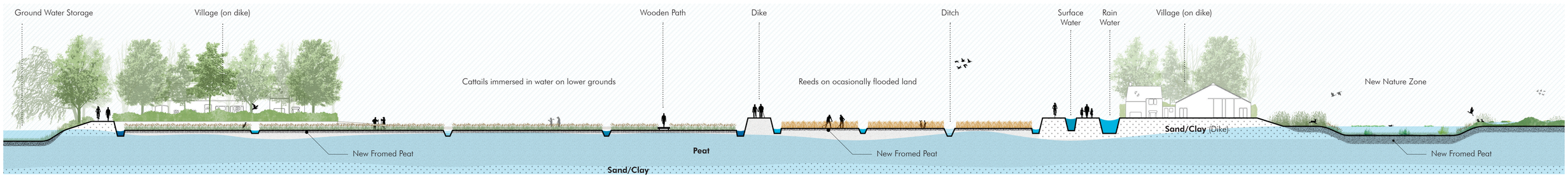
3.3 A DETAILED FRAME

3.4 DIKE TYPES



Type 1 - Along the Boezem | Type 2 - Regular Dikes | Type 3 - With a Mid Canal | Type 4 - On Settlements Border | Type 5 - New Nature Border

3.5 SECTIONS



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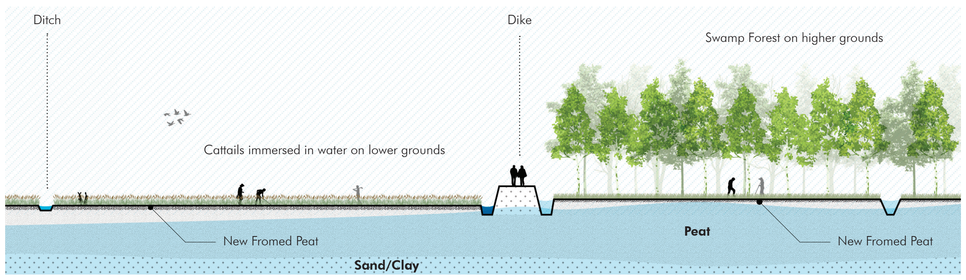
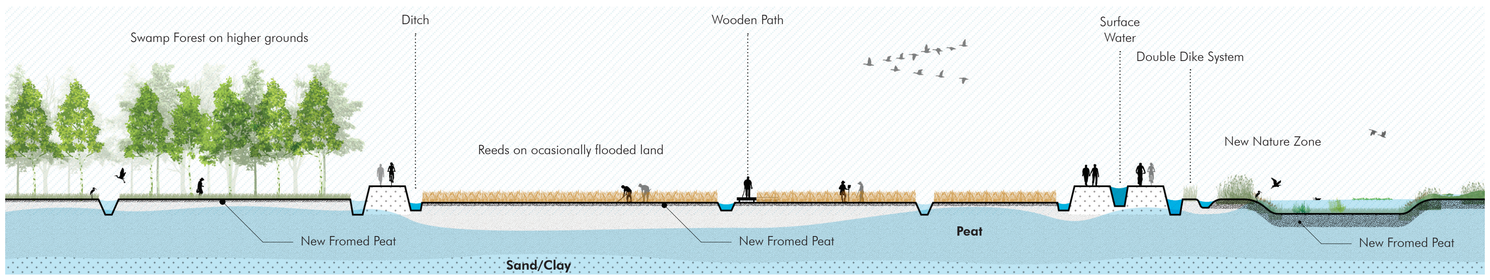


Section C - C **1:2,000**



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