1. Clarenhof

2. Melaan

3. Potsdamer Platz

URBAN DESIGN PROJECTS INTEGRATING INTENSIVE STORMWATER MANAGEMENT IN DENSE CITY CENTERS.

CLARENHOF, MECHELEN, BELGIUM
MELAAN, MECHELEN, BELGIUM
POTSDAMER PLATZ, BERLIN, GERMANY

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ABSTRACT

Climate change gives rise to more extreme weather conditions, resulting in more frequent and heavier storms. Therefore especially dense city centers need comprehensive stormwater management solutions. Integrating these solutions in existing city fabric is nevertheless a difficult task and at present many cities take measures to try to solve stormwater issues in public space and on public land. How to engage private development in a comprehensive stormwater management plan remains a difficult question.

This paper presents two design cases where stormwater management is integrated comprehensively in private inner-city redevelopment projects. The two cases show how the parallel design of the architectural project and the adjacent public space achieve an intensive cycle of stormwater management through stormwater reuse and integration of a buffering waterbody as an amenity for the public realm.

The detailed description of the cases clarifies the design decisions made regarding architecture and landscape that led to the high quality of the stormwater solutions. Not only the general design decisions, but also the technical aspects of the project are discussed. The administrative prerequisites will be touched upon to clarify the relation between private investment and public regulations.

The two European cases discussed are Clarenhof in Mechelen, Belgium and Potsdamer Platz in Berlin, Germany.
The project Melaan in Mechelen is shortly mentioned as a interesting side-note to the Clarenhof project to illustrate the actions taken by the City of Mechelen to reopen the old ‘Vlieten’ in the city.

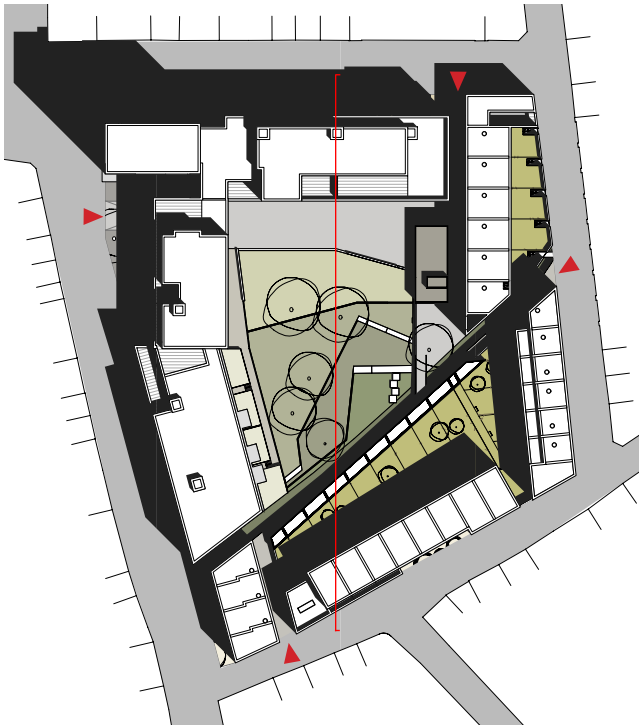
4. Aerial Picture of Mechelen showing the historical watercourses called ‘Vlieten’ and the location of the Clarenhof Project Site

CLARENHOF, MECHELEN, BELGIUM

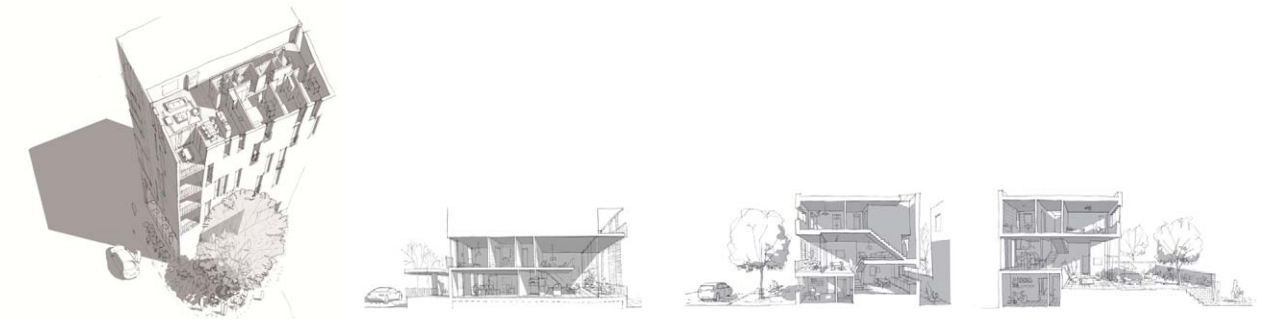
Designers: WIT Architecten, POLO ir. architecten, Ana Beja da Costa.

Investor/Client: Bouwfonds

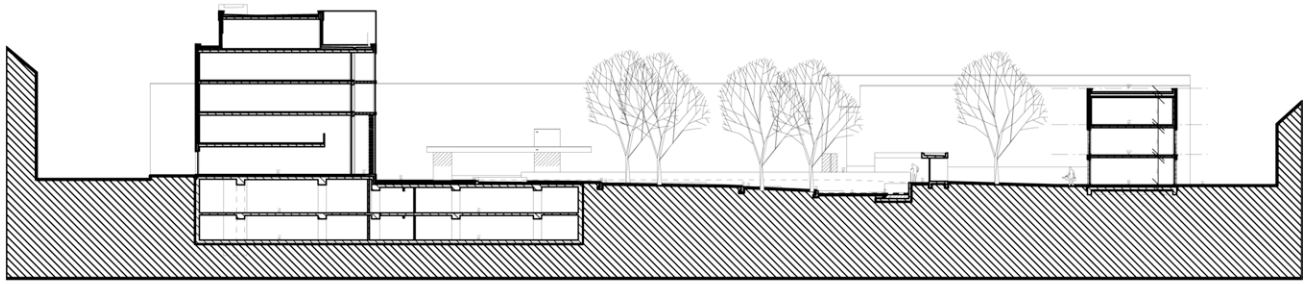
Date: Started in 2005, Currently (2012) under construction



5. Plan of Clarenhof with apartments on the Northwest side and Houses on the Southeast side. Arrows show the entrances to the semi-public water garden with the Vliet cutting diagonally through the project.



7. Perspectival sections through different housing types in Clarenhof



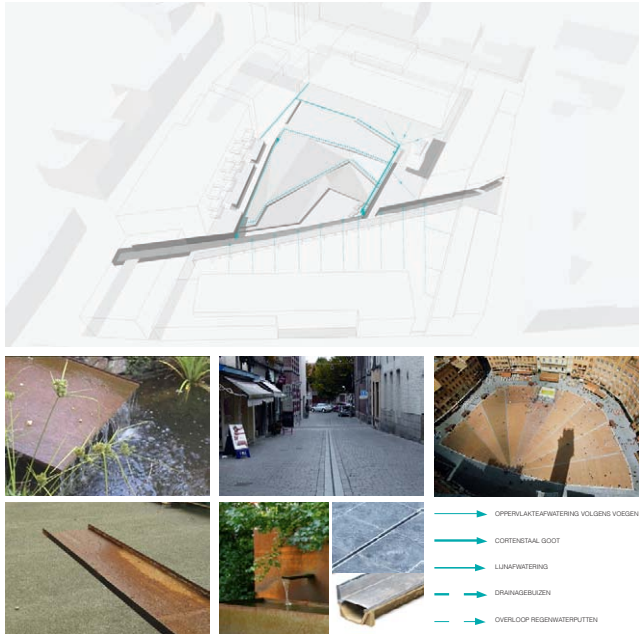
6. Section of Clarenhof showing the re-opened Vliet in the center of the building block

1. General project description

'Clarenhof' is an urban renewal project of circa a hundred houses and apartments, replacing a deteriorated parking building in the centre of Mechelen. The project has the scale of an entire building block and organizes apartments around a semi-public water garden and houses with private gardens. The main feature of the water-garden is the reopened historical watercourse called 'Vliet' in Dutch, which acts as a rainwater buffer for the project.

The buildings of the project each relate with specific typologies to the surrounding streets and the garden. Gates between the different volumes provide acces to the inner courtyard. This stimulates the small-scale pedestrian traffic through the project and a makes the reopened historic water course visible in the city fabric.

10. Perspective and references showing the selected gradient from impervious to pervious material in the courtyard



11. Perspective and references showing the open gutters leading the rainwater towards the vliet in the courtyard

12. Planting scheme for the courtyard and gardens. Private gardens are planted with grassbeds for infiltration of rainwater

8. Visualisation of inner courtyard looking from the water

9. Trajectories of public crossings through the courtyard and visitors for the water garden

2. Design of the courtyard

The inner courtyard is designed as a water garden and incorporates all ambitions and conditions of the surrounding buildings.
The different public, private and functional trajectories crossing the project structure the topography and layout of the courtyard. The different terraces are designed with a gradient of materials, using impervious pavement at the building edges, which gradually evolves in more soft and pervious materials towards the Vliet.
The perception of water in the garden is reinforced by open gutters and overflows that guide all rainwater of the courtyard to the water body.
The planting scheme reinforces the water-garden perception. The private gardens are planted with grassbeds to let rainwater infiltrate and replenish the aquafir.

3. Water system

The houses and apartments have a different water system to optimally integrate rainwater reuse and buffering.in the project.

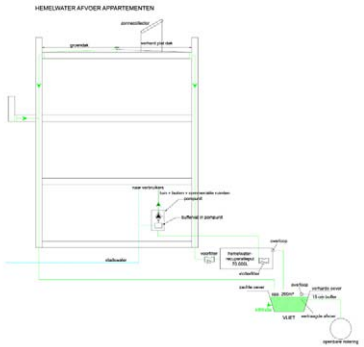
3.1 Rainwater reuse

For each house, rainwater is collected from the rooftop into a cistern of 3000 liter. This cistern is connected to a rainwater unit that pumps the reusable rainwater to toilets, washing machines and taps for washing cars and use in the garden in the house. In case of drought a buffervolume connected to the rainwater unit is filled with tapwater to provide water for toilets and washing machines.
In the apartments rainwater reuse is only provided in the collective areas for common use: watering the gardens, taps in the parking and rainwater provision for the commercial parts on the groundfloor of the apartment building.

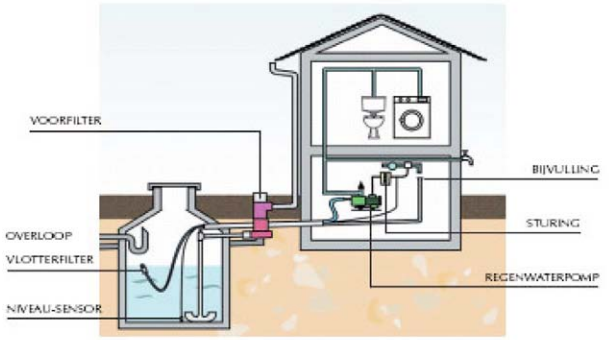
The sustainability report of the project mentiones multiple advantages of rainwater reuse.
Firstly it is financially interesting to reuse rainwater because of the rising prices of tapwater in Belgium and the rising environmental taxes.

usage	usage liter/day/person	usage share %	% saving
toilet	43	36	36
garden	5	4	4
cleaning	5	4	4
laundry	16	13	13
bath/shower	39	33	-
dishwasher	8	7	-
cooking	3	3	-
TOTAL	**119 liter**	**100 %**	**57 %**

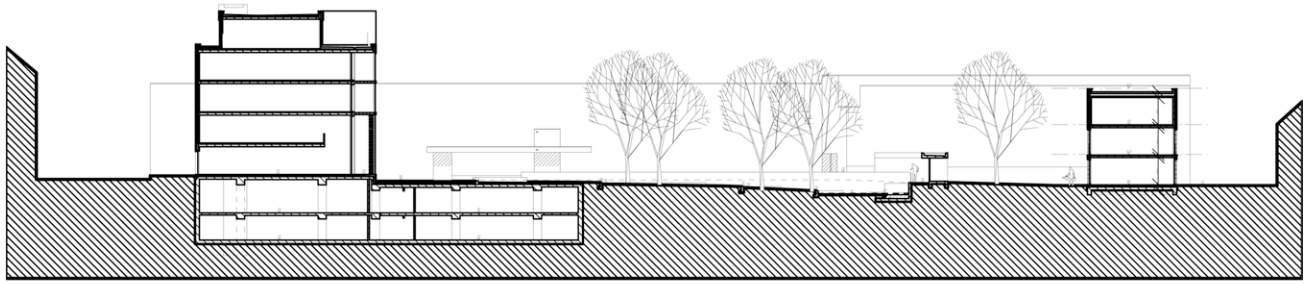
13. Table showing the water savings through reuse in Clarenhof



14. Diagram showing the collective rainwater reuse in the apartment building with its overflow in the vliet. Which overflows on its turn in the city rainwater sewer.



15. Diagram showing the rainwater reuse logic of the Private houses

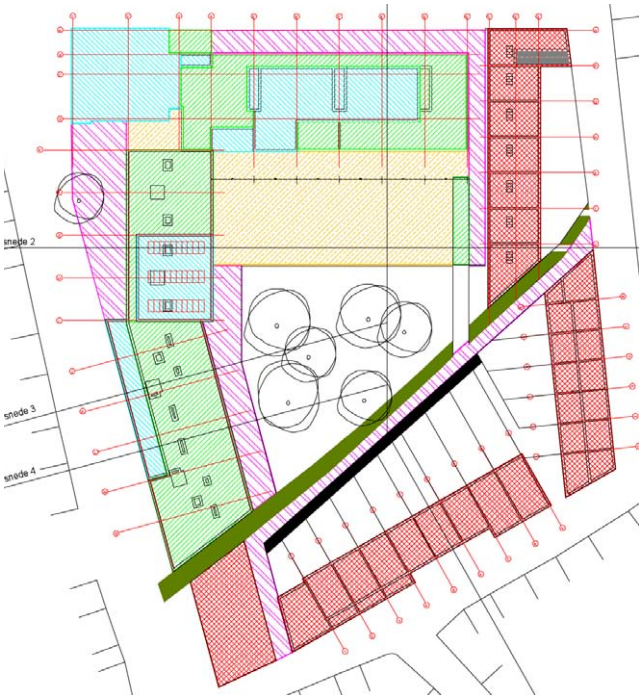


16. Section through Clarenhof Showing the connection of the apartments and Houses to the vliet

Secondly it is environmentally more sustainable to reuse rainwater: The extraction of water from the aquafir is less pressured and therefore provides more time for the aquafir to be replenished and the city sewage system is less pressured and water purification plants can function more efficiently. Finally rainwater is softer than purified tapwater, it contains no lime. This is an advantage for the lifetime cycle of household machines and deminishes the usage of soaps and washing powder which is normally partially absorbed by the lime in tapwater.

3.2 Stormwater buffering and infiltration

The size of the rainwater cisterns in the houses is sufficiently large to provide a certain amount of buffering, but the intensive rainwater reuse cycle in the houses makes additional rainwater buffering actually unnecessary according to city regulations. Therefore the cisterns overflow directly to the separate city rainwater-sewer.
Natural infiltratration of rainwater is possible in the private gardens.
The Vliet acts in multiple ways as a rainwater buffer for the apartments. The collective rainwater cistern overflows in the Vliet. The greenroofs on the apartments partially buffer rainwater in the soil and overflow superfluous water in the Vliet. The Vliet on its turn buffers all water and overflows in the separate city rainwater-sewer.
The section of the vliet is designed with a hard edge along the pedestrian path and a soft edge towards the garden to make infiltration into the garden possible.



17. Plan showing the different types of rooftops
zone A : houses with rainwater cistern, intensive reuse and overflow to separate rainwater sewer
zone B : greenroofs with overflow to the Vliet
zone C : normal flat roofs, rainwater catchment for use in common areas and watering of garden
zone D : Semi-pervious pavement : infiltration + catchment in the Vliet
zone E : impervious pavement : infiltration in semi-pervious areas through topography + catchment in the Vliet

3.3 Additional water saving measures

The sustainability report of Clarenhof mentiones the additional water saving measures taken on the scale of fixtures and taps in the apartments and houses.

Water saving flush on toilets
- Solid waste: 6-9l - Liquid waste: 3-4,5l.
- Saving on average 40,000l per family per year.

Aeriating nozzle on all taps
- Same features as watersaving shower head.
- Gives the impression of a fuller water-jet and therefore stimulates less water usage.

Water saving shower head
- Mixes water with air.
- 40 % less water and energy usage for the same comfort.
- uses max. 8l per minute vs. normally 10-18l.

Hot water circulation system
- Installed when tap is too far from boiler.
- Saves unnecessary flushed cold water

Thermostatic taps for showers and baths
- Separate button for temperature control.
- Faster and automatic mixing of cold and warm water.

Single stream mix tap
- Minimal loss of water while searching for right water temperature.
- Adaptable flow amount (average 6l/min.)

18. Images from the Sustainability report showing additional water saving measures

19. Renderings of the courtyard

4. Regulations

The following overview describes the different regulations that guided the project to develop an intensive rainwater reuse cycle and buffer volume.

4.1 Public-Private Partnership

The project is developed as a public-private partnership, which made it possible for the city to sate the following strict guidelines and requirements starting from the competition for the project:
- The reopening of the Vliet running through the project was required. The Vliet to the north of the project could be reopened, but this was not required.
- Qualitative (semi)-private green space had to be included in the project.
- The project had to fit into the environmental policy plan 2005-2009. Therefore a holistic sustainability approach regarding water, energy, material choices, nature, mobility, nuisance, waste, design of public space, function and flexibility had to be described starting from the competition phaze.

4.2 Flemish Region regulation regarding stormwater management.

Required since 2004 for every renovation or new project that needs city approval.
- A rainwater cistern is required.
- Depending on the site a calculated amount of infiltration or buffervolume has to be provided.
- For each project one has to state for what functions rainwater will be reused (no binding requirements.)

4.3 City sewage regulation

- Required separate sewer-connection for sewage and rainwater for renovations and new buildings.
- A rainwater cistern is required for projects with a roof surface bigger than 50m2.
- The distribution of rainwater has to happen with a pump-installation except if it is possible to organize the reuse in a purely gravitational way.
- Reuse of rainwater for minimum one toilet or one washing machine is required for residential projects.
- The rainwater network has to be completely separated from the tapwater network.
- A rainwater cistern has to overflow into (stating most desirable first)
    - an infiltration unit on private domain
    - a ditch
    - an infiltration unit on public domain
    - open water
    - rainwater sewer network
    - combined sewer network.
- Impervious paving is required for surfaces larger than 500m2.

4.4 Stimulating measures

Home owners or investors can be subsidized by the Flemish Region and by the local government when installing individual purification installations, rainwater cisterns or infiltration-systems.

5. Price of tapwater

The price of tapwater was also an important reason why the project integrated intensive rainwater reuse cycles. The comparison between tapwater in Mechelen and Philadelphia shows how an adaptation of usage cost could stimulate more rainwater reuse.

5.1 Mechelen

According to Pidpa the cost of water in Mechelen is the sum of a yearly charge and the price of water per cubic meter.
1. The yearly fixed charge per household with a meter size ø 20 mm is € 61,36 incl. 6% VAT. (price since 16-03-2009, consulted in november 2012)
2. The price of water per cubic meter combines three components:

- Cost of water provided by Pidpa.
  per m³: 1,3412 €
- Cost of disposal of sewage and rainwater through sewer (communal/city-level purification cost).
  per m³: 0,987178 €
- Cost of purification of sewage (district-level purification cost).
  per m³: 1,294048 €

In total this is a cost of 3,622426 € incl. VAT (6%) per cubic meter water.

A base usage of 15m3 per person per year is provided for free according to regulations. The purification costs for this free water have to be paid.
The average use of water in Mechelen according to Pidpa is shown in the following table.

Family members	l/day and client	l/day and person	m³/year and client	m³/year and person
1	118	118	43	43
5	416	82	152	30

20. Table showing average use of water in Mechelen

5.2 Philadelphia

According to the Philadelphia Water Department the monthly water bill in Philadelphia has three parts.
1. A usage charge, based upon the amount of water used and wastewater produced, as measured by the water meter.
to be able to compare with Mechelen I calculated the price per cubic meter for the first 2mcf.

Water		Wastewater	
Monthly Water Usage	Water Service Charge per Mcf	Monthly Water Usage	Wastewater Service Charge per Mcf
First 2 Mcf	$32.85	All billable water usage	$22.14
Next 98 Mcf	$26.62		
Next 1,900 Mcf	$24.43		
Next 2,000 Mcf	$18.60		
1 Mcf = 1,000 cubic feet = 7,480 gallons			

21. PWD Usage charge

2mcf = 2000 ft3 = 56m3
56m3 = 55US$
1m3 = circa 1 US$ = circa 0,77€

2. A monthly service charge, based on the size of the water meter. The service charge is the cost of basic service, which includes metering, billing and collecting revenues.
To be able to compare this to Mechelen I calculated with the 1-1/2 inch meter size which has a combined monthly charge $ 58.73 (yearly = 704,64 $ = 538€)

Meter Size (inches)	Meter Code	Monthly Water Charge	Monthly Sewer Charge*	Combined Monthly Charge*
5/8	R	$ 6.37	$ 4.41	$ 10.78
3/4	Z	$ 7.31	$ 15.21	$ 22.52
1	Q	$ 9.65	$ 23.55	$ 33.20
1-1/2	P	$ 14.81	$ 43.92	$ 58.73
2	X	$ 21.82	$ 68.92	$ 90.74
3	O	$ 37.27	$ 126.64	$ 163.91
4	W	$ 65.10	$ 213.19	$ 278.29
6	N	$ 125.72	$ 423.20	$ 548.92
8	V	$ 195.78	$ 673.29	$ 869.07
10	E	$ 284.23	$ 969.86	$ 1,254.09
12	T	$ 495.30	$ 1,787.53	$ 2,282.83

*Does not include Stormwater charges.

22. PWD service charge

3. The stormwater charge, which is the cost of collection and treatment of all rain water in the City that drains to waterways or to the sanitary sewer and stormwater collection systems. This is calculated separately per property.

According to the US Geological Survey the average use of water at home per person is 80-100 gallon/day = 0,37m3/day = 138,5m3/year For a family of 5 this would be 693 m3/year.

5.3 Conclusion on tapwater

The following calculations show the comparison between a Belgian and American family of five and their cost for tapwater.
The most important conlusions from this comparison are that the average US family uses 4,5 more tapwater than the Belgian family. The price of tapwater per cubic meter is 4,6 times higher in Belgium than in the US. Regarding this I have to mention that the stormwater charge is included in the cubic meter price in Belgium, while it isn't in the US. The fixed charge that households have to pay for water provision is on the other hand almost 9 times more in Philadelphia than in Mechelen. In general it is clear that the regulations regarding tapwater price in Mechelen stimulate less use of water, wheras the high fixed monthly charge in Philadelphia is an important cost, but the low price per cubic meter tapwater and even lower price for more use stimulates more use of tapwater.

Mechelen, Belgium

family of 5persons uses 152m3/year = 547,2€ 15m3 for free pp = 100€ discount yearly charge = 61,4€ total/year = 508,6€ (666US$)	if belgian would use as much as american use 693m3/year = 2495€ 15m3 for free pp = 100€ discount yearly charge = 61,4€ total = 2456€ (3218US$)

Philadelphia, US

family of 5 persons uses 693m3/year = 693US$ (= 529€) monthly charge: 58,73$, yearly = 704,64 $ = 538€ total/year = 1398 US$ (1066€) (stormwater charge not calculated)	if american would use as much as belgian use 152m3=152US$ yearly charge 704,6US$ total/year= 857US$ (654€) (stormwater charge not calculated)

23. Aerial Picture of Mechelen showing the historical watercourses called ‘Vlieten’ and the location of the Melaan Project

MELAAN, MECHELEN, BELGIUM

Designer: OKRA landscape architects
Investor/Client: City of Mechelen
Date: 2006

24. The different stages of the Melaan: Before 1906 / From 1970 until 2006 / After 2006 day and night

25. Plan and perspective of the reopened Melaan

26. Subtle topography changes differ the waterside walk from the driving lane.

1. General project description

As a short sidetrack to Clarenhof, it is interesting to show the different measures and projects that the city of Mechelen undertakes to reactivate water in the city center. A successful case is the reconstruction of an old watercourse ‘Melaan’ in the historic city center by OKRA landscape architects. This acts both as a stormwater-management tool as well as an amenity for the public realm.
Before 1906 the watercourse was also part of the ‘Vlieten’ water network in the center of Mechelen and it was used for transport, sewage and washing/laundry. The course was covered for hygienic reasons in 1913 and has been used as parking space since 1970. The fact that the watercourses streambed remained mainly unbuilt stimulated its re-opening.

2. Water system.

The reopened Melaan acts as a stormwater buffer for the water collected from adjacent roofs and public space. The canal overflows on his turn in the Dijle river. To keep sufficient current in the stream, part of the water in the Melaan is pumped water from the Dijle river. During the renovation the sewage pipes have been removed from the riverbed and are connected to the city sewer system located under the street paving.

3. Regulations.

This project was one of the 6 projects supported by the EU Water In Historic City Centres (WIHCC) subsidy (2003-2007). Which covered 50% of the costs of the projects. Other cities that collaborated in this EU stimulation program to exchange experiences regarding water in cities were Breda, ‘s-Hertogenbosch, Gent, Limerick and Chester, which all had an exemplary project on water in the city.

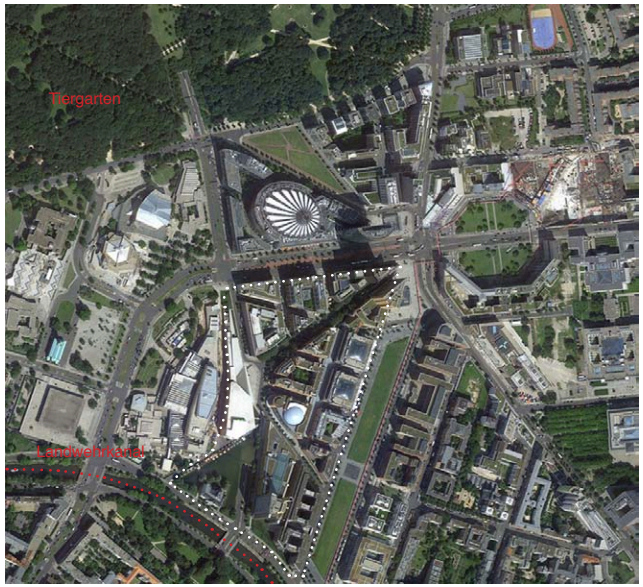
27. Aerial picture showing Berlin City Center and the location of the Potsdamer Platz site between the Spree River in the North and the Landswehr Kanal in the South. The Tiergarten park is located close to the site in the Northeast.

POTSDAMERPLATZ, BERLIN, GERMANY

Designers
Architects Masterplan: Renzo Piano Building Workshop, Kohlbecker + Partner
Landscape Architect: Atelier Dreiseitl

Investor/Client: Daimler-Benz group

Dates: Masterplan project 1992, construction: 1996-2000 - waterwork: completion 1999



28. Aerial picture of the site in 2012 showing the Masterplan site.

29. Masterplan showing the water-project as a connector.

1. General project description

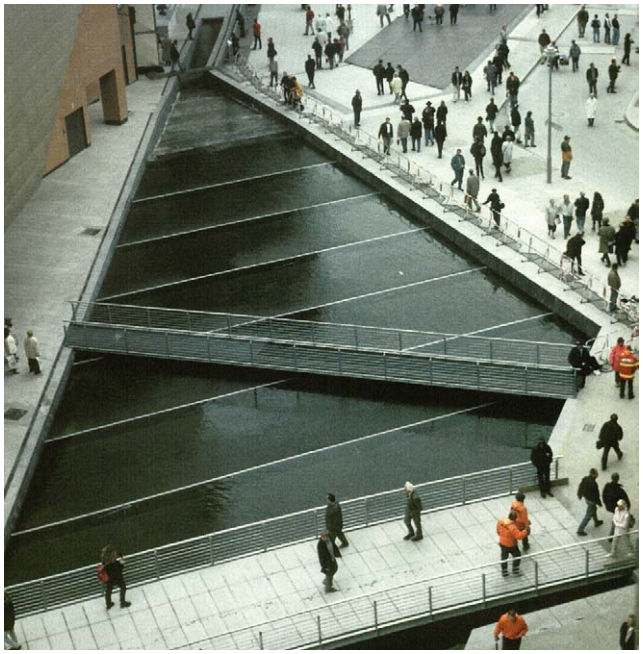
The Potsdamer Platz site is located between de Spree river and the Landwehr canal. To the south of the Tiergarten Park in the center of Berlin.
The Potsdamer Platz masterplan by Piano and Kohlbecker was the reconversion of the bombed wasteland site in the center of Berlin, next to the demolished Berlin wall. It 'stiches' the remaining historic buildings from the 'Kulturforum complex' (the Neue Nationalgallerie, the Philarmonic headquarters and the National library) together with the newly planned commercial center Potsdamer Platz together.
The plan contains 18 new buildings with a wide range of functions: offices, apartments, hotels, shops, restaurants, cinemas a casino and a theater.

The main design choice of the plan was to 'heal the wounds' of the site with 3 main elements:
-nature
-mixed range of activities to revive the site
- a uniform material palette of brick and terracotta to guarantee a formal continuity with rest of the Berlin city fabric.

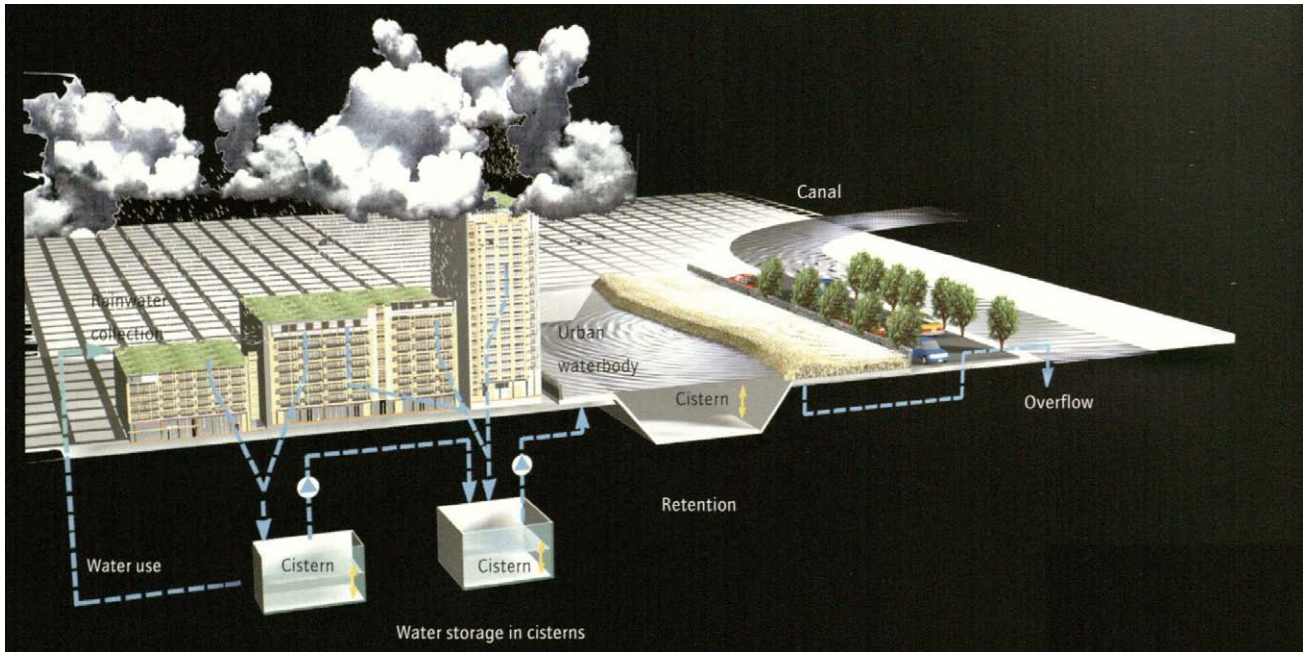
The general nature concept was to 'have the trees decend from the Tiergarten park', to act as a connector, and to bring the water up from the Landwehr canal to connect the buildings on the site and define the public space.

This paper will only focus on the natural elements used to link and hinge the city fabric. More specifically on the water element.

Before the competition for this masterplan was set up, Atelier Dreiseitl had done a study on the site and had suggested a high ecological water system. These high ecological ambitions for the site were strongly supported by both the investor (Daimler Chrysler) and the Senate. Therefore Renzo Piano collaborated with Atelier Dreiseitl to develop the ecological water feature.
The general goal of the landscape design and water feature was to not only to function as a 'work-surroundings' but also as a 'leisure-space'.



30. Main water feature on the Marlène Dietrich Platz



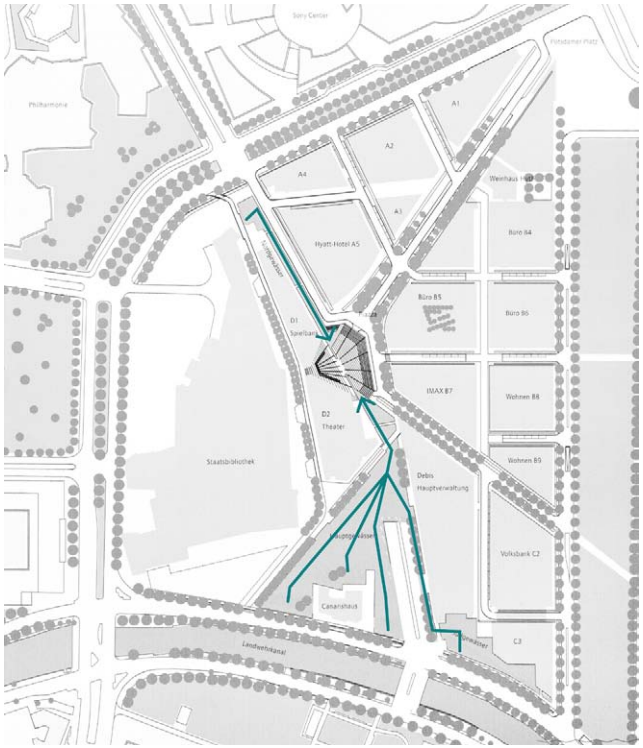
31. Diagram showing the rainwater storage, reuse and overflow logic.

2. Water system

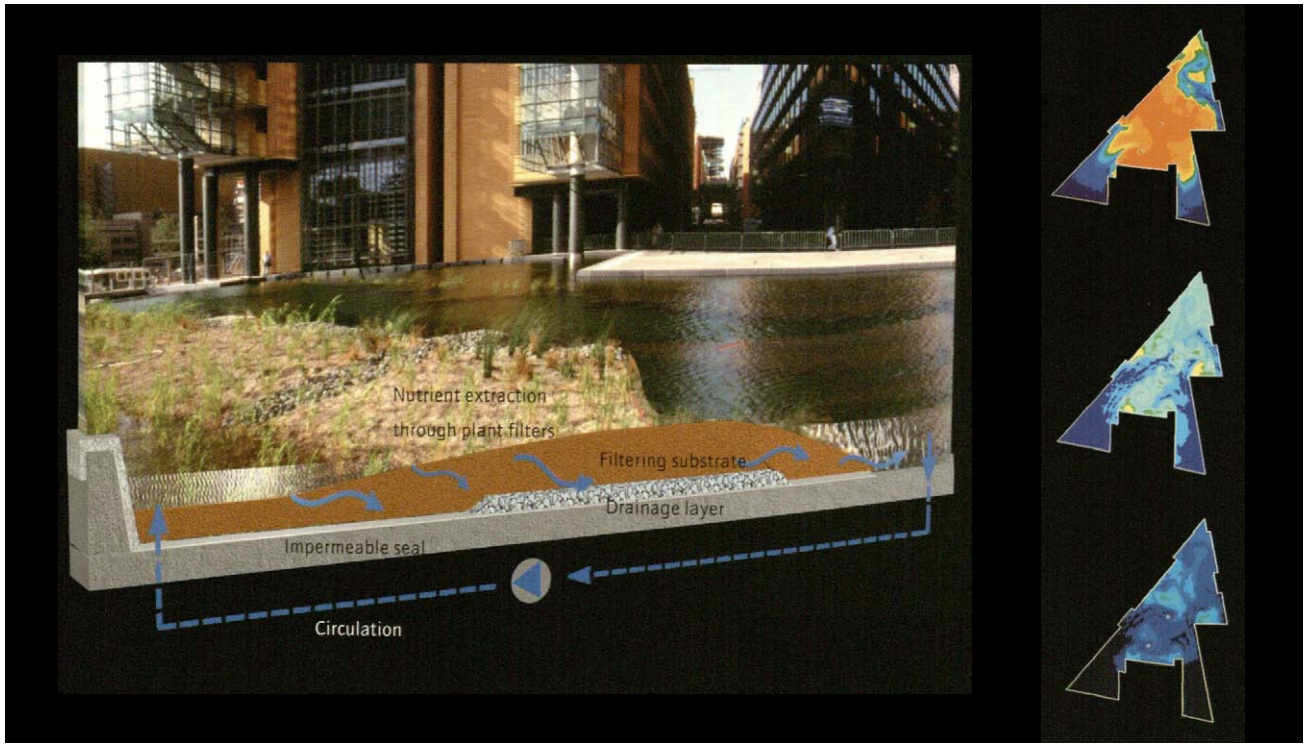
Seventy procent of the rainwater is caught on the Masterplan site, approximately half of the catchment area (16,5 rooftop acres) are green roofs with a special soil design. This rainwater is filtered and piped into large cisterns that are located in the basements of the buildings and in the parkings. These cisterns provide a buffer capacity of 2600 cubic meters, of which 900 cubic meters are left free in case of heavy precipitation.

The rainwater of the cisterns is reused for flushing toilets, automated plant-watering system in the shopping malls and the fire sprinkling system in buildings.
When it rains, a system pumps the surplus water via the south pond into the big triangular lake. This lake offers an extra reserve of 15 centimeter between the normal and maximum water level, which provides an additional rainwaterbuffer of 1300 cubic meters.

This tank on his turn overflows in the Landwehr canal. Computer simulation predicted that the Landwehrkanal would only need to absorb heavily increased amounts of precipitation three times in ten years.



32. Diagram showing the general waterflow logic on the site



33. Section through the cleansing biotope and diagrams showing the turbulence calculations in the main basin

When it is not raining the water of each basin is 'kept fresh' through a circulation system that pumps the water from the central tank on the Marlene Dietrich-Platz to the inlets of each tank. At these inlets a cleansing biotope is located to filter the water. The location of these cleansing biotopes was defined by measuring the turbulence in the water and defining the points of low turbulence, where sedimentation of particles could take place.

Atelier Dreiseitl made a very detailed design of the different water elements, integrating steps to provide wrinkles in the water to create the right atmosphere in the public space. The project is clearly a succes in combining an intensive rainwater reuse and buffering system with a buffering waterbody as a public amenity.

APPROACH FOR THE PHILADELPHIA WATER DEPARTMENT

The presented projects show how intensive rainwater reuse can be an important and strong factor in stormwater management and a more sustainable water approach.
My goal by presenting these projects was to inform the PWD how rainwater reuse and private projects could be integrated in the stormwater management plan for Philadelphia.
The different scales of water-related choices, from taps, to single house reuse, collective reuse, buffer volumes and an interconnected reuse on a masterplan scale provide in my opinion feasible approaches for stormwater management that can be stimulated by the necessary accompagnying regulations. By stimulating and guiding the private sector to undertake such water-intensive measures, the PWD could accelerate change in Philadelphia to reach the goals set up in the ‘Clean Cities Green Water’-report.

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