

## Introduction Rotterdam

Rotterdam, Holland's second-biggest city after Amsterdam is directly connected to the deep waters of the North Sea with the river Nieuwe Maas. Rotterdam is a flat and low area in the Netherlands with horizon about 1m below sea level. Rotterdam has mild climate in winter and cool climate in summer with the coldest average temperature of 1°C in January and the hottest average temperature of 17°C in July. The annual precipitation is about 700 mm.



## Problem Definition

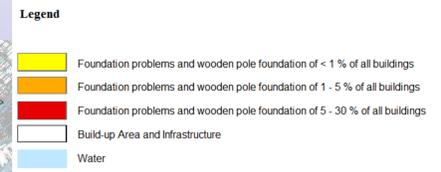
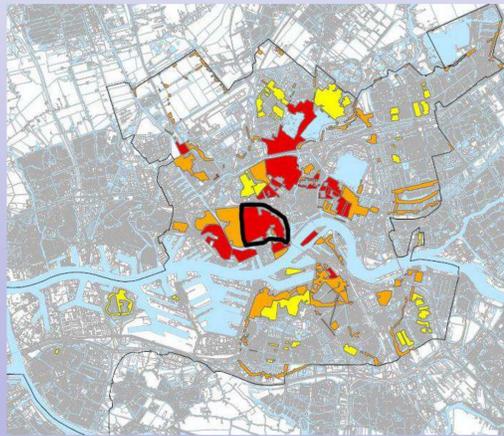
Groundwater is an important critical resource for a city like Rotterdam. Especially the ground water level is of importance. Climate change has a substantial impact on the ground water level.

Falling groundwater levels do have many effects like:

- land subsidence
- supply wells must be deepened
- pumping costs increase because groundwater must be lifted more
- salt water may intrude into previously fresh aquifers

A fluctuation of the water level results in the rot of wooden fundaments of some of the cities older buildings. To avoid these problems it is from importance to minimize the groundwater level fluctuation.

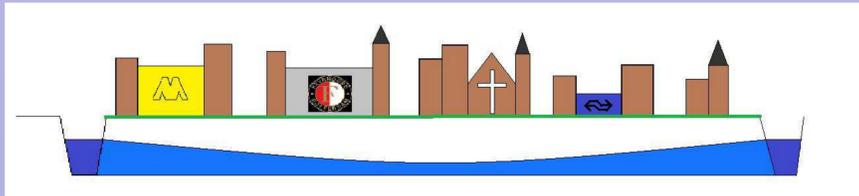
## Problem Definition & Problem Area



## Problem Area

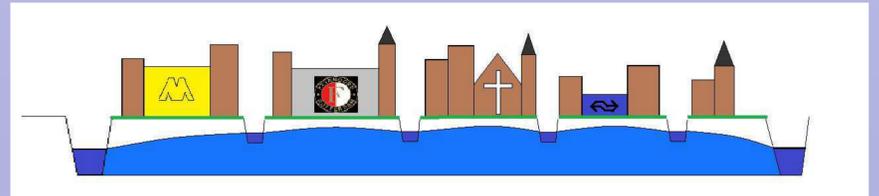
The figure on the left shows the city of Rotterdam. The coloured areas are the problem areas for foundation problems and wooden pole foundations. Most of these problems occur in the city centre of Rotterdam where most important buildings are. Therefore it is decided to select this area as the problem area, to solve the problems there as first.

## The Project Idea



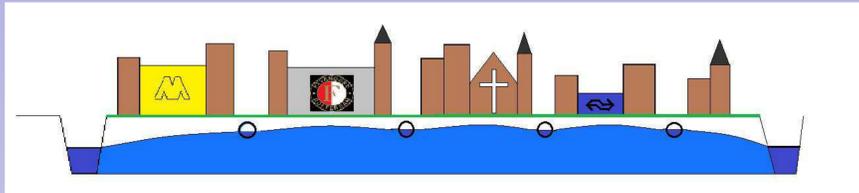
### Present Situation

The groundwater table is given as the dotted line under the buildings. It becomes clear that the groundwater level becomes lower with an increase in distance from the canal. In this situation there is no rainfall and the groundwater table is low.



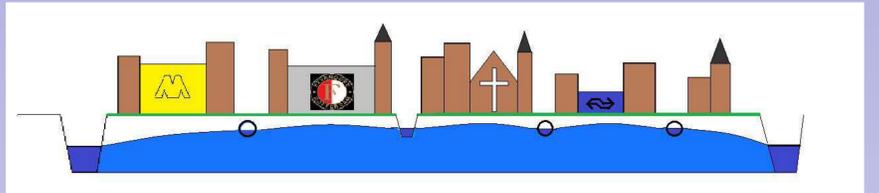
### Possible Solution I

To get a higher water table in dry periods, extra canals are needed to lift up the overall groundwater table. This figure shows the lift up of the groundwater table in the middle of the city. At possible open spaces.



### Possible Solution II

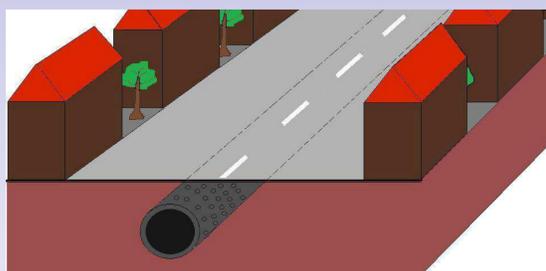
Open spaces in the city of Rotterdam are very rare and most of the times these open spaces are streets. It is impossible to open these streets and make an open canal on those places. Therefore an underground water canal can be build. Water is pumped into these canals and can leak out from the permeable layer of the pipes.



### Selected Solution

The underground water canals are quite expensive compared to the open water canals. Therefore, if possible the open water canals are used otherwise the underground water

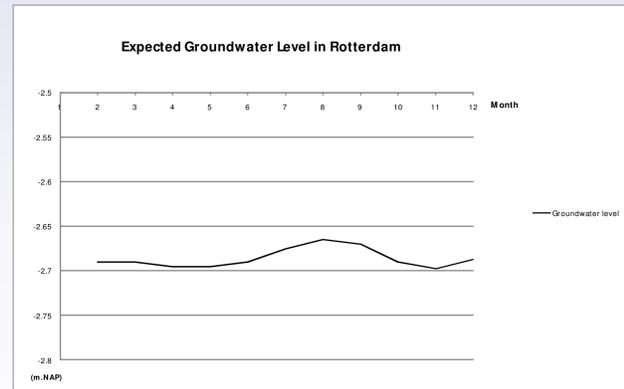
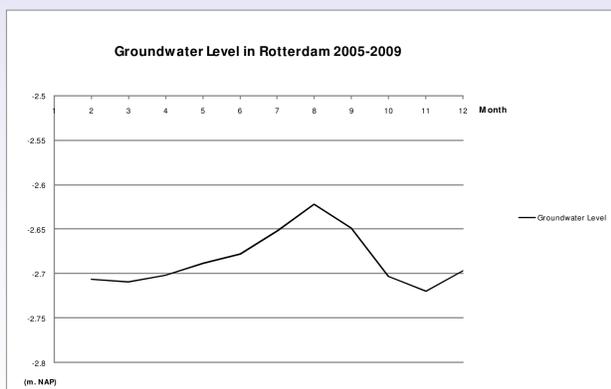
## The Underground Canal Tubes



The canal tubes used for this project will be placed under the roads and parallel to each other. Water is pumped in those pipes to get a constant water flow through the pipe. The permeable layer (as can be seen on the figure on the left and right) causes a water flow in the unsaturated soil. If the soil is saturated, the pipes work like a normal canal and the water just flows to the end of the pipe and will be dropped in the River. This system is very useful because it will work as an irrigation system in dry periods and as a drainage system in periods with too much water.

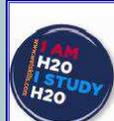


## Influence of the Measure



Harold Hoiting  
Margot Leicher  
Haoran Liu

Yu Zhang  
Ren-xi-zi Ren  
Bo Wei



Sponsored by:



Gemeente Rotterdam  
Gemeentewerken



WAGENINGEN UNIVERSITEIT  
WAGENINGEN

mede mogelijk gemaakt door het ministerie van Economische Zaken