Climate Changes and Résistance to Change

Céline Patouillard, Jean-Yves Toussaint, Sophie Vareilles

ENVIRONNEMENT VILLE SOCIETE
UMR 5600 du CNRS
18 rue Chevreul
69362 LYON CEDEX 07
tèl. 04 78 78 75 44 – Fax : 04 78 78 71 85

Climate Changes and Resistance to Change

Initial Considerations Based on a Study of the Diffusion of Stormwater Drainage "Alternative Techniques" and Sustainable Urban Drainage Systems - 1970-2010. The Cases of the Lyon Conurbation and Wales

`Programme: PREPARED - Work Area 6: Towards an Adaptive Water Sensitive City Future`

Céline PATOUILLARD, Jean-Yves TOUSSAINT, Sophie VAREILLES

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Summary

Introduction

The PREPARED Programme considers climate changes through a lens of urbanisation processes and urban water management[1]. It supposes that today' s cities, and especially cities in industrialised countries, are not ready to face events resulting from climate changes such as increases in weather hazards (flooding, droughts) and their potential consequences (population migrations, etc.)[2]. This multidisciplinary research programme –including engineering and social sciences– focuses on the answers to bring forward when faced with these changes in terms of urban water management: modification of technical devices, reorganisation of services, changes in modes of government and decision-making, etc. It seeks to define new technical, organisational, and social norms and to consider possible modes for their diffusion[3]. The contribution of the team to the PREPARED Programme and in particular to Work Area 6, "Towards an Adaptive Water Sensitive City Future", relates to the latter aspect. It aims at better understanding possible conditions for a change in norms and paradigms in activities relative to urban water management, and thus a better understanding of favourable or unfavourable factors for planned changes. For this, it relies on an analysis of the diffusion of technical devices considered as alternatives to urban sewer systems since the 1970s.

1. The Problem

Climate changes are one of the symptoms of the environmental crisis affecting contemporary urban societies. This crisis also appears through natural resource depletion, the pollution of aquatic and terrestrial areas, the "ozone hole", etc. It is based on a double process of massive accumulation: an accumulation of individuals (increase and concentration of populations), and an accumulation of objects (multiplication of technical and organisational devices necessary to social life). This double accumulation flows from scientific and technological developments and urbanisation processes, which have been increasing since the Industrial and Agricultural Revolutions in the 19th century (Polaniy, e1983). In this respect, the present environmental crisis would also be an urban crisis (Brundtland, e1987). It would be at once technological, economic, political, and social: failures of technological devices with heavy environmental impacts, inappropriate specifications for technical and organisational devices regarding climate change, questioning of the distribution of resources and wealth produced among cities, and a challenge

1- By urban water, we mean drinking water, wastewater, and stormwater. Its management in the city implies a group of stakeholders and organisations: local communities, water companies, decentralised State agencies and services, technical study companies, landscapers, and so on.

2- See for example the report by Intergovernmental Panel on Climate Change (IPCC), available at http://www.ipcc.ch/ (accessed December 6, 2013).

3- In particular, Work Area 6 considers the implementation of a new urban model, "*The Adaptive Water Sensitive City*", a city that would be able to adapt to changes due to climate variations.

regarding the organisation of social labour and the political and technical representation in place, etc.

The PREPARED Programme looks at the present environmental crisis and ways to come to terms with it through the question of urban water management. Urban water management is affected by the ecological crisis as an ensemble of technical and organisational devices of urban areas (Toussaint, 2003). In other words, the crisis compromises technical objects for urban water systems (sewers, wastewater treatment plants, basins, storm drains, etc.) and the organisations in charge of these systems (local communities, water companies, technical study companies, etc.) However, although diagnoses concerning the ecological crisis are now widespread, practices linked to urban water management do not seem to change, or if changes are made, they are far inferior to those seemingly necessary in the light of those diagnoses[1]. In this context, research programme expectations are descriptive, normative, and prospective. They include producing knowledge and tools in order to help urban water stakeholders to take account of the ecological crisis and climate changes in their activities and to ensure the conditions for a change in the management of urban water in a context of climatic, ecological, and urban crises.

The goals of the PREPARED Programme lead to a questioning of the attitude of stakeholders of the water sector and more broadly the public as faced with climate changes and the ecological crisis. The questions can be divided into three groups: a first group concerns the effects of the ecological crisis on water management activities and current practices; a second group concerns the reasons for change or stability of these practices; and the third group concerns the possible conditions for an orientation of social activities.

- What are the effects of climate changes and the ecological crisis on the activities of water stakeholders? In which way do these actors take account of the ecological crisis through their activities?
- How does knowledge of the ecological crisis inform water management activities? What are the reasons (technical, economic, political, and social) driving individuals to change their behaviour and urban practices?
- Is it possible to orient this change and how?

2. Our Research Stance

In this contribution, we look at the possible conditions for a change in the practices of urban stormwater management. In order to do so, we focus on urban drainage, especially so-called "alternative techniques": basins, trenches, soakaways, swales, ditches, etc.[2] Although these techniques were already tested out about forty years ago –some of them even reuse very ancient techniques (ditches, soakaways)– they remain rarely implemented today and are often seen as experimental. Their development tends to raise technical, organisational, economic and social difficulties (Berdier, Toussaint, 2007; Patouillard, in progress). The observation and analysis of the conditions for their diffusion could provide information on possible conditions for a change in the urban water management activities, especially towards a better recognition of climate changes and the ecological crisis.

1- See for example an anthology proposed by Ariane Debourdeau (2013) of the founding texts on Ecology, most of which evoke the present ecological crisis.

2- These techniques are so called because they can be considered as alternatives to sewer systems. They can also be qualified as “compensatory” [*techniques compensatoires*] in the sense that they counterbalance the effects of urbanisation; or “integrated stormwater management” [*gestion intégrée des eaux pluviales*].

Given the team's past and present research work, this study main focus is on the Lyon Urban Community [*communauté urbaine*], called Greater Lyon [*Grand Lyon*][1]. This local community [*collectivitié territoriale*] brings together 58 municipalities including Lyon and ensures urban water management for all of them. The investigation consists of a study of two development projects integrating alternative techniques. A secondary study site in Wales completes the investigation[2]. Two Welsh case studies are carried out and concern the implementation of SUDS, or "Sustainable Urban Drainage Systems"[3]. This category, which partially overlaps with that of alternative techniques practiced in France, includes ditches, swales, soakaways, and detention and infiltration basins. The development of SUDS seems to raise similar difficulties to those of alternative techniques in France. The Welsh case studies, although summaries, help to better understand the results from the Lyon case studies as to the conditions for implementation and diffusion of new urban water management techniques. They especially provide information on the permanence of the reasons leading stakeholders to change their practices, or to maintain their current practices.

This report is organised into three parts and a conclusion. The first part develops our research questions and hypotheses, drawing from the various fields of the social sciences literature. The second part presents the sites and the research method as implemented. The third part reports the case studies. Finally, the conclusion presents an initial speculation on changes in the urban stormwater management practices.

1- See Berdier and Toussaint, 2007; Toussaint and Vareilles, 2013a; Toussaint and Vareilles, 2013b; Patouillard, in progress; Ah-leung et al., 2013; Ah-leung, in progress; Baati, in progress.

2- These investigations were carried out in collaboration with a group of researchers from the Pennine Water Group of the Universities of Sheffield and Bradford, responsible for *Work Area 6*.

3- Also known as "Sustainable Drainage Systems" (SuDS).

Research Questions and Hypotheses

The team has established an analytical framework that considers the city and its urban environment to be an assembly of technical and spatial objects and devices. According to this analytical framework, technical objects and devices are instruments for social activity. This approach leads us to pay special attention to technical objects and devices, in this case to the technical devices related to stormwater management. In France and the United Kingdom, this is principally provided by a network of pipes buried under roads, collecting runoff during rain events and directing them towards an outlet (wastewater treatment plant, streams, rivers or seas). This system, called a “sewer system”, became widespread during the 20th century. However, it has been questioned since the 1960s and 1970s, and other technical devices (alternative techniques in France and SUDS in the United Kingdom) were developed and implemented. The diffusion of these new devices is still limited due to various difficulties. Past and present studies lead us to establish a series of hypothesis guiding the investigation’s work[1].

1. Our Analytical Framework

Our analytical framework is based on a theory of the technical object as an instrument for social activity. It is inspired by the work of Gilbert Simondon (e1989), Pierre Rabardel (1995) and the sociology of technology (Akrich et al., 2006), and it was grounded on the observation of urban public spaces (Toussaint and Zimmerman, 1998; Toussaint and Zimmerman, 2001; Toussaint, 2003; Vareilles, 2006). This analytical framework aims at better understanding the use of technical objects and devices in social activity[2]. What do makers “make” when they make urban devices? What does the urban public “make” with made devices?[3] This analytical framework can be summed by three propositions:

- the city can be seen as an assembly of objects and technical devices;
- technical devices call social practices;
- individuals are reasonable actors[4].

1- See the projects SEGTEUP-ANR PRECODD 2008 (http://segteup.org), OMEGA-ANR Sustainable Cities 2009 (http//www.omega-anrvillesdurables.org) and MENTOR-ANR ECOTECH 2011; as well as Berdier and Toussaint, 2007; and Patouillard, in progress.

2- By ‘object’ we mean any fabricated thing. Devices are groups of objects or sophisticated objects (for example tools or machines). Objects and devices can be completely artificial (for example an automobile) or partly alive (trees or landscaped spaces).

3- These two questions are borrowed from Michel de Certeau (e1990).

4- On the foundation of, and inspiration for this analytical framework, see Toussaint, 2009; on the role of devices as instruments in urban social activity, see Toussaint and Vareilles, 2010.

1.1. The City can be seen as an Assembly of Technical Objects and Devices

In our research work, the processes of urbanisation are looked at through technical and spatial objects and devices. Their assemblies constitute urban environments and make urban life possible. These devices are diverse, more or less spread out or sophisticated such as buildings, automobiles, tramways, sewers, drains, traffic lights, green spaces, candelabra, etc. Some of these devices, such as those making up public urban spaces or traditionally the commons, are shared among the urban public and pertain to the common good[1]. Systems for urban water management mostly fall under this category of devices.

The mode of existence of urban technical and spatial devices falls under making and using techniques. These devices result from the activity of making, which are principally civil engineering, architecture, and urban planning. Their use by the urban public requires skills and thus learning[2]. Technical devices are also organisational ones. Regarding their conception, construction, maintenance, destruction, and so on, they depend on organisations such as local communities, public utilities, construction companies, technical study offices, etc. These organisations are in return legitimised to gain resources from these devices. In other words, there are no technical devices without an organisation, or any organisation without technical devices. Thus urban environments are considered as a political, technical, organisational, economic, and social embeddedness, as per Marcel Mauss (e2002). Accordingly, devices for urban water management are considered as both technical and organisational devices: pipes, basins, ditches, swales, captors, storm drains, wastewater treatment plants, municipalities, urban metropolitan areas, network managers, public works companies, captor manufacturers, technical study companies, research laboratories and organisations, etc.

1.2. Technical Devices call Social Practices

There is no action, nor activity without the use of technical objects and devices, whether this action or activity is ordinary, trivial, profane, sacred, collective, individual, private, or public. In this way, technical objects and devices pertain to action, especially as instruments. Just as individuals are actors, they are non-human actors (Akrich, 2010). Through the practices they call, due to their configuration or "affordance" as Gibson (e1986), they open up possibilities of action for individuals. For example, benches call to sit upon them (on the seat or the back) or to lie down upon them (when they have no central back-support); steps with smooth edges prompt gliding games (skates or scooters). In this way, urban facilities and technical and spatial devices making them up constitute offers for social activities. Each new technical device in the city, such as mobile phones, bicycle-rental networks, infiltration basins, and so on, renews the offers for social practices. Among these practices, some of them were expected by the makers while designing the device, and others extend beyond the "script" encouraged by the makers (Akrich, 1991)[3]. These unexpected practices can run against current norms or deteriorate the device[1].

1- By urban public, we mean all of the individuals and organisations that use technical and spatial urban devices for their social activities, such as inhabitants, users, clients, store owners, drivers, parents, children, associations, etc. Among the urban public, we make a distinction between those who contribute to the making or urban devices (their conception, realisation, management, maintenance, recycling, etc.): elected members, civil servants, engineers, landscapers, planners, local communities, technical study companies, construction companies, researchers, etc. Those are grouped together in the category of "makers".

2- For example, individuals learn how to walk in the city in the same way as they learn to ride a bicycle. These lessons explicitly appear in the directions that parents give their children in the urban public space. The experience of handicapped people in the city (Toussaint and Vareilles, 2010) also demonstrates the need and sometimes the difficulty in learning how to use urban facilities and devices for social activity.

3- When designing objects, the makers expect certain practices and activities, according to one or more "scripts." These scripts are based on hypotheses about socio-technical environments into which the devices will be integrated, and situations for action in which they will be used (Akrich, 1991).

Answers to those unexpected uses range to modification of the device's configuration, installation of extra technical devices or information campaigns directed at individuals or groups of individuals considered as troublesome in relation to the dominant uses for the device or its working[2]. Thus, the possibilities for action opened up by technical devices depend on the configuration of objects and are regulated by current uses.

Resuming Gilbert Simondon's work (e1989), technical devices allow the person using them to "see" the world differently, to find ways of acting within it and then to take action. In this sense, they are instruments for the urban public. Their ability to become instruments for the public and to serve their urban intents can vary. Technical devices more-or-less call for practices, multiplying or on the contrary limiting the means for action of the individuals using them. Depending on this ability of devices to allow for social activities, three general modes of suitability can be established –or three ideal types of objects, in the sense of Max Weber (e2006)[3]:

- "convivial" objects (Illich, 1973), which increase individuals' possibilities for action;
- "heteronomous" objects (Illich, 1973), which limit possibilities for action;
- unusable objects, which cannot be actualised into uses and which remain inactive or cause erratic uses[4].

In the first case, the devices' functioning rules are subordinated to the uses. In other cases, they subordinate uses and create obligations for individuals. These objects do not fit well social activities. As for urban water devices, considering them as instruments for social activities means that their diffusion would depend on their suitability for the activities of the water sector stakeholders and the urban public (economic, domestic, political activities, etc.).

1.3. Individuals are Reasonable Actors

Individuals involved in action, which we group under the category of "actors", are reasonable or rational in the sense that their actions are based on reasons[5]. In other words, an actor has "good reasons" to act thus: he is acting in his own interest, for example to maintain his reputation or to earn a salary, and in the interest of groups or organisations of which he is part, for example family, community, association, municipal council, company, and so on. These reasons are based on the "world" in which the individual is immersed.

This "world" depends on the individual's situation; whether it be at work, home, on vacation, walking down the street, with family, colleagues, and so on. These spatial, temporal, and social circumstances create value regimes or "orders of worth" (Boltanski and Thévenot, 1991) which are necessary to evaluate actors' behaviour and action[6]. The different worlds fall under different value regimes, which are called here "worldly regimes" [*régimes mondains*]. Thus the evaluation of actors' reasons varies according to worlds. For example, valid reasons differ between the world

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1- It can go as far as using tools to carry out tasks for which they were not design, a phenomenon referred to as catachresis in ergonomics (Béguin, Rabardel, 2000).

2- The central back-support on benches is an example of an extra technical device, added to prevent lying down. For an initial survey of devices limiting sleeping and sitting positions in urban public spaces, see Paté and Argillet, 2005. Educational events on the uses of trees in the city aim at convincing the children to change their behaviour when they encounter such a device in favour of more respectful uses (Vareilles, 2006).

3- In this sense, these categories are not a reality. They describe "pure" objects i.e. abstract (or synthetic) ones, which help to reveal the role of devices over action and thus provide information about these roles in the less "pure" conditions of the real world (Becker, 2009, pp. 161-176).

4- Typically, street cabinets make up some "nooks" that call for more or less licit practices (posters, urinals, garbage disposal, etc.).

5- We refer to "actor" as per Bernoux (1985, p. 166). This proposition is based on the work of Pierre Bourdieu and Raymond Boudon on actors and action. See especially Bourdieu, 2001; and Boudon, 2003.

6- By value regimes [*régimes axiologiques*], we mean en ensemble of practices, values and norms specific to social groups and action situations.

of making and the world of the urban public, or between the corporate world and the world of research.

Urban worlds can be categorised into four main worldly regimes (Toussaint, Vareilles, and Zimmerman, 2007; Toussaint, 2009): intra-worldly, extra-worldly, infra-worldly, and super-worldly regimes (Table 1)[1]. In general, the same individual experiences all worldly regimes on a daily basis[2].

Table 1. Urban worlds.

Worldly Regime	Action Situations: ideal-type and examples
Inter-worldly (in the world)	Activities related to the common good, such as activities legitimate in urban public spaces
Extra-worldly (out of the world)	Domestic-type activities, i.e. activities related to family and communities, such as linguistic or faith communities
Infra-worldly (below the world)	Production and distribution of resources, management of people and things, i.e. activities related to industrial and commercial organisations, civil service or civil society organisations[3]
Supra-worldly (beyond the world)	"Inspired" activities, i.e. artistic, intellectual, or religious activities

2. Sewer Systems, Alternative Techniques, and SUDS

This analytical framework led us to consider urban stormwater management through the technical devices forming it: the sewers, which are the most spread devices, and alternative techniques or SUDS, which were developed in reaction to sewers since the 1970s.

2.1. The Sewer System

The urban sewer system is made up of an ensemble of buried pipes, which collect and direct stormwater to an outlet (wastewater treatment station or natural environment). It was put into place very progressively over the 19th century, first in England, in Manchester and London[4], then in other large and medium-sized cities in Europe, in North America, and in colonies of industrialised countries. It became widespread during the 20th century in industrialised countries and in large cities elsewhere. Among French cities, Paris was a pioneer in this field (Dupuy and Knaebel, 1982, p. 4; Frioux, 2009, pp. 451-463). The development of sewers was more broadly integrated into the development of urban infrastructure (especially highways and drinking water systems). It sprang from urban, social, economic, political, and technological changes (Barles, 1999; Guillerme, 1983)[5]. This reticular approach is especially linked to the importance given by the scientific and technological community to the circulation of the elements, as well as to the role of engineers in the making of the city and urban spaces. Thus, the stationary, humid, and organic model of the urban milieu typical to the society of the Old Regime was replaced by that

1- The definition of these worldly regimes takes up in part the "polities" [*cites*] proposed by Luc Boltanski and Laurent Thévenot (1991): the extra-worldly regime intersects the "domestic polity"; the intra-worldly regime can be seen as akin to the "civic polity" by integrating part of the "inspired polity" as described by the authors.

2- This is why an actor can be defined as plural (Lahire, e2001).

3- "Management" is meant here as the mode suggested by industry such as planning, organisation, direction, coordination, and inspection.

4- Which was then the world's most populous city.

5- André Guillerme (1983), in his history of cities, demonstrated how water management technologies were embedded within social, economic, and political organisations. On this embeddedness, also see the work of Marcel Mauss on social morphology (Mauss, e2002).

of a dynamic, dry, and mineral urban milieu[1]. The 18th century city, considered to be full of miasmas and congestion, was then entirely transformed. This transformation concerned roads, central squares, and all technical networks. For urban water management, it meant the rapid evacuation of wastewater and stormwater via underground pipes. The septic fields –and other systems where excrement where disposed of or transformed into fertilizers for example– were progressively given up in favour of wastewater treatment plants, which followed the development of drinking water plants. These technical devices heralded the reign of speed: wastewater treatment plants typically tend to accelerate natural purification processes, and this over a smaller space (Barles, 1999, pp. 210-212).

Today, there are two types of sewer system: combined sewer systems and separate sewer systems. Combined sewer systems are the older type and because of this, especially concern the centres of large cities, which are also the oldest urban areas and the first that were equipped. They collect all of the city's effluents, including domestic wastewater, industrial water, runoff during rain events, and water used for urban space cleaning[2]. Separate sewer systems are made up of two distinct systems of pipes. The first directs wastewater towards a treatment plant; the second directs stormwater to an outlet, which is most often a natural environment. In this case, pipes are sometimes replaced by ditches. Separate sewer systems were developed after the Second World Ward (Barles, 1999, p. 330) and became the norm for sewer systems in the 1970s (Chocat, 1997, p. 1102). They were especially present in small cities and villages, which were equipped with them in the 1960s, as well as in new towns (Hassan, 1998, p. 115). Separate and combined sewer systems generally coexist in urban agglomerations.

The separation of wastewater and stormwater into two sewer systems is related to the flow and quality of the waters transported. While the flow of wastewater is roughly constant over time, stormwater flows ranges from zero to numbers greatly exceeding that of wastewater. Thus the sizing of sections and the degree of slope for pipes in combined systems is tricky. Pipes too small can cause overloading, overflow, and frequent flooding during rain events; pipes too big can create additional costs and can generate stagnancy during dry weather. The separation of wastewater and stormwater allows this problem to be resolved. It also provides an answer to environmental problems. Pollution caused by wastewater and the nuisances accompanying it, such as odour, sickness, pollution of wetlands, have led water stakeholders to develop wastewater treatment plants before the water is discharged into aquatic environments (Barles, 2005, pp. 208-210). The working of these treatment plants is sensitive to variations in flow and pollutants, stormwater being differently polluted from wastewater. In separate sewer systems, only wastewater arrives at the station, which makes its treatment easier.

The development and construction of sewer systems during the 20th century generally caused many technical, social, political, and environmental controversies (Patouillard and Forest, 2011). They were concomitant to the specialisation of urban professionals (Frioux, 2009, p. 18), and were accompanied by a standardisation in technical devices. This standardisation was linked to the rise of a new discipline, urban hydrology, which appeared in the 18th century (Barles, 1999, p. 178). This discipline concerned the circulation of urban water and especially the sizing of pipes, through the elaboration of formulae for calculation and the creation of charts[3]. Sewer system standardisation also came from a process of normalisation, which was reflected in an increase in

1- Which was accompanied by a specific economy; in France, this was principally the textile, paper, and tanning industries, which used maceration and putrefaction techniques (Guillerme, 1983, pp. 149-185).

2- Wastewater includes both "sewage" and "grey water". "Sewage" designates water coming from toilets, a device introduced into the United Kingdom and then into France at the end of the 19th century. "Grey water" includes all other domestic wastewater (wash water).

3- For example, in France, Caquot's formula to estimate stormwater flows in urban areas, developed in 1941 and published in 1949.

prescriptive documentation (guides, technical norms, ministerial decrees), inspection procedures, and law enforcement organisations[1].

From the 1960s and 1970s on, this model was brought into question[2]. Increasing sensitivity to environmental problems, and among them the destruction of humid environments that proved to be conducive to a high level of biodiversity, led to rethink principles of city management. In contradiction to principles linked to movement and speed, management based on recycling and slowing down flows and goods were promoted[3]. This development was reflected in waste policies (encouragement for sorting and recycling waste), transportation policies (encouragement of non-motorised modes of transport), and stormwater management (development of detention and infiltration basins, "alternative techniques", and "SUDS").

2.2. Alternative Techniques

The category of "alternative techniques", which is used by french researchers and professionals in urban hydrology (Chocat, 1997, pp. 968-979), and which is resumed in this report, brings together techniques whose principles are said to be opposite to the "pipe" technique's. However, when put into practice, these techniques reveal themselves to be complementary to the sewer system, for they are generally placed as outlets to the existing sewer system, or set up in parallel to it. These techniques have been developed from the 1970s on in order to address the increasing impermeability of urban soils and infrastructural limits, such as flooding and pollution of the receiving environment. They are designed to store stormwater during rain events and possibly filter them before discharging them back into the water treatment system or into a receiving environment (river, stream, etc.). Among alternative techniques, we principally notice basins, trenches, soakaways, ditches, and swales (Table 2)[4]. Some of these devices are landscaped and integrated into urban public spaces, such as parks, public gardens, and squares.

The implementation of alternative techniques in the 1960s and 1970s were related to problems with flooding and economics and concerned the construction of "New Towns" [*Villes Nouvelles*] and the extension of urban agglomerations[5]. According to those who promoted them, their use meant struggling against flooding at the least cost. In the case of the New Towns, the land built upon was difficult to drain, fairly flat, without natural surface water system. The construction of a sewer system proved to be very costly and the developers and town planners preferred less onerous solutions, such as detention basins (Chatzis, 1993, pp. 292-297). In the case of metropolitan extensions, the increase and concentration of flows of wastewater and stormwater caused the sewer system's saturation and an increase in flooding[6]. Rebuilding the network to increase its capacity seemed too expensive to local communities. In order to surmount the difficulties and to allow the conurbations' development, storage devices were deployed. In city centers, detention structures were integrated into the existing sewer system. On the outskirts of the city, less densely built, lot scale and neighbourhood scale devices where implemented, such as swales, ditches and basins.

From the 1980s and especially the 1990s, the use of alternative techniques were encouraged by some stakeholders involved in water management, including state services, local communities,

1- See for example, for France, Frioux, 2009, p. 285.

2- Sabine Barles (1999, p. 331) for example cites Able Wolman (1965) and Eugen P. Odum positions (1954) on urban waste.

3- Thus they tend to recast principles in use in the 18th century city and urban society.

4- There also exist various detention structures built under roads, in buildings basement or on their roofs.

5- New Towns were built in the 1970s to relieve the urban pressure on existing cities and restructure urban development around major metropolises, for example l'Isle-d'Abeau east of Lyon, and Cergy-Pontoise in the Parisian Region.

6- The increase and concentration of stormwater (runoff) was due to an increase in soil impermeability.

and urban hydrology researchers. At the national level, the Urban Plan [*Plan Urbain*] for the Ministry of Public Works [*Ministère de l'Équipement*] surveys the use of these techniques (*Plan urbain,* 1985)[1]; the CERTU disseminates practices and procedures to help stakeholders wishing to put them into practice (CERTU, 1998)[2]; and researchers provide information on the choice of techniques and their design. At the local level, local communities seek to establish methodological guidebooks, standardising and optimising existing practices (Azzout et al., 1994)[3].

Table 2. Brief description of the main alternative techniques for urban stormwater management (according to Chocat, 1997).

Device	Principles	Description
Basins [*bassin*]	Storage areas, that infiltrate stormwater through soil or discharge it into a natural environment or sewer system (with a regulated flow)	ponds [*bassins en eau*]: landscaped excavated areas with a permanent water pool; basins [*bassins secs*]: surface-level excavations, dry most of the time, that can be detention or infiltration basins, landscaped or not underground detention systems [*bassins enterrés*]: great variety of material and design of storage systems
Soakaways [*puits*]	Vertical holes, either empty or filled with porous material, that temporarily store water and then discharge it directly into the soil	infiltration soakaways [*puits d'infiltration*]: stormwater goes through a layer of non-saturated soil, which assures a certain filtration of pollution injection soakaways [*puits d'injection]:* stormwater is directly injected into the water table. That sort of soakaway is more likely to put underground water at severe risk of pollution and is sometimes forbidden.
Trenches and French drain [*tranchées*]	Horizontal excavations filled with porous material that collect and discharge stormwater into the soil or towards an outlet	filter and infiltration trenches [*tranchées d'infiltration*]: stormwater is infiltrated through the soil detention trenches [*tranchées de rétention*]: stormwater is discharged towards an outlet (i.e. sewer, drain) with a regulated flow
Ditches [*fossés*] and swales [*noues*]	Horizontal excavations that collect and discharge stormwater through the soil or towards an outlet	infiltration ditches and swales: stormwater is infiltrated through the soil detention ditches and swales: stormwater is discharged towards an outlet (sewer, drain) In the category of ditches, swales are distinguished by being large and shallow constructions. They are often covered over with grass.

2.3. SUDS

SUDS (Sustainable Urban Drainage Systems) designate in Great Britain drainage components and principles considered as more sustainable than conventional drainage methods (CIRIA, 2007, p. XXV). SUDS components store stormwater and discharge it into receiving waters, either through soil infiltration or evapotranspiration, as close as possible to the source. This category includes trenches, filter drains and filter strips, swales, soakaways, detention and infiltration basins, wetlands, green roofs, etc.[4] Their implementation in the 1990s seemed linked to the rise of environmental preoccupations and to the spread of sustainable development principles. SUDS

1- This service develops both research programmes and practical experiments for the Ministry's account. It was replace in 1998 by the PUCA (*Plan Urbanisme Construction Architecture* - Urban Planning, Construction, and Architectural Plan). See http://rp.urbanisme.equipement.gouv/fr./puca/index.htm (Nov. 22, 2013).

2- Study Centre on Infrastructure, Transportation, Urban Planning, and Public Works [*Centre d'études sur les réseaux, les transports, l'urbanisme et les constructions publiques*]. See http://www.certu.fr/ (Nov. 22, 2013).

3- For example, that was the case of the Urban Community of Bordeaux [*Communauté Urbaine de Bordeaux*].

4- These devices can also be qualified as "best management practices" (United States) or source control (McKissock et al. 1999, p. 47) Here we employ the most common term used in Wales.

were promoted as devices limiting the pollution of receiving environments. First, stormwater does not run as much on polluted surfaces and objects[1]. Second, the techniques used encourage the settling of polluting particles before discharging stormwater into the environment. The development of SUDS also tended to fall into a strengthening of European law related to water management and the protection of natural environments, especially wetlands (Clifforde and Morris, 1995, p. 600)[2].

The first SUDS were built in the 1990s starting with Scotland, and then in the rest of the United Kingdom[3]. Some of them were integrated into public urban spaces such as parks, public gardens, and squares. At the beginning of the 2000s, they were the subject of technical guidebooks, notably published by the Construction Industry Research and Information Association (CIRIA, 2000)[4].

3. Research Hypotheses

In both cases, alternative techniques and SUDS tend to be put into place "against" the sewer system, involved in floods and pollution of natural environments. Thus, the same arguments in their favour are put forward: a reduction in flooding, a reduction in wetland pollution, a control of urbanisation impacts (for example heat islands), and water presence in urban environments[5]. The use and diffusion of alternative techniques and SUDS proceeded from an evolution of management practices for urban water, concerning technical devices, organisations, the legal framework, water services, urban uses, and so on. In practice, despite the efficiency of these devices in what concerns stormwater management and their consistency with the rise in environmental concern, they seem to remain partly experimental and are not yet common practice.

Some first observations of the case in Lyon allows for the proposal of a series of hypotheses on diffusion conditions for alternative techniques and SUDS[6]. The difficulties raised by the diffusion of these techniques would come from the robustness of the network. This technical device seems to be well adjusted to today's social norms of use and making, norms that are reflected in political, economic, and social organisations (labour and marlet organisations, use of commons and public space, etc.). The diffusion of alternative techniques and SUDS would depend on their

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1- In the 1980s, studies proved that stormwater contains pollutants. This pollution is due to atmospheric pollution and to leached surfaces (zinc and copper roofs, roads, facades, etc. - Chocat, 1997, p. 804).

2- Especially Directive 76/160/CEE from Dec. 8, 1975 concerning bathing waters quality, Directive 91/271/CEE from May 21, 1991 concerning urban waste water treatment and Directive 2000/60/CE from Oct. 23, 2000 establishing a framework for a Community action in the field of water policy. Directive 91/271/CEE made the collection and treatment of urban effluents obligatory (domestic, industrial and storm water). Directive 2000/60/CE requires the establishment of a system of water governance by hydrographic regions and sets out deadlines for water bodies to reach a "good ecological and chemical status ". All of these directives must be incorporated into the law of each member country.

3- This gap can be explained by variations in institutional and regulatory frameworks within the United Kingdom, and by a Scottish framework that was more favourable to new techniques. These variations result from the present process of devolution (McKissock et al., 1999, p. 47).

4- CIRIA is e reference body in the United Kingdom concerning standards for the construction industry.

5- See for example the guides published by CERTU (2008) and by CIRIA (2007). The convergence of arguments can be explained by the spread of experiments and exemplary cases as well as the intensity of exchange amongst researchers and between researchers and practitioners in the 1990s and 2000s. These exchanges especially concern researchers in urban hydrology, local communities officers and network managers. They took place through meetings and professional associations, scientific and technical publications, conferences, and research programmes, for example the Scientific and Technical Association for Water and Environment (*[Association scientifique et technique pour l'eau et l'environnement]* (ASTEE), the TSM Journal, "NOVATECH" conferences and "International Conferences on Urban Drainage", and the European Daywater and PREPARED programmes (Deroubaix et al., 2000).

6- For a first version of these hypotheses, see Berdier and Toussaint, 2007.

ability to fit into this adjustment, or else to establish new norms more consistent with their functioning. In this sense, our research hypotheses concern on one side the incompatibility of these devices to the existing urban environments (H1) and on the other side the inertia of these urban environments faced with these new devices (H2).

H1: The incompatibility of alternative techniques and SUDS to present urban environments would be in large part economic, technical, and organisational.

- This would stem from the low level of technicality of these devices. Their added value would be affected by this level of technicality: the higher a device's technicality, the greater the added value expected from its making, and the more important the resource for the organisations involved in the making of this device[1]. In this sense, alternative techniques and SUDS, whose design and implementation are often less sophisticated, thus less expensive, would not be economically viable.
- It would be connected to the existing technical environment: alternative techniques and SUDS would be incompatible with other urban techniques (techniques for cleanliness, mobility, construction, etc.) blocking or compromising their implementation or functioning.
- It would result from the multi-functionality of alternative techniques and SUDS (flood prevention, stormwater management, green spaces, urban public space, etc.). This quality would bring into question the configuration of existing stakeholders, especially the organisation and management of the city through specialisation (green spaces, sewers, drinking water, highways, etc.)[2].

H2: The inertia of urban environments when faced with alternative techniques and SUDS would be especially technical, organisational, and social.

- It would result from the sophistication of existing organisational and technical devices. Activities relative to the making of urban devices are increasingly segmented, which implies the development of coordination activities. This sophistication also results in investments in machines and the agents' education that need to be amortized.
- It would result from the technical and organisational efficiency of the sewer system. Despite the forementioned criticism, the service that the sewer systems renders is still considered as satisfactory.
- It would be due to the suitability of the technical and organisational devices making up the network to social organisation, especially the social organisation of labour. To most of individuals, this system of organisation leaves little time outside of their participation in production activities[3]. Individuals' lack of availability would encourage a collective support system for urban services. Typically the stormwater is managed via a collective device, the network, to the detriment of an individual undertaking, for example lot scale water management through swales or basins.

1- Included in "making" activities are the design, construction, management, maintenance, destruction, and recycling of technical devices.

2- This segmentation also concerns the assignment of responsibilities relative to the devices and to the effects of their functioning. Thus, the distribution of responsibilities would be made difficult when making alternative techniques and SUDS.

3- See publications by André Gortz (1988) on work and Vareilles, 2006, pp. 222-228, 285-286.

Study Sites and Research Methods

The inquiry set into place deals with urban development projects that integrate alternative techniques or SUDS. Given the previously accumulated knowledge and the partners of the programme, the case studies are located in Greater Lyon and Wales[1]. Greater Lyon appears to be a pioneer in alternative techniques: the first projects integrating these techniques were started in the 1990s. Wales' interest in SUDS is more recent and dates from the end of the 2000s.

Research protocol includes an analysis of the documentation produced during the urban development projects under investigation –including technical notes, presentation posters, correspondence, and so on– as well as a series of interviews with the stakeholders involved in these projects, especially in the choice of stormwater management devices. The implementation of research methods varies according to case study. The studies in Lyon were carried out in the framework of doctoral research (Patouillard, in progress). All of the research methods were applied in these case studies that therefore constitute the main terrain. The Welsh studies are more summary and are based on two research projects carried out in collaboration with Pennine Water Group's research group (Larnaud, 2011; Montoya, 2011)[2].

1. Research Sites

The presentation of the research sites concerns both local communities studied. French and British contexts, especially legal and regulatory, are presented in Annexes 1 and 2.

1.1. Greater Lyon

Greater Lyon is an inter-municipal structure organised in the form of an "urban community" [*Communauté urbaine*][3]. It has about 1.3 million inhabitants divided into 58 municipalities over a surface area of 510 km^2[4]. Its jurisdiction includes highways, drinking water, sewers, garbage disposal, mobility, parking, the environment, urban planning documents, the economic development scheme, and conurbation scale public facilities[5].

1- These two local communities were involved in the PREPARED programme. Moreover, there are several collaborations in place with Greater Lyon as part of national research programmes (ANR PRECODD 2008 Projects, ANR 2009 Sustainable Cities OMEGA, ANR CESA 2011 CABRRES, and ANR ECOTECH 2011 MENTOR).

2- These projects involved 5th year students in the Department of Civil Engineering and Urban Planning of the INSA Lyon.

3- According to law n. 66-1069 of Dec. 31, 1966 relative to urban communities, introducing urban communities into four French conurbations, namely Bordeaux, Lille, Lyon, and Strasbourg. The Lyon urban community was created on January 1, 1969. This new organisation meant sharing skills amongst municipalities and the urban community.

4- Including Lyon, Villeurbanne, Vaulx-en-Velin, Vénissieux, Pierre-Bénite, Saint-Fons, Rillieux-la-Pape, Craponne, Marcy-l'Etoile, Ouillins, etc. See http://www.grandlyon.com (accessed Nov. 28, 2013).

5- Green spaces are managed by municipalities. In this manner, the management and maintenance of alternative techniques integrated into green spaces are shared between Greater Lyon and the municipalities.

From the beginning of the 1990s, Greater Lyon, and especially the Department of Water supported the implementation of alternative techniques for stormwater management. This support was made manifest in the elaboration of a community strategy to encourage the implementation of alternative techniques in zones to be urbanised (Grand Lyon, 1992a). This strategy concerned changes in urban planning and stormwater management regulation, especially in the local urban plan, and the construction of exemplary projects, for example the construction of the Lyon Technology Park[1].

The encouragement and development of alternative techniques within Greater Lyon was supported by an important and continuous process of collaboration and exchange between practitioners and researchers that had been going on for about thirty years. These collaborations and exchanges involved officers from the Department of Water and researchers belonging to research organisations of the Lyon conurbation (INSA Lyon, ENTPE, University of Lyon 1, CNRS, etc.). Problems encountered in the management of stormwater were discussed and answers and solutions suggested[2]. These collaboration and exchange were more broadly included into the activities of GRAIE (Rhône-Alpes Research Group on Infrastructure and Water [*Groupe de recherche Rhône-Alpes sur les Infrastructures et l'Eau*])[3].

1.2. Wales

Wales has 3 million inhabitants distributed over 20,780 km^2. Water service is privatised; thus water management is principally shared among private enterprises, the Welsh Parliament, Ofwat, the Environment Agency, the countryside council, and local authorities.

- There are two private companies in Wales: DCWW and Dee Valley Water. DCWW (*Dŵr Cymru* Welsh Water) has been managed by Glas Cymru since 2001, and is a company limited by guarantee. This status means that all of the profits generated by the company are reinvested into water management. DCWW manages drinking water and wastewater including stormwater for all of Wales except a sector located in the north-west, which is under the responsibility of Dee Valley Water.
- The Welsh Parliament provides strategic and regulatory documents concerning stormwater management. The encouragement of SUDS notably appears in two documents published respectively in 2004 and 2012. Technical Advice Note (TAN) 15 states that SUDS "should be implemented, wherever they will be effective, in all new development proposals" (Welsh Assembly Government, 2004, p. 10). Planning Policy Wales classes SUDS among the "features that provide effective adaptation to, and resilience against" climate change (Welsh Assembly Government, 2012, p. 64).
- Ofwat inspects water companies on economic terms. It especially surveys service fees and use of these fees. These verifications among others are listed on the five-year Asset-Management Plan (AMP), which is signed by water companies and Ofwat.
- The Environmental Agency implements the Central Government (London) and Welsh Government policies regarding environmental protection and improvement as well as the encouragement of "sustainable development".

1- This project was included in the case studies.

2- They came out as the set-up and carrying-out of common research programmes and the construction of an Observatory of Urban Territory and Hydrology [*Observatoire de terrain en hydrologie urbaine*] (OTHU). The observations are made possible by fitting with instruments the facilities of the Department of Water (detention and infiltration basins). Thus the facilities functioning could be monitored, hydraulic models better set out, or new technical devices or management practices tested. See http.//www.graie.org/othu/ (accessed Nov. 28, 2013).

3- The GRAIE is an association created in 1985 to network stakeholders in urban water management, including local communities (Greater Lyon, municipalities, Departments, Rhone-Alpes Region, etc.), researchers, technical study companies, water agencies, associations, and so on. The association participates in the spread of information and research results. It is also involved in working groups on the elaboration of legislative texts. See http://www.graie.org/ (accessed Nov. 28, 2013).

- The Countryside Council takes action regarding the protection of vulnerable receiving waters, such as already-polluted areas, those likely of becoming so, or those which present a low rate of self-purification[1].
- Local authorities are responsible for administering their territories[2]. This responsibility especially concerns environmental protection, highways, and urban planning. Also, local authorities write local urban plans and process building and planning applications[3]. Those are agreed if the planned project is in conformity with the planning documents in force, unless material considerations justified a different decision. In this way, local authorities may authorise projects that depart from planning and building regulations, or refuse requests that do conform.

The case studies are located within the territory covered by DCWW. This water company put into place in 2007 a Surface Water Management Strategy (DCWW, undated; MWH, 2010)[4]. Surface water includes all of the water present at the soil's surface, whether it be stagnant or running, including stormwater. This strategy aims at improving water management in order to better comply to environmental regulation on effluents discharged into wetlands and to reduce flooding caused by system overload. This Strategy encompasses a series of actions including diagnostic surveys, reports on foreign experiences, educational campaigns aimed at stakeholders in hydrological domains, interventions on private lots, and more rarely participation in planning projects. Some actions concern the promotion of SUDS: on the one hand they involve studying existing developments using these techniques in order to learn lessons relevant to Wales, and on the other hand they involve building showcase projects[5].

This strategy was the subject of discussion with Ofwat in 2009, during the renewal of the Asset Management Plan (AMP) for the 2010-2015 periods. The discussions concerned the strategy funding. DCWW may have used the capital generated by water fees, but only if Ofwat acknowledged this strategy as beneficiary for water management[6]. This recognition was conditional on the positive results of a cost-benefit analysis, which DCWW found difficult to prove. Thus the strategy was modified in order to answer Ofwat's demands. In its modified version, the actions concerning surface water are aligned with Ofwat's existing requirements. Water companies indeed have to keep a register of flooding by system overload, and to resolve issues causing flooding[7]. They are allowed to use resource from water fees, in accordance to their AMP[8]. DCWW succeeded in linking this requirement with its strategy aiming at implementing

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1- In April 2013, the Environment Agency, Countryside Councils, and Forestry Commission were brought together under a new organisation, Natural Resources Wales.

2- Wales is made up of 22 local authorities who are led by an elected council.

3- Before 2004, planning documents were called Unitary Development Plans (UDP), and after 2004 and a political reform of the Welsh planning system, they were called Local Development Plans (LDP).

4- The Surface Water Management Strategy was written by an internal DCWW group, locally referred to as SWEAR (Surface Water Elimination and Reduction) and by a Design Company external to DCWW.

5- Today, the stormwater management context in Wales has changed following a change in legislation and a reorientation of DCWW's strategy. In 2010, the Flood and Water Management Act made the creation of a SUDS Approval Body obligatory and placed it under the responsibility of local authorities. Moreover, DCWW has reviewed its priorities since 2011. It has since then concentrated its resources on its obligation to take care of sewers that had been private until now, to the detriment of surface water management. Due to this fact, stormwater management depends more and more on local authorities.

6- Without this recognition, DCWW must use other resources.

7- This register includes flooding by system overload on private property and in urban public spaces, especially roads.

8- Water companies commit themselves to quantitative goals. In DCWW's AMP, more resources are allocated to resolve flooding issues that concern private lots, and especially flooding inside houses, than to resolve flooding issues affecting urban public spaces. It should also be noted that DCWW reimburses entirely or in part bills of clients whose houses have been flooded.

SUDS: Ofwat agreed that 1/5 of flooding issues would be solved using SUDS, provided that these solutions cost no more[1].

1.3. Case Studies

We have chosen four case studies: two are located in Greater Lyon, and two in Wales. These studies (Table 3) concern urban development projects integrating alternative techniques or SUDS and considered as exemplary for stakeholders in water management[2]:

- Jacob Kaplan Park (Lyon);
- Lyon Technology Park (Saint-Priest, Lyon);
- Single-family-homes in Cross Roads (Holywell, Wales);
- Gatewen Village (Wrexham, Wales).

Table 3. Case studies.

Cases Studied	Type of development or Intervention	Alternative Techniques, SUDS	Years
Jacob Kaplan Park (Lyon)	Redevelopment of an industrial area, construction of a group of residential buildings, offices and a public park.	Infiltration and detention basin	2000-2007
Lyon Technology Park (Saint-Priest)	Construction of a tertiary activity zone	Drainage trenches and swales, detention and infiltration basins, infiltration ditches, drains	1992-2011
Cross Roads Houses (Holywell)	Retroffing on a malfunctioning sewer system	Soakaways	2010-2011
Gatewen Village (Wrexham)	Real-estate development (single-family-homes with yards)	Detention and infiltration basins, soakaways	Since 2003

These developments principally occurred throughout the 1990s and 2000s, and the first three are finished. They involve Greater Lyon for the cases in Lyon and DCWW for the Welsh cases. The choice of these projects was made with regard to the stormwater management devices implemented (detention and infiltration basins, swales, draining trenches, etc.), the nature of the development (construction of residential buildings, urban public spaces, urban renewal, retrofitting, etc.), the stakeholders involved (local communities, water companies, technical study offices, etc.), and the financing methods used (public financing through taxes, or private through owners, investors, or developers). Even if these case studies are not exhaustive, they allow for a consideration of several types of urban developments involving alternative techniques or SUDS. In this sense they constitute "scenarios in a finite universe of possible configurations" [*« cas de figure dans un univers fini de configurations possibles »*] (Bourdieu, 1994, p. 16). Through their differences, they allow for an understanding of the reasons motivating stakeholders to put alternative techniques or SUDS into place, for example economic, organisational, urban planning, technical, environmental or political reasons[3].

1- That is, a goal of 133 issues for 594 identified issues. This represents 12.4 million pounds (about 14 million euros in 2009).

2- The stakeholders in Lyon consider the two Lyon case studies as "successes": they were cited on posters presenting Greater Lyon's water policy; they were subject to technical visits; and the Jacob Kaplan Park was given a prize by the Architecture, Urban Planning, and Environment Council [*Conseil d'architecture, d'urbanisme et de l'environnement*] (CAUE). The exemplary character of the Welsh cases is based on their novelty, SUDS being little implemented in Wales.

3- Here we are referring to Pierre Bourdieu's point-of-view on how the social world is understood: "All of my scientific work is indeed inspired by the conviction that we can only understand the deepest logic of the social world by immersing ourselves in the particularity of an empirical reality, which is historically and temporally specific, but constructing it as a "special case of the possible" according to a phrase by Gaston Bachelard (…)." [*"Toute mon entreprise scientifique s'inspire en effet de la conviction que l'on ne peut saisir la logique la plus profonde du monde social qu'à condition de s'immerger dans la particularité d'une réalité empirique, historiquement située et datée, mais pour la construire comme 'cas particulier du possible' selon un mot de Gaston Bachelard […]*"] (Bourdieu, 1994, p.16)

2. Research Methods

The case studies are supported by an analysis of the documents produced during the projects and interviews. The use of these research methods and the data collected varied according to the case study.

2.1. Document Analysis

A document analysis was carried out before stakeholders were interviewed. It aimed at collecting data on activities related to the projects: project chronology, organisation of stakeholders involved, developments and constructions built or planned, stormwater management devices installed or planned, financing methods, etc. It aimed at collecting information on the condition for the adoption of alternative techniques or SUDS in developments. The document analysis focused on the "traces" produced by project activity, that is to say[1]:

- Notes and documents, such as technical notes, letters, emails, plans, application files, public survey records, etc., circulating among the stakeholders involved in the project; through the circulation of these documents, the stakeholders interact and define together the contents of the project who together constitute a collective statement (Toussaint, 1996).
- Documents destined for the urban public, such as presentation posters, communication documentation, municipal bulletins, press articles, records and minutes of local community councils, etc.

For the cases in Lyon, part of the documents analysed came from the local communities' Internet sites (especially council records and communication documents on the projects), press reviews from the Lyon Urban Planning Agency [*Agence d'urbanisme de Lyon*] (press articles, and municipal and community bulletins) and Greater Lyon archives (letters, technical notes, initial studies, application files, etc.). Other documents were given by the stakeholders interviewed. For the Welsh cases, part of the documents studied came from the internet sites of the organisations concerned by stormwater management, such as DCWW and local authorities, and another part was given by the stakeholders interviewed.

The archival work concerned only the development of the Lyon Technology Park. It was carried out from March 2011 to February 2012. The Greater Lyon archives have many documents related to this development[2]. These documents were issued by the Porte des Alpes local mission, which managed this project[3]. The mission collected, sorted, and added the document to the archives in 2010. The inspection and analysis of the documents involved the creation of a database where all documents were recorded and classified[4]. One-hundred-forty documents were thus referenced. They concerned stormwater management, project coordination, administrative procedures, and communication documents.

1- "Traces are more-or-less permanent pieces of material evidence generated by the activity. For example, memos, intermediate or final responses recorded on paper are traces. (…) As its name indicates, a trace is just limited information on the activity producing it." [*"Les traces sont les indices matériels plus ou moins permanents produits par l'activité. Par exemple, les brouillons, les réponses intermédiaires ou finales portées sur le papier sont autant de traces. […] Comme le dit son nom, la trace n'est qu'une information partielle de l'activité qui le produit."*] (Vermersch, e2006, pp. 20-21).

2- These documents include 173 archival boxes, measuring 17 linear metres –if the boxes were placed side-to-side, and over a hundred multimedia documents (CD-ROM, posters, plans). At the moment of the survey's undertaking, the documents had not yet been treated by the archival service –that is to say sorted, inventoried, and classified; they were only summarily classified by theme. One of these themes concerned stormwater management. The documents consulted appeared in the provisor

3- "Porte des Alpes" was the name of the urban project during which the Lyon Technology Park was built. A local mission is a team dedicated to such urban projects.

4- The database was created with LibreOffice. Each document was photographed or scanned and had a form in the database indicating the date the archival document was inspected, the file's document name, the document's reference, and a resume of its contents.

The document analysis was thematic and concerned planned or implemented stormwater management devices. It aimed at collecting factual data on the project and the reasons motivating the stakeholders' actions. It meant identifying the progression of technical devices (types, functioning, and forms) and the organisation of the stakeholders involved in the elaboration of these devices.

2.2. Interviews

The interviews complete the document analysis. They aimed at rounding off and confirming the data collected in this analysis. The interviews are carried out with the stakeholders involved in the implementation of the alternative techniques or SUDS in the case studies, including local community officers, the personnel from water companies, landscapers, developers, and so on (Table 4). The prior document analysis allowed for the establishment of an initial list of stakeholders to interview; following the first interviews, this list was amended.

Our corpus was made up of interviews carried out in 2004, 2011, and 2012. The oldest interviews came from a previous research project on the "social acceptability" of alternative techniques of stormwater management[1]. Most interviews were individual and were carried out in the office of the individual interviewed. Some stakeholders were interviewed twice, with the second interview allowing for a complement to the data collected during the first interview. These stakeholders are associated with two interview numbers in Table 4 listing the interviews. The issues addressed during the interviews were site development, the stormwater management devices implemented, the stakeholders involved, and the role of the stakeholders interviewed and their organisation in stormwater management. Most of the interviews were recorded and transcribed; others were subject to a detailed report (indicated by an asterisk). All of the interviews were thematically analysed regarding the stormwater management devices and their development during the project.

Table 4. Interviews and interviewees list.

No.	Function & Organisation	Year	Case Study
1	Project Manager, Technical Study Office, Highways and Utilities Infrastructures	2004	Lyon Technology Park
2	• Strategy and Sustainable Development Engineer, Department of Water, Greater Lyon • Officer, Studies Office, Studies and Works Service, Department of Water, Greater Lyon	2004	Lyon Technology Park
3	Head of Service, Development Service, Urban Planning and Development Delegation, Greater Lyon	2004	Lyon Technology Park
4	Officer, Development Service, Urban Planning and Development Delegation, Greater Lyon	2004	Jacob Kaplan Park
5	Technical Director, Developer	2011	Jacob Kaplan Park
6 7	Network Planning Manager, Asset Strategy and Planning, DCWW	2011	Cross Roads Houses
8 9	Flooding Performance Manager, Asset Strategy and Planning, DCWW*	2011	Cross Roads Houses

1- This research project was financed as part of Rhone-Alpes Region priority themes. It falls within the framework of Action 8, "Increased Knowledge of the Social Acceptability of Innovative Solutions" of the Programme "Mastering the Flows of Pollutants in the Urban System: Definition of an Environmental, Technical, and Socioeconomic Evaluation Method of Stormwater Management Strategies through Infiltration in Urban Areas." For the results of this research, see Berdier and Toussaint, 2007.

No.	Function & Organisation	Year	Case Study
10 11	• Investment Manager, Asset Strategy and Planning, DCWW • Consultant, Asset Strategy and Planning, DCWW	2011	Cross Roads Houses, Gatewen Village
12	Project Chief, Hydraulic Technical Study Office*	2011	Cross Roads Houses
13	Project Chief, Buildings and Public Works Company*	2011	Cross Roads Houses
14	Buildings and Public Works Company*	2011	Cross Roads Houses
15	Foreman, Buildings and Public Works Company*	2011	Cross Roads Houses
16	Neighbourhood inhabitant*	2011	Cross Roads Houses
17	Inhabitant*	2011	Cross Roads Houses
18	Wastewater Strategy Manager, Asset Strategy and Planning, DCWW	2011	Gatewen Village
19	Technical Manager, Developer Services, DCWW	2011	Gatewen Village
20	Technical Manager, Developer Services, DCWW	2011	Gatewen Village
21	Design Engineer, Buildings Technical Study Office, Civil Engineering and Planning	2011	Gatewen Village
22	Technical Engineer, Developer and Builder	2011	Gatewen Village
23	Regional Technical Manager, Developer and Builder	2011	Gatewen Village
24	Planning Officer, Local Urban Planning Office, County Borough of Wrexham	2011	Gatewen Village
25	Officer, Local Urban Planning Service, Delegation for Urban Development, Greater Lyon	2012	Lyon Technology Park
26	Landscaper	2012	Jacob Kaplan Park
27	• Officer, Green Assets Management Service, Green Space Direction, Lyon • Officer, Environment Service, Green Space Direction, Lyon	2012	Jacob Kaplan Park
28	Area Officer, Green Space Direction, Lyon*	2012	Jacob Kaplan Park

2.3. Data Collected

This section (Table 5) summarises the implementation of research methods and the data collected for the case studies.

Table 5. Data collected by case study and research method implemented.

Case Study	Document Analysis	Survey of Interviews
Jacob Kaplan Park	Administrative acts (records), press articles Thematic analysis	5 interviews (2004-2012) Recording and transcription of interviews Thematic discourse analysis
Lyon Technology Park	Municipal archival work: Technical documents and administrative acts Creation of a database Thematic analysis	4 interviews (2004-2012) Recording and transcription of interviews Thematic discourse analysis
Cross Roads Houses		12 interviews (2011) Recording and transcription of 5 interviews Thematic discourse analysis
Gatewen Village	Technical documents collected in interviews Thematic analysis	8 interviews (2011) Recording and transcription of interviews Thematic discourse analysis

Case Studies

Four case studies were carried out. They especially attempted to describe the choices made in stormwater management technical devices during development projects, and to account for the reasons why these choices were made. Given the variations between the research project's implementation protocol, the Lyon cases are developed in greater extent and are better referenced than the Welsh cases[1].

1. Jacob Kaplan Park (Lyon)

Jacob Kaplan Park is roughly a 5,000 m^2 city park located in the 3rd Arrondissement of Lyon, in the Part-Dieu neighbourhood, near the TGV station and a large shopping mall. The Part-Dieu neighbourhood is a downtown area that includes residential buildings and offices as well as shops and restaurants. The park is surrounded by residential buildings and a school. It has been built as part of a ZAC [*Zone d'aménagement concerté*] ceded to a private developer, the Jardins de la Buire ZAC[2]. This ZAC stretches over 5.5 hectares of brownfield and its plan includes public buildings (day-care, school, public park, community hall) and residential and office buildings[3].

The park is made up of grassy areas including a lawn, an ornamental pond, a detention and infiltration basin as well as paths (Figure 1, Figure 2). The lawn constitutes the central part of the park. It has several trees planted on it and includes two playgrounds for children. The ornamental pond is located in the north-west, between the lawn and the detention basin. It is shallow and includes a grassy island at its centre planted with a pine tree. The detention and infiltration basin is a sunken space characterised by a supporting wall made of gabions separating it from the rest of the park. Water jets are integrated into this wall and feed a stream at the foot of the basin, over a part covered with stones[4]. The other part at the bottom is covered with grass. The other sides of the basin are made up of gentle slopes covered in vegetation stretching until the park's fence. A locked gate provides access to the basin, and is reserved to maintenance personnel[5]. The park

1- These variations notably concern the duration of the field studies. The French studies were stretched out over a year, while the Welsh studies lasted four to five months.

2- The ZAC [*zone d'aménagement concerté*] is at the moment the most common development procedure in France (Merlin and Choay, e2005, pp. 952-957). It begins at the initiative of a local community, and it can be carried out directly or by a planning sub-contract.

3- Measuring 140,000 m^2 of net building area [*Surface hors oeuvre nette*], distributed as follows: 64,000m^2 of housing (of which 20% is affordable housing), 68,000 m^2 of tertiary services, and 8,000 m^2 of public buildings. See http://www.lyon.fr/page/projects-urbains/quartiers-nouveaux-espaces/jardins-de-la-buire.html (accessed Dec. 12, 2012).

4- Gabions are metal containers filled with stones.

5- Due to its configuration, the detention and infiltration basin is called a "moat" by participants in the project (landscapers, Greater Lyon officers).

depends on the City of Lyon's Green Spaces Direction. It is enclosed and its opening hours vary according to season[1].

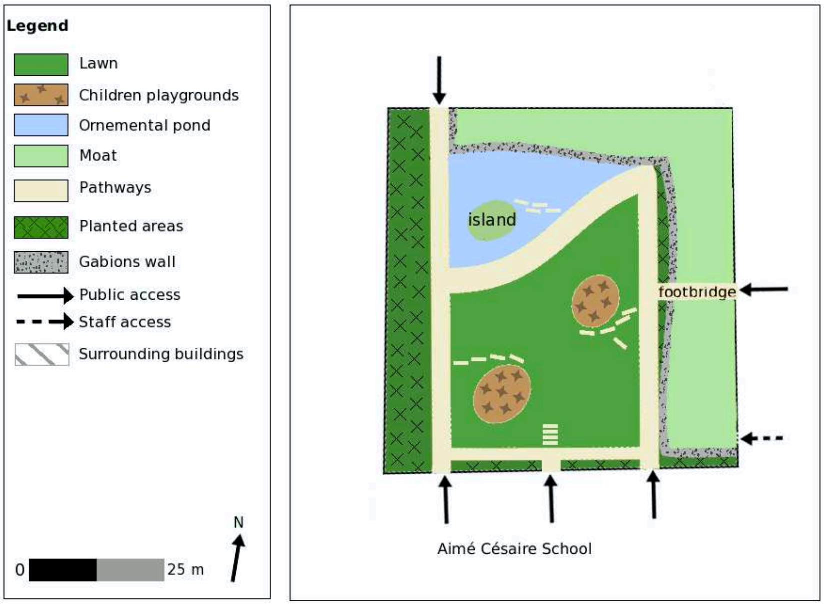

Figure 1. Schematic representation of Jacob Kaplan Park.

Figure 2. Photos of Jacob Kaplan Park. The detention basin is in the foreground (2011).

1.1. Technical Devices for Stormwater Management

The technical devices for stormwater management in Jacob Kaplan Park concern "clear" stormwater from residential buildings. This includes roof water and runoff from the spaces located within the lots; and excludes road runoff[2]. Three types of devices have been set up: a system of pipes, a detention and infiltration system, and a storage system (Figure 3). The buried system of pipes collects clear water from most of the residential building lots and directs them towards the park[3]. This water is distributed among the storage system and the detention and infiltration system.

1- 8am - 7pm from October to April, 8am - 10pm from May to September.

2- These spaces have a contributing area (that is to say the area that contribute to runoff) of 2.7 hectares.

3- Stormwater from the residential buildings located in the north is only partially collected. This limitation is linked to the difficulties in separating clear water and connecting it to the built detention and infiltration devices.

The storage system is made up of two cisterns. The first is installed in the school's crawlspace[1]. It serves to water the school's green spaces and is linked to a second cistern buried at the park's north-west corner. This second cistern provides the water for the ornamental pond, the fountains, and the park's automatic sprinklers. The fountains work on a nearly closed circuit[2]. Waters from the cistern, via the water jets, supply the ornamental pond, which in turn supplies the detention and infiltration pond through weirs built into the gabion wall. Water from the detention basin is pumped and redirected towards the cistern[3].

- The detention and infiltration system includes the detention and infiltration basin and a distributing element built into the north-west corner of this basin. It is meant for 20-year rains.

The construction of these devices meant installing solenoid valves on the pipe network, one pump in each cistern, probes allowing for the water level's measurement in each cistern, command boards, and remote-control transmission devices[4].

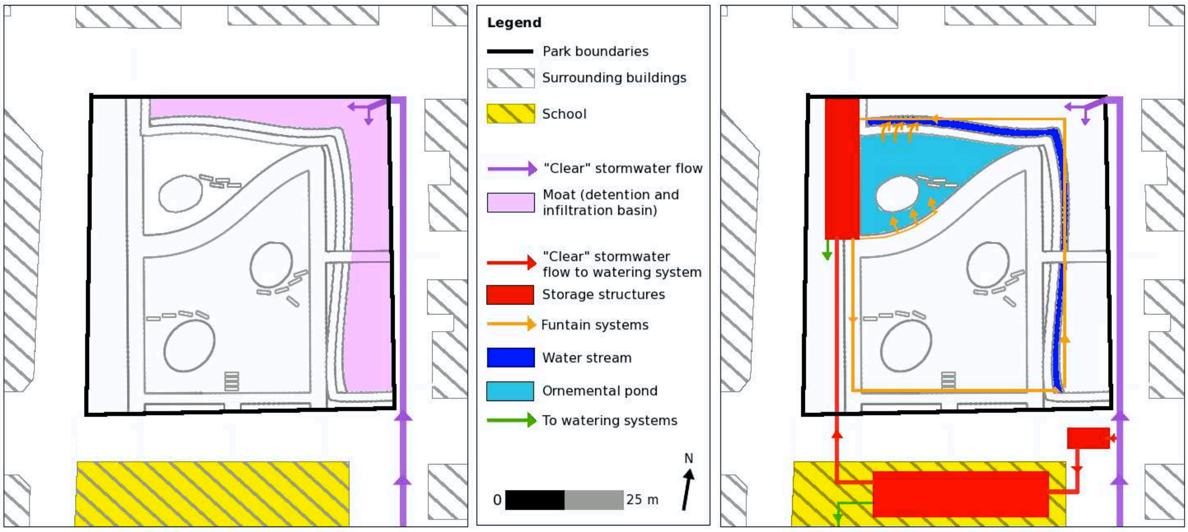

Figure 3. Schema of the stormwater management devices in Jacob Kaplan Park. Right: the storage and reuse device (when the weather is above freezing). Left: the detention and infiltration device.

1.2. Project Chronology[5]

Jacob Kaplan Park falls under the Jardins de la Buire ZAC's Programme for Public Facilities [*programme d'équipements publics*]. The integration of stormwater management devices into the park is linked to the ZAC's development, which was carried out by a private development company created by the lands' owners in 2000 (Figure 4). This *ad hoc* structure hired a project manager [*assistant à maîtrise d'ouvrage*] and a designing team made up of an architecture and urban planning agency, a design company specialised in highways and utilities infrastructures, and a landscaper from 2006 on. This team was charged with making an overall plan for the ZAC and its public facilities, including the park.

1- This 150m³ cistern is part of a larger device for the management of stormwater set up to store the school's stormwater. This building also has green roofs. The municipal authority is responsible for the school's management, as well as for Jacob Kaplan Park.

2- The circuit's closure is not perfect because of evaporation; thus a regular external resupply of water is necessary. The fountains only work when the temperature is above freezing.

3- The fountains are programmed on a daily cycle allowing for a variation in water heights in the basin throughout the day.

4- Solenoid valves are directed by an electric current.

5- This chronology focuses on the planning and construction of the park's stormwater management devices.

In 1995, the first negotiations on the future of the industrial lots took place between the lots' owners and the communities involved (Greater Lyon and the City of Lyon). They would not be followed up until the early 2000s. In 2000, the owners created a development company to develop their land. This company ordered some studies for a development and made contact with Greater Lyon[1]. Between 2000 and 2004, the ZAC's development was discussed among the developer and the local communities involved[2]. Some of the negotiations were about stormwater management. From the very first negotiations, Greater Lyon's Department of Water informed the developer on the local community's policy in favour of *in situ* detention and infiltration devices. This policy (Grand Lyon, 1992a) aims at limiting massive discharges into the public sewer system. In the beginning of the 2000s, it had not been reflected into any statutory clauses[3].

The procedure for the ZAC development began in January 2003[4]. An emergency procedure aiming at rewriting the planning document then in force, as required by the project, was also started in May 2003[5]. However, when the developer submitted its application for the ZAC development to the planning authority, there was no local stormwater management: all stormwater was to be discharged into the urban sewer system. The developer justified using the sewer system over alternative techniques through technical, economic, and environmental arguments. According to the developer, using alternative techniques would:

- cause the water table's pollution if the water filtered through polluted soils;
- be difficult given two levels of parking, made obligatory by urban planning regulations;
- would compromise the development's viability, making the lots' resale too difficult due to management constraints that would be too difficult for future buyers.

In negotiations with Greater Lyon, the developer insisted on additional delays that the application's modification and a new submission to the community would cause: time required for Greater Lyon's services to examine the new application, to approve it and to begin the other administrative procedures needed[6]. Thus a modification to the ZAC's application would delay housing construction, whereas its approval would ensure their construction before the 2008 municipal elections[7].

The elected members of Greater Lyon thus had to arbitrate between the Department of Water and the developer. In October 2003, the application for the ZAC development was approved. It included a draft Plan for Public Facilities to which the developer had to contribute (school group, a community hall, a day-care, and a public park). The question of stormwater management had not yet been solved and was the subject of negotiations between Greater Lyon and the developer. The planning document's revision was endorsed in March 2004. Thereafter, the final version of the Plan for Public Facilities was approved. Stormwater from roads and clear water were to be managed separately, and the charges were to be deferred to the local community. Thus, water from roads would be accepted into the sewer system –a preferred solution due to the amount

1- Especially the Local Urban Planning Service and the General Delegation on Urban Development. The urban community is responsible for ZACs and deals with them through two dedicated services to manage them: the Local Urban Planning Service (during the planning phase) and the Development Service (during the construction phase).

2- Greater Lyon is responsible for urban planning and water, and the City of Lyon for green spaces.

3- In the 2000s, this policy was adopted in two statutory texts: The Wastewater Public Service Regulation adopted in 2004 (Grand Lyon, e2012, art. 22 and 23) and the Local Urban Plan (art. 4 and 13).

4- The ZAC procedure includes two steps: first the approval of its "creation" (application defining mostly its perimeter and objectives), then the approval of its "realisation" (application detailing the contents of the developement, its public facilities and their financing). In this case both applications were made at once in order to speed up the process.

5- The planning document in force was then called "*Plan d'occupation des sols*", meaning Zoning Regulation.

6- I.e. the planning document's emergency modification procedure necessitating a public enquiry.

7- Housing construction, especially in the downtown, is an important political and social issue in the Lyon conurbation given the difficulties inhabitants of Lyon have in procuring housing (Grand Lyon, 2007, p. 14).

and type of pollution coming from it. Clear water from lots would be directed through an ensemble of pipes and managed in a detention and infiltration system buried under Jacob Kaplan Park[1]. The system of pipes and the detention and infiltration works would be retroceded local communities, who would be responsible for management and maintenance. The agreement also provided for a transfer of investment costs through an additional participation of Greater Lyon in the ZAC's balance sheet[2].

Based on this Plan for Public Facilities, the developer hired a landscaper to design the Park Kaplan. The landscaper proposed to showcase water with fountains, an ornament basin and a moat around the park that would also be a detention and infiltration basin. The fountains and sprinklers were to be supplied from a borehole to the water table. This design was submitted to Greater Lyon for approval of the stormwater management system, to the City of Lyon for the park's future management, and to the DRIRE due to the drilling to the water table[3]. The local communities approved the proposed design, but the DRIRE refused it. Greater Lyon's Department of Water judged this design to conform to its expectations for stormwater management. The City found that the drilling was a good solution for the economic and ecological issues because it avoids the consumption of drinking water. However, the DRIRE opposed this solution because it carried risks of polluting the water table through contaminants present in the soil. Following this refusal, the City's Green Spaces Service and the landscaper made an agreement on the use of clear water to ensure this supply. This solution, which was accepted by the developer, needed a change to the initial design. This change resulted in the present park's set-up: a pipe system, a stormwater storage and reuse system made of two cisterns, and a detention and infiltration system.

Preliminary studies and design phase lasted about six months. The park construction began in 2006. It was completed in the beginning of 2007 and inaugurated by the local communities in 2009. Jacob Kaplan Park is now an example of stormwater management integration in urban environments recognised by planning and water management professionals, including planners, urban designers, landscapers and local communities[4].

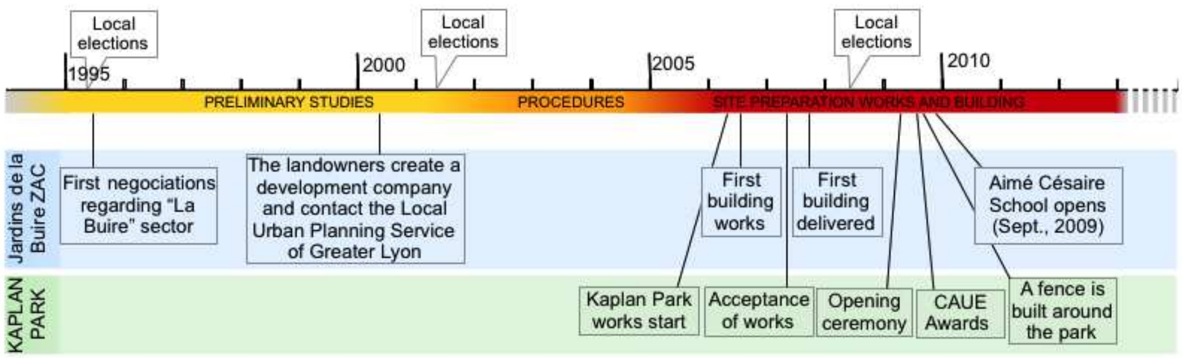

Figure 4. Main steps in Jacob Kaplan Park's urban planning project.

1- Made of honeycombs blocks.

2- This additional investment was 640,000 € including taxes.

3- The City of Lyon has responsibility for green spaces and therefore for the park's upkeep and maintenance, including the fountains and sprinklers. Greater Lyon ensures maintenance of other hydraulic devices. The DRIRE or Regional Directory for Industry, Research and Environment [*Direction Régionale de l'Industrie, de la Recherche et de l'Environnement*] is a decentralised State agency, depending on the Ministries responsible for the environment, industry, research, transportation, and labour. In 2009, DRIRE were replaced by DREAL (Regional Directory for Environment, Urban Planning, and Housing) [*Directions Régionales de l'Environnement, de l'Aménagement et du Logement*].

4- It was awarded the 2009 "Urban Planning and Landscaping" prize by the Rhone Council of Architecture, Urban Plannning and the Environment (CAUE).

1.3. Technical, Political, Economic, and Organisational Choices

The use of alternative techniques for this development was especially due to Greater Lyon's Department of Water, the City of Lyon's Green Spaces Service, and the landscaper. Economic, technical, organisational, and political choices were at stake.

Greater Lyon preferred alternative techniques in order to limit discharge into the sewer system and thereby ensure the system's proper functioning as well as a good service level. In this respect, encouraging alternative techniques meant for Greater Lyon ensuring the sustainability of the sewer system, not its disappearance. The Department of Water saw the ZAC des Jardins de la Buire's development at the beginning of the 2000s as an opportunity to promote Greater Lyon's water management policy, and especially alternative techniques in densely urbanized area. Thus the project acquired an exemplary character for the local community, which could explain its position towards the developer[1].

At the beginning of the project, the developer refused to use alternative techniques on its lots. In his opinion, these techniques would compromise the lots' marketing and the development's viability by imposing on future buyers more constraints than the sewer system would. These constraints are linked to the "individual" management of these techniques, in comparison to a "collective" management through the sewer system, which falls under public domain and the community's responsibility. When Greater Lyon proposed a "collective" solution through a pipe system and a detention and infiltration basin located in the public domain, the developer accepted this idea and participated in its elaboration through the Jacob Kaplan Park project. Thus, these techniques take part in the economy of the ZAC: their implementation and the amenity space they form add value to the surrounding lots[2].

2. Lyon Technology Park (Saint-Priest)

The Lyon Technology Park is a tertiary sector activity zone located in Saint-Priest, a municipality in Lyon's eastern suburbs. Greater Lyon built it between 1992 and 2011[3]. Its development was part of a large-scale urban project called the "Porte des Alpes", started by the urban community in 1991. This project aimed at structuring eastern Lyon's urban development and improving the image of the east of the conurbation compared to the west (Gallot-Delamézière, 2007, p. 44). The Technology Park was part of this project: it aimed at attracting high added-value activities and international-scale companies, by "developing industrial activities together with quality landscaping and urban integration" ["*reconciliation entre activités industrielles, qualité paysagère et insertion urbaine*"] (Greater Lyon, 1996). At the beginning of the 1990s the Porte des Alpes project also included an enlargement of the University of Lumière Lyon 2 and the construction of about 200 housing units (Figure 5)[4]. It was modified in the 2000s, and then extended over 1,450 hectares (Figure 6).

Near motorway A43, the Technology Park stretches over 140 hectares and is characterised by many green spaces (70 hectares or 50% of the total surface area), three water stretches of 4 hectares, and a relatively low built density (SERL, undated). It includes companies that are part of

1- Today, the local communities often cite the project in their communication. See for example Grand Lyon, 2010; Sibeud, 2010; Soulier-Bouvin, 2012.

2- Finally the stormwater management devices proved to be less costly than expected and the savings were devoted to other park elements, for example playgrounds.

3- It was one of the first tertiary-sector developments under Greater Lyon's direction. The "Economic Development" service was transferred to Greater Lyon's municipalities in 1992 see http://www.40ans.grandlyon.com/?p=5625 (accessed Dec. 5 2013).

4- Either single-family-homes or small buildings of collective housing units.

the “superior” tertiary sector such as engineering companies, environmental services, biotechnology, and health; and business services such as restaurants, a hotel, and a business centre. It represents about 6,000 jobs.

Figure 5. The Porte des Alpes project in 1994 (Grand Lyon, 1998).

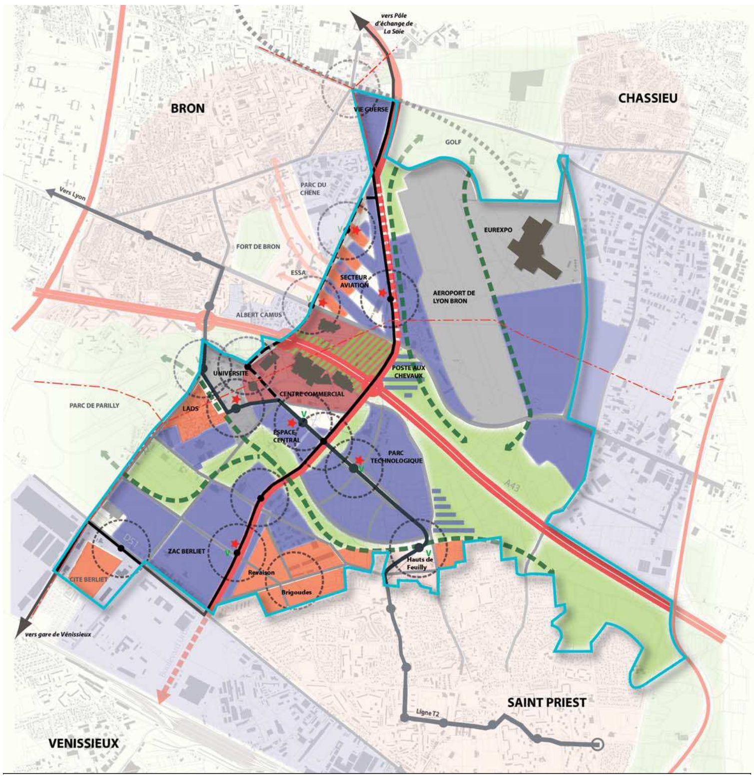

Figure 6. The Porte des Alpes project in 2008 (Grand Lyon, 2008).

2.1. Stormwater Management Technical Devices

The stormwater management system implemented in the Technology Park manages the lots’ and routes’ stormwater. It includes on-site detention devices as well as detention and infiltration devices installed on a parcel near the park, the “Minerve Sector” (Figure 7). Most of these devices are landscaped. Their management depends on Greater Lyon, namely the Department of Water’s hydraulic works, and the green spaces' management depends on the Department of Logistics and Buildings. In both cases, the upkeep and maintenance of the devices are delegated to an external management company[1].

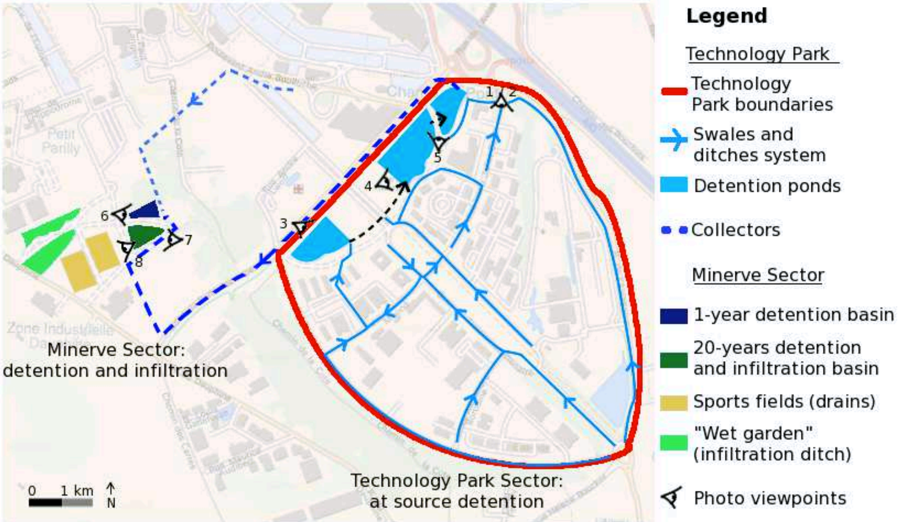

Figure 7. Schema of the stormwater management system's principle of the Technology Park (IGN Raster base map, 2012).

Stormwater from private lots and roads are drained through a set of ditches and detention swales (Figure 8, Figure 9),[2] which directs them towards three landscaped wed detention ponds constructed in cascade (ponds 1, 2, and 3)[3]. Ponds 1 and 2, called "*Lac de Feuilly*" and "*Lac des Perches*" are equipped with water jets that go off according to a random rhythm, in order to scare off birds and limit their presence on the site (Figure 10)[4]. The banks of these two ponds are

partly occupied by a reed bed (

1 Since the project's start, two malfunctions were noted: the introduction of fish into the detention basins (1998) and non-conform connections to the stormwater network (2001). According to Greater Lyon, the introduction of fish compromises the landscape quality and attracts birds, whose present disturbs the proper functioning of the nearby Bron airport. The development of fishing which seemed to be the goal of introducing the fish also raises sanitary risks linked to water quality, contamination of the fish caught, and their consumption.

2- These devices do not allow infiltration.

3- Due to their configuration, they are categorised as "lakes" [*lacs*] in project documents.

4- Given their function, these water jets are called "scarers".

Figure 11). Pond 3, "*Lac des Mouilles*", is smaller than the first two and completely covered with a reed bed (Figure 12). These three basins were designed for 100-year return period rains and ensure summary stormwater treatment, to which the reed beds contribute. A pump ensure the water circulation throughout the three ponds, The hydraulic elements through which the water flows are designed to facilitate the settling of floating material and suspended particles present in the water[1]. The circulation of water, which encourages the process of oxygenation, may be stopped in case of pollution: each pond may be isolated by manually closing valves. The pump is also used during dry periods to supply ponds with underground water via a borehole, in order to maintain the lakes' water level.

Figure 8. Swale, Irène Joliot-Curie Alley, Technology Park (2011)

Figure 9. Swale, Irène Joliot-Curie Alley, Technology Park (2011)[2]

1- The inflow runs through a sand-trap (allowing the separation and storage of hydrocarbons, oils, and greases contained in water) with a siphon wall (which forces the flow downwards, thus trapping less dense matter on the upper part); overflows between ponds are aslo equipped with siphon wall

2- The swales shown in Figure 8 and Figure 9 had the same original configuration. In order to facilitate pedestrian access, this one was covered over with wooden planks.

Figure 10. Pond 1 or "*Lac de Feuilly*", Technology Park (Winter 2011)

Figure 11. Pond 2 or "*Lac des Perches*", Technology Park (Winter 2011)

Figure 12. Pond 3 or "*Lac des Mouilles*", Technology Park (Winter 2011)

During periods of heavy rain, the excess stormwater (exceeding the capacity of the three ponds) is discharged at a controlled flow rate into a collector built under the adjoining urban boulevard after having gone through the basins. Afterwards, the stormwater travels to the Minerve Sector, located several metres from the Technology Park. This area is equipped with detention and infiltration devices receiving stormwater from the Technology Park and other nearby spaces – including the shopping centre[1]. Contrary to the stormwater from the Technology Park, stormwater water from other areas has not undergone any pretreatment. This is why the systems in the Minerve Sector also aim at pretreating the water (by decantation) and thus limiting the transfer of pollutants into the underlying soil and aquifers during infiltration. The detention capacity relies on to basins. The first basin is enclosed and is designed for 1-year rains (Figure 13). The second one is landscaped and open to the public, and is designed for 20-year rains (Figure 14). The infiltration system consists of a large infiltration ditch with aquatic plants[2], and a system of drains, which is buried under two football fields. These fields are moreover submersible and represent an additional detention capacity –up to 100-year rains (Figure 15). Stormwater flows via overflows through the different elements of the Minerve sector as following: it arrives at the first detention basin, spills into the second detention basin, then goes into the infiltration ditch, and finally into the system of drains. In case of accidental pollution, valves allow the detention basins to be isolated.

Figure 13. Minerve's first detention basin (Winter 2011)

1- Prior to the developement of the Technology Park, there was a detention basin nearby the shopping centre, dedicated to storing its stormwater. This was not supposed to change; however due to changes in the project, the lot the basin occupied was required for another purpose. Thus a collector directing stormwater from the shopping centre towards the Minerve Sector was built.

2- Thus called a "wet garden".

Figure 14. Minerve's second detention basin (Winter 2011)

Figure 15. Minerve's sports fields (Winter 2011)

2.2. Project Chronology[1]

The construction of a Technology Park was part of the "Porte des Alpes" urban project. This project began in 1991 with a master development plan design. The winning team was declared in 1992 and consisted in an architecture agency and a design company. From 1992 to 1994, feasibility and preliminary studies for the Technology Park were carried out. The overlying principles for stormwater management were established. The park's development was subject to constraints on non-built space. According to the planning documents in effect, the zone was classified as "of landscaping interest"[2]; this classification aimed at creating a "green corridor" between agricultural spaces and a great urban park (Grand Lyon, 2010, p. 12)[3]. It limits built areas to 50% of the total surface area. In 1994, the master development plan for the Porte des Alpes project was endorsed and the operational phase began. The Technology Park was built through two ZACs:

- The Perches ZAC was created in 1994 and measures 39 hectares;
- The Feuilly ZAC was created in 1995 and measures 85 hectares.

The stormwater management devices present in the Technology Park were planned and built during these procedures. Both ZACs were granted to SERL, who signed a concession contract with a design team in 1995[4]. This team was made up of an architecture agency and two technical study offices, of which one was specialised in urban water management. It had to elaborate a preliminary plan for water management infrastructure. Works on the Technology Park began in 1997 and ended in 2002.

Technical devices for stormwater management outside of the Technology Park (the collector and Minerve Sector) were developed through projects directed by Greater Lyon starting in 1995. The Greater Lyon's services designed the collector conveying stormwater from the park to the Minerve Sector. The urban planning of the Minerve Sector was studied by the Lyon Urban Planning Agency and a landscaping agency. In 1997, a design team was chosen through a public

1- This chronology focuses on stormwater management devices.

2- The master plan for the Lyon conurbation "Lyon 2010", approved in 1992 (Agence d'urbanisme, 2010).

3- This is Parilly Park.

4- SERL [*Société d'équipement du Rhône et de Lyon*] is a mixed private-public development company. This status applies to companies where the majority of the capital is held by public organisations. SERL's public shareholders are local communities.

competition and the management of the project was handed over to SERL. The collector and Minerve Sector were finished in 1998 (Table 6)[1].

Table 6. Main steps of the construction of stormwater management devices for the Technology Park.

Developments	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Technology Park (all)	Yellow	Yellow	Yellow	Yellow	Orange							
Perches ZAC						Orange	Red					
Feuilly ZAC									Orange	Red	Red	Red
Collector						Yellow	Orange / Red	Red				
Minerve Sector					Yellow	Yellow	Orange	Red				

Colour code. Yellow: preliminary studies; orange: operational studies; red: construction works (concerning stormwater management devices).

The development of the stormwater management system for the Technology Park is based on deliberations and studies carried out in the 1970s by Greater Lyon, and especially the Department of Water. The local community then planned for the development of the eastern Lyon conurbation and for possibilities of water management beyond the sewer system whose extension seemed very costly[2]. It meant thinking about the least costly forms of urban extension. In this context, solutions implying detention and infiltration devices were set up in this zone in the 1980s, for example in the Champ du Pont shopping centre[3]. At the beginning of the 1990s, these deliberations were concretised in a Greater Lyon master plan for water management (Grand Lyon, 1992a), which established stormwater management specifications for each catchment basin[4]. For the Technology Park sector, Greater Lyon specified the use of detention and infiltration basins (Grand Lyon 1992a, p. 197). In 1993, the Department of Water realised a draft for the water management system in the Technology Park (Grand Lyon, 1993), in conformity with the specifications of the Water management Master Plan (Figure 16).

1- The Technology Park's development and its stormwater management devices required administrative acts and procedures: impact studies, public enquiries, archeological digs, applications for declaration of public utility, etc. These administrative acts and procedures, which can stretch over long periods, overlap here with operational studies. Their links with the design of stormwater management devices are indirect only, which is why we do not elaborate on this point in this report.

2- To this purpose, a hydrodynamic study evaluating the possibilities of infiltration was carried out in this zone (BRGM, 1977).

3- This is the forementioned shopping centre, located near the Technology Park.

4- These specifications remained optional until the 2000s, see *supra* §1 le parc Jacob Kaplan.

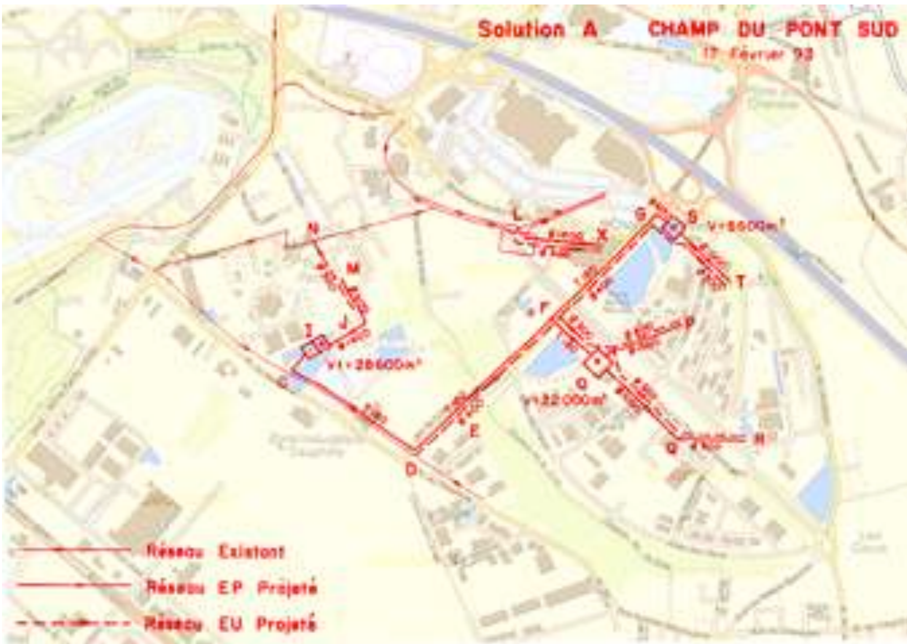

Figure 16. Draft of the stormwater management system for the Technology Park as established by Greater Lyon (Grand Lyon, 1993)[1].

Starting from this draft, the design team specified in a document entitled "*Système de l'eau - notice explicative*", the technical devices for stormwater management (functions, operations, configurations)[2]. The designer's report confirmed the choice of *in-situ* stormwater management via detention ponds[3]. It added that these ponds could serve as ornamental ponds adding value to the development and its surroundings. The stormwater management system and especially the development of ponds was thus adjusted to the statutory constraint on non-built-up spaces (50% of the total), and satisfied the landscaping quality which Greater Lyon wished to bring to the development (Grand Lyon, 1996). However the drafting of this document (Ove Arup, 1993) meant many discussions between the designer and the Department of Water. The discussions took place between September 1993 and March 1995 and especially focused on the consideration for future urbanised zones in the stormwater management system, on environmental questions concerning the detention ponds, such as water quality in the ponds and effluents, the risks of hyper-eutrophication of the ponds and the means to avoid them, and the sizing of the works[4].

After the creation of the Perches and Feuilly ZACs, a design company was charged with reviewing the stormwater management plan. Complementary studies were undertaken; they concerned stormwater pretreatment systems before their arrival into detention ponds and the design and management of water bodies. Following these studies, the number of detention basins was reduced (from four to three) and their configuration was modified (pond depth, vegetation in pond 3, and location of overflows). A "water mirror" was also added between ponds 1 and 2[5].

1- This is one of the propositions. EP means "*eaux pluviales*" i.e. stormwater, and EU means "*eaux usées*" i.e. wastewater. In order to demonstrate the proximity between this draft and the devices finally constructed, a plan dated 2012 (© Géoportail) was added to the background.

2- It especially involved the team's technical study office.

3- During this period, the system included four communicating detention ponds, an infiltration basin, a collector, and a system of pipes. Geological and hydrogeological studies were carried out by a design office during 1994 in order to check the possibility of locating the infiltration basins in the Minerve sector and to specify the design and construction of the detention ponds in the Technology Park (investigation about earthworks, reuse of extracted material, ponds waterproofing).

4- These themes appear when comparing the different versions (six in total) of the document. Thus, discussions on stormwater management were carried on beyond the master development plan's approval in 1994.

5- A shallow basin designed to limit waves so that the water reflects the landscape. It was finally not built.

During this period, SERL studied the allocation of ownership of the spaces and technical devices built as well as their management. It meant sharing the responsibilities between the two local communities involved: Greater Lyon and the City of Saint-Priest. In 1995, a report (Architecture SA, 1995) established an owner and a manager for each technical device (Figure 17)[1]. This allocation is related to the statutory powers of each local community and was greatly discussed between Greater Lyon and the City[2]. The urban community accepted to take on the responsibility of hydraulic works, but was against managing green spaces[3]; the City also refused committing itself to its management. The negotiations lasted two years and in 1997, Greater Lyon consented to taking on all of the responsibility for managing the lakes, namely the hydraulic works and green spaces[4].

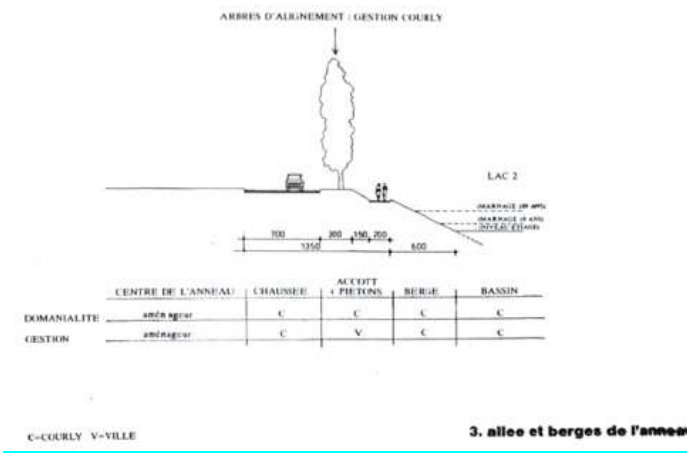

Figure 17. An example of the allocation of state ownership and the management of technical devices in basin 2 (Architecture SA, 1995)[5]

The design of detention and infiltration basins in the Minerve Sector began in 1995, after the elaboration of the master development plan for the Porte des Alpes project. This plan set certain goals for the sector's development, especially the limitation of built areas and respect for the zone of landscaping interest (Grand Lyon, 1992b). In this context, in 1995 and 1996, Greater Lyon studied different landscaping solutions. It ordered a study from the Lyon Urban Planning Agency on the uses of public space in the zone (May 1995). It also hired a landscaping agency to draft a chart of landscaping interest spaces, as well as a study to define the landscape of the infiltration basins (April-July 1996). Greater Lyon also asked the nearby organisations (City of Saint-Priest, University Lumière Lyon 2, the firemen) to create partnerships for this development. This meant creating multifunctional spaces, which would serve for the management of stormwater and other urban activities[6]. All of these organisations were interested in the development of sports fields, but only the university had the means to take on a part of the investment and the management of stormwater management devices. Thus the development of infiltration basins was made possible through the development of university football fields.

1- This report also covers an estimation of maintenance costs. Ownership and management is not necessarily granted to the same person.

2- Greater Lyon is responsible for highways and water, the City for green spaces.

3- Estimating that it did not have the material and personnel means to do so.

4- The negotiations between the local communities are also related to the allocation of the professional tax coming from this activity zone, due to Greater Lyon, which had been responsible for "economic development" since 1992. The City considered that the urban community, taking all the benefits from the development, should also take on all of the expenses linked to management.

5- C designates Greater Lyon (called "la Courly" from 1971 to 1991); V designates the City of Saint-Priest.

6- The Minerve Sector covers 10 hectares.

An engineering and architecture competition was launched in summer 1996 for the design of the Minerve Sector. It was based on a programme drawn from the landscaping agency's preliminary study (1996) and draft of the stormwater management system as established by Greater Lyon (1993). The organisation of the competition followed the legal procedure governing the attribution of public funds[1]. The technical commission and the jury examined the three design plans closely. Their discussions covered infiltration speeds of the proposed technical devices, the upkeep and management of sports facilities, the frequency of floods in the lots, the techniques used and projected development costs[2]. The winner was declared in July 1997. The plan included two detention basins, an infiltration trench, and a system of drains under the sports fields. It was built in 1998.

2.3. Political, Urban Planning, Technical, and Economic Choices

The decision to use alternative techniques in the Technology Park was made by Greater Lyon, especially the Department of Water. It was decided during the first years of the project and especially in 1993 with the elaboration of the stormwater management system draft (Grand Lyon, 1993). During those years, Greater Lyon controls entirely the project, for the Perches and Feuilly ZACs had not yet been granted to SERL. The stormwater management system's draft (Grand Lyon, 1993) established stormwater management principles for the park, especially in regards to the type of technical devices to use and their location (detention ponds in the park, detention and infiltration basins in the Minerva Sector). This plan remained stable throughout the project's duration, with marginal modifications.

The use of alternative techniques (swales, trenches, detention ponds and basins, infiltration ditches, and a drain system) into the park's development is due to broader scale Greater Lyon's policies. These policies concern water management and urban development, especially urban development in the eastern part of the Lyon conurbation. The use of alternative techniques allows for a less costly urban development in this zone for the community: limiting the use of the public sewer system avoids reworking it in order to increase its capacity. In the case of the Technology Park and the Minerve sector, alternative techniques also open up the possibility of landscaping: the zone of landscaping interest created allows compliance to the Master Plan of the Lyon conurbation.

3. Cross Roads Houses (Holywell)

The Cross Roads Houses are located in Holywell, which is a city of about 6,000 inhabitants in the north-east of Wales, in the Flintshire County Borough. These houses with yards are located near the River Dee's estuary, at the city's periphery. The south-west end of Cross Roads constitutes a low point and experiences regular flooding. These floods affect five individual houses (Figure 18). The intervention consists in separating wastewater and stormwater and installing a distinct network for stormwater. It is DCWW's initiative.

At the time of the study (Spring 2011), designs studies were in progress and construction was planned for summer 2011.

1- After an accord by the community council (September 1996) a tender for the competition was published in an official bulletin. After this tender's publishing, 11 candidates presented their applications and skill profiles (November 1996). Among these candidates, only six were admissible. The jury, which based itself on the work of the technical commission including officers from the urban community, retained three. Three months later, the candidates handed in their design plans. These plans were examined by the technical commission (February-April 1997), and then by a jury, who designated the winner (July 1997).

2- One candidate had proposed replacing the drains by soakaways. This solution was less costly, but the landscaping did not please the jury.

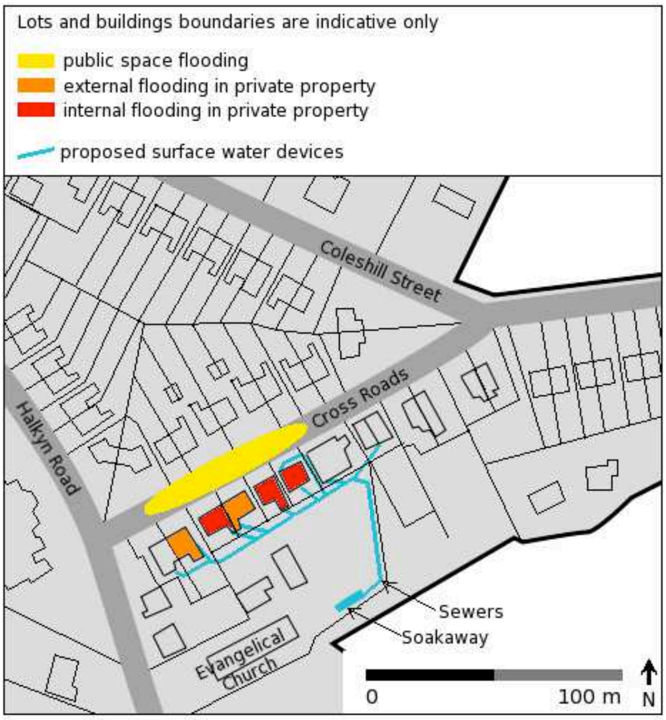

Figure 18. The location of flooded zones and new stormwater management devices of Cross Roads (pipes and soakaways).

3.1. Stormwater Management Devices

Before the intervention, stormwater management was managed by a combined sewer system, which collects all of the effluents (wastewater and stormwater) in Cross Roads, from the north-east towards the south-west, to Halkyn Road. The intervention aims at limiting the flow for this section. In the upper section of the street, effluents are diverted through new pipes and an existing pumping station towards the combined sewer system of Coleshill Street. In the lower section of the street, effluents are separated: wastewater remains in the same system but stormwater is collected into a specific sewer system. This meant modifying the collection of stormwater on roofs and installing new pipes in the houses' yards. The stormwater is then directed to a soakaway built on a private lot next to these houses.

3.2. Project Chronology

The creation of a separate sewer system and soakaway aim at limiting flooding in Cross Roads (Figure 19). In the 2000s, this road had several floods, which were due to the overflow of the combined sewer system. These overflows first affected the street, then the houses' yards, and finally the interior of these houses. It especially came from a man's hole located in the lower section of the street. Initially, to deal with this flooding, this man's hole was sealed. This closure caused overflows within the houses (July 2009)[1]. This situation caused DCWW to intervene as part of its programme for the resolution of flooding caused by sewer overflow established in 2007 (under Ofwat's watch).

1- About fifty floods had been recorded along this street by DCWW since the flood register is held. The first floods began in 2001 and the flood inventory revealed an increase in the frequency and size. Thus, the floods were recorded in 2001, then in 2003, then every year, and finally several times a year. They affected the street, the yards, and then the houses' interiors in 2009.

In 2010 DCWW asked its capital partner for the north of Wales (an engineering and construction company) to study these floods, namely to find out their causes to identify solutions[1]. In order to carry out this study, the capital partner relied on a design office, specialised in hydraulics. The study concluded that the combined sewer system was too small for rain events following the urban extension above the Cross Roads section. Following this diagnosis, DCWW undertook the resolution of this malfunction and asked its capital partner to propose solutions. Several solutions were imagined by the capital partner and the design office it had recruited:

- The augmentation of the existing combined sewer system's capacity;
- The construction of an additional detention tank on the existing combined sewer system;
- The deviation of flow crossing through the combined sewer system of Cross Roads towards the combined sewer system of Coleshill Street via an existing pumping station.

These solutions were not chosen. The first two were rejected relative to the costs they would entail. The rejection of the third solution was due to technical reasons. The existing pumping station's capacity was insufficient to evacuate all of the flow during rain events. Finally, a mixed solution including pipes and SUDS was elaborated. According to this solution, the upper and lower sections of Cross Roads would be treated differently, as described previously. This plan was proposed to DCWW, who approved it in January 2011. It should avoid private lots flooding, but overflow onto the street may continue.

The capital partner also directed the implementation of this solution. It included interventions on private lots: lots affected by flooding (equipped with pipes) as well as an adjacent lot, unaffected by flooding (equipped with pipes and a soakaway). The capital partner informed the lot owners and obtained their accord for the intervention. The inhabitants recognised that this development was a means of resolving this flooding and accepted the work. The owner of the adjacent lot, which was a place of worship, authorised the work on its lot under the condition that the pipes run along the border of the lot so that the rest of it remain constructible. The design was also submitted to the Environmental Agency and the Flintshire County Borough highway authority. The Environmental Agency approved the design[2]. The highway authority gave instructions on how long the works should last in order to reduce nuisances. Since the works required a closure of a street that normally gave access to a school, it asked that the works be carried out outside of school times. The capital partner planned the works for summer 2011. All of the works was estimated to cost 365,000 £ and was funded by DCWW[3].

Figure 19. Main steps in the Cross Roads houses intervention.

1- Capital partners are companies with whom DCWW has signed agreements for the undertaking of studies and projects, according to geographic sectors.

2- It only required invasive species control measures. The plant in cause is the Japanese Knotweed, present in some of the yards. The Environment Agency imposed confinement measures on excavated materials to avoid the plant's dissemination. Those requirements did not seem to be a problem to DCWW. At the moment of the study (Spring 2011), the on-site reuse of excavated materials as bankfill was under investigation. If unconclusive, the excavated materials treatment costs would be covered by DCWW.

3- In 2011 this represented 410,000 €.

3.3. Economic and Technical Choices

The choice of the stormwater management devices implemented belonged to DCWW, its capital partner, and the capital partner's sub-contractors. Within this group, the stakeholders were not equal. Their relationships were directed by contracts (contract between DCWW and its capital partner, contract between the capital partner and its sub-contractors). DCWW dominated the whole process. It approved and took control of all different steps of the intervention. The public affected by the project, such as owners who had flooding or those affected by the works, were excluded from the design process. They were consulted once the solution had been chosen in order to authorise the works that this solution would involve on their lots. They could only marginally affect the intervention: for example the church's request to bury the pipes at the borders of its land was accepted even if it meant an additional cost for DCWW.

The reasons leading these stakeholders to choose a solution including a soakaway were technical and economic. It meant solving a flooding problem at least cost. The least costly solution was implemented, especially compared to a remodelling of the sewer system or pumping station in order to increase their capacities, or the construction of a detention tank on the sewer system. The creation of a soakaway is thus complementary to the sewer system by ensuring the conditions for its proper functioning.

4. Gatewen Village (Wrexham)

The Gatewen Village is located in the northwest of Wales, in the Wrexham County Borough. It extends over 8 hectares and is under construction. The project was undertaken at the lot owners' initiative. It includes the construction of 200 single-family-homes[1] in a zone forming a green barrier aiming at protecting a space essentially covered in fields and forests from encroaching urbanisation (Figure 20)[2]. The housing estate is surrounded by residential zones, sports fields, and rural areas. A tributary of the Gwenfro runs along one side of the lot and then runs through the Gatewen Marsh, a wetland recognised as a Site of Special Scientific Interest (SSSI)[3]. Before the housing estate development, the site was used for industrial, tertiary, and agricultural activities. Its central section was occupied by an old coalmine that had been in use until the 1930s. After the mine's closure, some of the lands belonging to the old mine were used to store coal, and another part was used as test tracks and parking for transportation (trucks and buses)[4]. The other parts of the site include agricultural land in the northwest, an old paddock for the horses used to work the mine in the south, and a forested area on a steep slope in the northeast. The site included buildings and infrastructure associated with these activities, especially with mining, such as mine pits, underground tunnels, and railways[5]. The soil was also polluted with hydrocarbons and traces of metal.

1- This number has varied during the project. It was initially 250 single-family-homes which were supposed to be constructed. Due to the financial and banking crisis –which affected Great Britain in 2008 after the "subprime crisis" of 2007– and the resulting constriction of the real estate market, developers redesigned the plan to build less houses. The part allocated to affordable housing was also reduced, in agreement with local authorities (from 20% to 5%) in order to assure the project's viability.

2- According to the Unitary Development Plan of Wrexham County Borough, the planning document applicable in the sector. This plan was approved in 2005 and has been in effect until 2011. The green barrier includes a few farms and houses.

3- This classification creates obligations for the construction in regards to environmental protection. These obligations are defined by the Countryside Council for Wales, a Welsh organisation, in partnership with the Environmental Agency. See http://www.ccw.gov.uk/interactive-maps/official-maps-search/official-maps.aspx?sitetype=SSSI&sitecode=1065 (accessed Jan. 4, 2013).

4- Coal was stored in the northern part of the old mine.

5- Most of these activities continued until the developer purchased the lots.

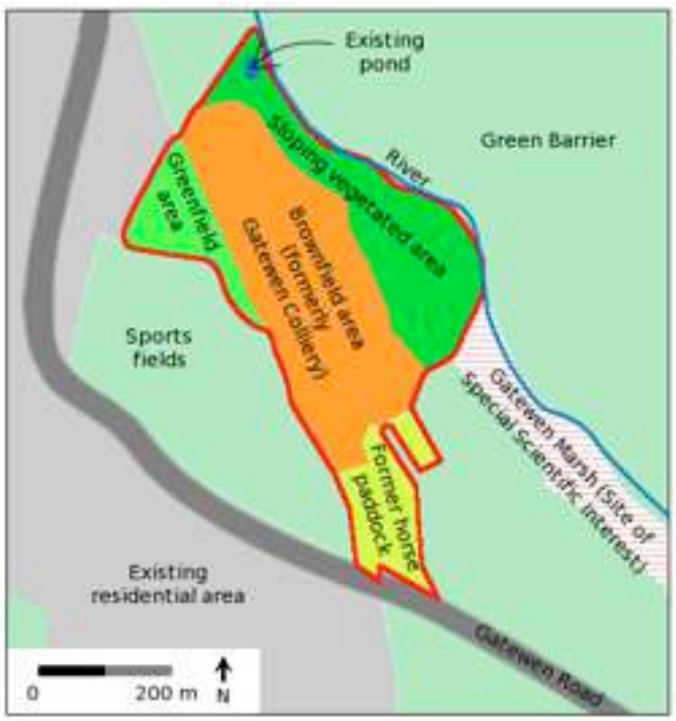

Figure 20. The site's occupation before the construction of Gatewen Village.

The development project had two phases, corresponding to the development of each of the two zones defined by the ridgeline–which is also the watershed divide[1]. The first phase concerned the southwest portion and included the construction of 76 houses and a public open space. The development of this zone was carried out in 2009 including lot servicing and public open space construction, and about thirty houses were built and put up for sale starting in 2011[2]. These single-family-homes with yard vary from two to five bedrooms. The second phase will include the construction of 150 to 200 houses in the north-western section. Its construction depends on the state of the real estate market and had not begun yet at the time of the study (2011). The data collected concern the master development plan and the construction of the first phase.

4.1. Technical Devices for Stormwater Management

The development project planned for the separation of stormwater on private lots –to be collectively managed– from water from the roads. The project also differentiates the management of stormwater according to the ridgeline and the project phases (Figure 21). Thus two different pipe systems were built for the southeast and northwest zones and function autonomously except during very heavy rains.

1- Altogether, the gradient is not very large (a maximum of several metres).

2- Sales are set to continue until 2013.

Figure 21. Stormwater management systems for Gatewen Village and photos of the basins and detention and infiltration trenches in the southwest zone (above: upper section; below: lower section).

In the southeast section, stormwater from private lots are directed through the pipe network towards an infiltration zone. This infiltration zone is located at the southern edge of the housing estate, near its entry, and is bordered by a road and pedestrian paths. It occupies the place of the old paddock, where no evidence of soil pollution was found and where the infiltration rate is sufficient. The infiltration zone is constituted of two shallow, grassy detention and infiltration basins with gently sloping sides. The two basins are separated from the pedestrian paths by a, half-metre high wooden fence. Another wooden fence surrounds the inlets (Figure 21). A gravel infiltration trench is built at the bottom of the basins[1]. The design for this infiltration zone takes account of current and future climate changes: flows equal to 100-year rains plus 30% where considered for calculations. In case of bigger rains, the basins are equipped with overflows directing the surplus flow towards the other stormwater management system of the housing estate, located in the northeast section. Runoff from the roads are collected separately and infiltrated by soakaways installed in the southern part of the housing estate. The soakaways are equipped with an oil trap in order to limit the pollution of soil and underground water.

The northeast part was not constructed at the time of the study. The system planned consists of two detention basins, set up in cascade in order to treat stormwater and then discharge it into the Gwenfro's tributary. The first basin will be constructed *ex nihilo*, while the second basin will results from the restructuring of an existing pond. At the request of the local authority of the Wrexham County Borough and the Environment Agency, the design and construction of these basins should allow for an improvement in the site's biodiversity by creating a wildlife habitat.

Several lots in the development are not connected to these two collective stormwater systems. These are lots in which the soil has not been polluted and can allow an infiltration of stormwater. In this case, stormwater is infiltrated through a soakaway built on each lot. Moreover, some of the houses are to be equipped with rainwater harvesting units[2]. This system includes a water tank,

1- This device is not visible since it is covered with grass.

2- Representing about 10% of the houses built or to be built. These numbers have been subject to discussion and negotiations between the project stakeholders. Given the project's ongoing nature, this may change.

buried in the yard and fitted with a filter and a pump. This tank supplies a tab located outside the house, as well as the toilets and washing machine via dedicated pipes.

The first phase of the project concerns the development of the south-eastern zone. Regarding stormwater, it includes the construction of the pipe network, the two detention and infiltration basins, the soakaways, and the rainwater harvesting systems. The responsibility for managing these devices is shared among the owners, the developer, DCWW, and the Wrexham Country Borough. The devices located on private lots, such as soakaways and rainwater harvesting systems are the owners' responsibility. The devices dedicated to highway water are the responsibility of the Highway authority of the Wrexham County Borough. The rest of the devices including the collection networks and devices for stormwater management built in public spaces are firstly the developer's responsibility, then DCWW's.

4.2. Project Chronology[1]

The Gatewen Village housing estate started in the beginning of the 2000s at the initiative of the owners of the lots (Figure 22)[2]. These owners ordered studies to evaluate the feasibility of building a residential project on their lands. These studies were led by a design team and included geotechnical studies on soil pollution, the drafting of a development plan, and studies on the servicing of lots, especially in regards to water management[3]. Given the site's configuration, the first studies showed the advantages of a stormwater management system disconnected from the city's sewer system. The advantage was above all financial[4]. The designer proposed to create a local management system consisting in two independent detention and infiltration systems based on the existing water divide on the site. This proposal was accepted by the owners.

An outline application for planning consent, based on this development plan, was submitted to the local planning authority for the Wrexham County Borough[5]. It was approved in March 2003. Nonetheless, difficulties linked to access to the lots did not permit the project's implementation within the delays established by the planning permission, which became void[6]. The development plan was reviewed and a new outline application for planning consent was submitted in June 2007. After consulting the organisations concerned, especially the Environment Agency, the local authority granted an outline approval with reserved matters in October 2007. The solution proposed for stormwater management was approved by the local authority because of its conformity to the Wrexham County Borough's position on flood protection and stormwater management. It also respected environmental and natural areas protection policies decreed by the Environmental Agency.

The reserved matters required the owners to negotiate and conclude agreements with the appropriate local authorities regarding public facilities, the management of the future housing estate, highways, and water management. Thus the owners had to sign a convention with local authorities determining the level of their financial participation for public facilities to the profit of

1- This chronology focuses on the design and construction of stormwater management devices during Phase 1.

2- The identity of these owners is not very clear in the documents consulted, since the owners appear under various aliases. It seems that some of the owners were involved in a private development company and took part in the project. The owners took on the project leadership for the development until 2009 when a development company bought the land in the southeastern zone and took over its development.

3- The design team included a geotechnical design office, an urban planning agency, and a all trades design office.

4- Connecting it to the sewer system meant the building of costly storage devices in order to limit the risks of saturating the network.

5- When granted, an outline planning consent stipulates the reserved matters, which are conditions the developer has to fulfil and additional elements he has to hand in in order to obtain the full planning consent, which allows the works to begin.

6- According to the first development plan, access to the lots was assured via a parcel that did not belong to the project developers and involving the purchase of this parcel. The difficulties encountered resulted from the owner's refusal to sell this parcel.

the housing estate's inhabitants, typically the schools, and specifying the design and management of the estate's open spaces, as well as the number of affordable houses. This convention required the recruitment of a management company for the management of the housing estate, especially open spaces management. The owners submitted their development plan to the authorities in charge of highways, drinking water, and water management[1]. The plan deals with phase one only, thus the discussions and negotiations that followed only concerned technical devices in the south-eastern zone.

Regarding stormwater management, the Highway authority and DCWW were consulted. They had to authorise the implementation of the technical devices proposed by the owners. The Highway authority examined the technical devices for the management of stormwater from roads (soakaways). It approved the owners' proposal and accepted to undertake the upkeep and maintenance of the works once the development was constructed. DCWW was consulted on the devices concerning wastewater and stormwater coming from private lots. Concerning wastewater, the water company carried out an impact study of the planned development on the existing sewer system. This study aimed at determining which improvements were necessary so that the development would not disturb the service level for wastewater management. The works needed were paid by the developer and the structures were then granted to DCWW, who ensures their upkeep and maintenance[2]. For what concerned stormwater from private lots, DCWW's developer services, especially the *New Development Consultancy*, examined the plans in regard with DCWW's policies regarding stormwater management[3]. As a general rule, all projects including collective devices for stormwater management were rejected[4]. In the case of the Gatewen Village, the person in charge of its evaluation saw an opportunity for this project to be part of the *Surface Water Management Strategy* developed by DCWW and integrated into its asset management plan. It sent the plan to the people involved in the programme. After approval by DCWW's executive board, Gatewen Village became part of this programme. Negotiations began between the owners and the water company and lasted for two years. During these negotiations, the owners sold the lands for Phase 1 (2009) to a development company, which carried on the discussions with DCWW[5].

The negotiations focused on the nature of the work, its management, and its configuration. DCWW considered that the planned system of pipes and basins was not sufficiently exemplary[6]. It asked the developer to include "at source" water management on the unpolluted lots allowing infiltration and stormwater harvesting. The developer included these requests in his development plan (November 2009). He built soakaways on unpolluted lots and installed harvesting units on 10% of the houses[7]. The management of stormwater management devices introduced some difficulties. In the context of discussions with the water company, the developer was asked to prove the durability of infrastructure in the housing estate, especially regarding stormwater

1- DCWW was a non-statutory consultee within the context of this project. Nonetheless the owners consulted this organisation and the DCWW got involved in the project.

2- By a transfer agreement as defined in the *Water Industry Act* of 1991, Section 104.

3- The NDC was originally an external service, which explains the term "consultancy" in its name. Today it is an internal service in DCWW.

4- DCWW supposed that these conditions did not in general allow for a good management of structures.

5- This development company is responsible for achieving the development of the site, building and saling single-family-homes. It does not question the site's design plans, especially the stormwater management system.

6- This solution was considered to be "end-of-pipe" in contrast to "at source" solutions which DCWW wished to promote through its *Surface Water Management Strategy*.

7- The requests also concerned the reduction in the use of drinking water, and the developer answered favourably. All of the requests aimed at improving the exemplary character of the project in order to obtained its integration into DCWW's asset management plan.

management[1]. SUDS management had no legislative or regulatory framework yet in 2000[2]. The management means were decided locally in an *ad hoc* manner. In the case of Gatewen Village, the developer considered to hand in the management of the basins either to the company managing the housing estate, to the Environment Agency or to the Wrexham County Borough.

The first solution was refused by DCWW, who did not want to delegate basin management to private companies. It preferred the participation of public organisations. However the two organisations considered refused: they thought that they lacked the necessary resources and legal skills to provide this service. In this context, DCWW decided to take on responsibility of the basins itself. This situation was unusual for the organisation[3]. It questioned the delimitation of its area of expertise and thereby the legality of DCWW managing the basins[4]. DCWW's legal service was asked to deliberate on the legality. A Queen's Counsel was also consulted in November 2009. It concluded that it was possible for DCWW to take responsibility for the basins on condition that they are juridically assimilated to a sewer. For this, an overflow had to be identified. This condition necessitated a modification of the system's configuration and an overflow was installed in the basins towards the network in Phase 2. Finally, the basins' configuration was subject to negotiations between February and March 2010. DCWW's developer services contested the structures' security due to slopes that were too steep and a water level too high during rain events. The development plan was also submitted to the Health & Safety service, which required a risk assessment. This assessment was carried out by the developer's generalised studies office[5]. This study surveyed the measures limiting the risks inherent to this kind of structure, namely gentle slopes, wooden fences indicating basins, grates installed on the inlets, and information panels on the structure's functioning. It also referred to the work done by CIRIA to justify the structure's sizing. Following exchanges between DCWW and the developer, the basins' slopes were modified and made gentler[6]. Thus the water level in the basin would be lower to it would be easier for individuals to get out of it. Finally, an agreement on the two detention and infiltration basins was made between DCWW and the developer in September 2010. During these negotiations, the relationship between these two stakeholders was tense; discussions delayed the beginning of construction and any additional delay represented a cost for the developer[7]. All of the reserved matters were addressed in 2010 and the developer obtained permission to begin the site preparation works in the summer of the same year. In 2011, the application for reserved matters regarding house building was submitted to the local planning authority that approved it. House construction began in 2011.

1- The developer thus had to produce many justifications to prove the efficiency and feasibility of the proposed systems. These justifications were based on normative documents published by CIRIA and on the realisation of a complementary study on hazard assessment and risk mitigation.

2- This situation changed with the publishing in 2010 of the *Flood and Water Management Act,* which decides that SUDS should be approved and managed by a dedicated service called "SUDS approval body".

3- The water company had always refused to take responsibility for this kind of stormwater management before this project.

4- It questioned the sharing of expertise and responsibilities among stakeholders in regards to water management and more broadly city management.

5- After DCWW had verified its competence in this field.

6- The gradient was 1 to 4 in the initial plan; it was limited as much as possible to 1 to 6 in the final plan.

7- That said, the developer wished to follow through on the negotiations and to obtain DCWW's authorisation to manage stormwater by a system of basins disconnected from the sewer system. Connecting to this network would represent a very great additional expense, which would put the whole development's profitability in question. DCWW's personnel who were interviewed justified this long negotiation process by the newness of the devices installed; personnel changes within the water company may also have slowed the process.

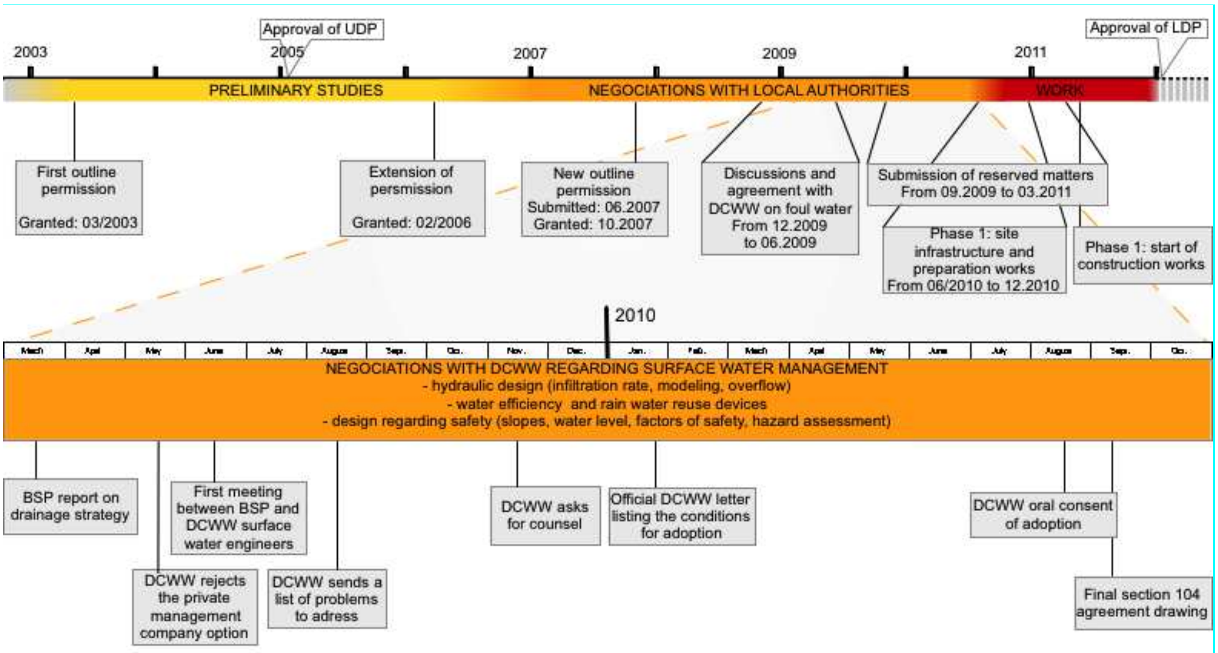

Figure 22. Main steps of the Gatewen Village.

4.3. Technical, Economic, and Organisational Choices

The choice of SUDS (detention and infiltration basins and soakaways) and their configuration depended on an initial group which included the lots' owners, the development company of Phase 1, the design offices, especially an all trades design office present during the whole planning phase, DCWW, and the local authority of the Wrexham County Borough. They were of technical, economic, and organisational nature.

The implementation of detention and infiltration basins appeared as an inexpensive stormwater management solution for the developer. It allowed to make up for the insufficiency of the public sewer system and to avoid soil pollution. It ensured in part the development's profitability. The developer accepted long negotiations with DCWW and its different services and to reconsider its plans in order to satisfy their requests, even if all of the requests were not directly linked to stormwater management or to the structures' functioning[1].

The choice of using SUDS was also part of DCWW's strategy. It fell under the policies it was promoting (*Surface Water Management Strategy*) and in respect of agreements with Ofwat (the asset management plan). The organisation's requests for the development aim at making it an exemplary case by increasing the SUDS installed (basins and soakaways). The people from DCWW interviewed during the survey in 2011 insisted on the experimental character of the development. A report on *Surface Water Management Strategy* proposed to make out of this development a showcase to present and encourage SUDS (Hyder Consulting, 2010, p. 5). Part of DCWW's requests also had to do with the recognition of this development by Ofwat as a development reducing flooding by overflow of the network. This recognition was granted and the development was integrated into the asset management plan concluded between DCWW and Ofwat for the 2010-2015 period[2].

The difficulties raised by the SUDS implementation in this project involve the sharing of expertise and responsibilities among the organisations in charge of water management and more

1- Typically, the installation of overflows in the basins allowed them to be classified as sewers. Despite the developer's interest for this stormwater management system and its exemplary character, it did not add any special value to the sale of the houses.

2- Namely the objectif to solve 133 flooding problems thanks to surface water reduction devices.

broadly the city's management. The upkeep and maintenance of SUDS questioned the sharing of expertise and responsibilities in effect. In this situation, no organisation appeared to be in a state to assume them. Legal studies have been carried out and a compromise has been made: DCWW, responsible for "sewers", would take charge of this infrastructure once it could legally be considered a sewer –by the addition of an overflow. This *ad hoc* arrangement implies a reorganisation of the water company[1].

1- These difficulties were in part solved by the *Flood and Water Management Act* adopted in 2010, attributing control over the design and management of SUDS to local authorities.

Initial Conclusions Regarding Technical Choices and Possible Conditions for Change in Stormwater management Practices

The case studies demonstrate that the implementation of alternative techniques and SUDS was principally due to technical, political, organisational, and economic reasons. It was always undertaken at the initiative of the organisation in charge of managing urban water (Greater Lyon for the Lyon conurbation and DCWW for Wales). To these organisations, alternative techniques and SUDS are considered as stormwater management at least cost, since they limited the modification, rebuilding, or extension of the network, interventions that reveal themselves to be very costly. The systems used in the case studies combined several devices such as detention and infiltration basins, swales, trenches, ditches, etc. These devices and the system they form did not seem to pose problems for the stakeholders as to their storage or purification efficiency. Difficulties were rather due to organisational considerations and linked to the devices' management. These were not allotted to one specific organisation[1]. Their hybrid character between a hydraulic structure and an open space makes it difficult to decide which organisation is responsible, especially because urban management is divided according to urban device (open spaces, highways, sewers, drinking water, etc.). Thus in case studies, management was the subject of discussions and negotiations between stakeholders and solutions were elaborated locally in an *ad hoc* manner[2].

The case studies provide information on the way in which alternative techniques and SUDS were integrated into socio-technical and existing urban environments. They especially allowed for a review of the technical and organisational relationships these devices have with the network.

1. Alternative Techniques and SUDS, Technical Devices Complementary to the Network

Alternative techniques and SUDS are used in the case studies in order to relieve the network and maintain its proper functioning and a good level of service. These devices divert stormwater from the network for an *in situ* management, or one relatively close to its source. Consequently, their development is not carried out in opposition to the network, but in favour of the network, for it tends to reinforce it by diversifying the technical devices making up the water management system.

1- This situation has changed in Wales with the publishing of the *Flood and Water Management Act* in 2010, which established a particular organisation for SUDS supervised by local authorities. During the interviews, we lacked sufficient information regarding the implementation of these new organisations.

2- In the Lyon conurbation, each development of public space integrating alternative techniques is subject to a special management agreement between Greater Lyon and the city.

The complementarity of alternative techniques and SUDS with the sewer system also appears in the solutions implemented in the case studies. These solutions have recourse to the sewer system or to elements of the sewer system. In certain cases, part of the stormwater remains connected to the network (Park Jacob Kaplan and the Cross Roads Houses). In all of the cases, the systems installed included objects and devices which also made up part of the network, such as pipes, valves, oil traps, pumps, etc. (Table 7). For example, pipes were used to centralise and direct stormwater towards the detention or infiltration devices[1]. In this manner, alternative techniques and SUDS nested within the network, for stormwater infiltration and detention devices complemented the pipes.

Table 7. Main elements of stormwater management systems in the case studies.

Case Study	Elements of the Stormwater Management System
Jacob Kaplan Park	Combined sewer system, pipes, landscaped infiltration and detention basin, gabions, storage sheets, cisterns, pumps, probes, electronic commands, fences
Lyon Technology Park	Swales, trenches, detention basins, pump system, trap valve overflow, reed bed, water jets, collectors, infiltration ditch, drains, oil traps
Cross Roads Houses	Pipes, soakaways, pump, combined sewer system
Gatewen Village	Pipes, infiltration basins, detention basins, fences, storage tanks, soakaways, limited-flow overflows, oil traps

2. Alternative Techniques and SUDS, Organisational Devices Similar to Those of the Network

The infiltration and detention devices promoted by the stakeholders in the case studies remain in the organisational and economic framework of the sewer system. These devices are related to the public domain and public good, and to this effect their management is ensured by the community in France for the good of all urban dwellers, and by its equivalent in Wales (DCWW)[2]. In this manner, the network manager maintains control over the flows, and in particular control over the quality of discharges into the receiving environment such as soils, water table, rivers, and streams. Devices falling outside of this framework remain marginal in the case studies, for example the soakaways installed in a few single-family-homes in Gatewen Village under the responsibility of their owners.

In the construction projects, i.e. Jacob Kaplan Park, the Lyon Technology Park, and Gatewen Village, the stormwater management system integrates urban public spaces. It is landscaped, and in large part open to the urban public –for example the detention basin constituting a field or a pond. Its upkeep and maintenance can then mobilise services responsible for open spaces. Thus, given the hybrid character of detention and infiltration devices, uses proper to the network or to urban public spaces become real. These uses belong to the world of makers and to the world of publics (conveniences, expertise, habits, norms, etc.). In this, the mode of existence of alternative techniques and SUDS is similar to those of sewers or to urban public spaces. Thus adjusted to existing socio-technical environments, and in particular to the socio-technical environments associated with sewers or urban public spaces, alternative techniques and SUDS could spread throughout the city. In this context, the difficulties met during the diffusion of these devices

1- The choice of using pipes instead of ditches or swales for the transportation of flows may be due to the familiarity of this device to the stakeholders, meaning ease in sizing them and organising their maintenance. The planning and management of the ditches and swales seemed less well-tried.

2- In France, the reference to public good justifies public funding of works in development projects.

result form the misalignments between the devices and the existing socio-technical environments. For example, the difficulties to find organisations to take in charge landscaped stormwater structures would result in their improper management. The *Flood and Water Management Act* passed in 2010 in the United Kingdom had as its goal to reduce these difficulties in attributing SUDS to local authorities, an attribution which reaffirms the specialisation and segmentation of activities making the city.

An analysis of the diffusion of alternative techniques and SUDS through the case studies demonstrates that every new technical device, even one which performs well, does not necessarily imply its adoption by stakeholders, nor a modification of practices or social activities[1]. Its diffusion would come from its ability to adjust to existing socio-technical and urban environments. These environments could present strong resistance and great inertia faced with novelty. This stability in urban environments is related to everything allowing individuals to carry on with their everyday activities, especially in their uses, governing relationships between individuals, and between individuals and technical objects. Every new object, as a new offer of social practices, opens up a contingency and can put in question this stability, and thereby conditions for urban life. A technical object that would both contributes to the stability of the world and brings novelty into it could provide possible conditions for a change in social practices and activities. It is without doubt related in part to the convivial object as proposed by Ivan Illich (1973), that is to say an object which serves the designs of individuals before serving the design meant by its making.

1- These comments also relate to those on housing. See especially Kopp, 1975 on the Russian experience in the 1920s and Renauld 2012 on the recent experience of ecodistricts [*Ecoquartiers*] in France.

Bibliography

Literature

AH-LEUNG S., (en cours), *Condition d'adoption des objets de nature en milieu urbain : analyse des effets sociaux, techniques et organisationnels de l'introduction d'un système de gestion et de traitement des eaux urbaines pluviales à base de filtres plantés de roseaux*, Thèse de doctorat sous la direction de J.-Y. Toussaint et S. Vareilles, INSA de Lyon.

AH LEUNG S., BAATI S., PATOUILLARD C., TOUSSAINT J.-Y., VAREILLES S., 2013, « Que fabrique-t-on avec les eaux pluviales urbaines ? Les dispositifs techniques et les usages du parc Kaplan dans l'agglomération lyonnaise », *8ème Conférence Novatech*, Lyon, 23-27 juin 2013

AKRICH M., CALLON M., LATOUR B., 2006, *Sociologie de la traduction. Textes fondateurs*, Paris, Mines Paris Les Presses, coll. Sciences sociales, 303 p.

AKRICH M., 1991, « L'analyse sociotechnique », in D. Vinck (dir.), *La gestion de la recherche*, Bruxelles, Ed. De Boeck-Wesmae, pp. 339-353

AKRICH M., 2010, « Comment décrire les objets techniques ? », *Techniques & Culture*, n°54-55, disponible sur http://tc.revues.org/4999 (consultation le 30 janvier 2013)

AZZOUT Y, BARRAUD S., CRES F.-N., ALFAKIH E., 1994, *Techniques alternatives en assainissement pluvial : choix, conception, réalisation et entretien*, Paris, Editions Tec et Doc, 372 p.

BAATI S. (en cours), *Fabriquer et user des systèmes techniques. Le cas du système d'assainissement urbain (Lyon, Bordeaux et Mulhouse)*, Thèse de doctorat sous la direction de J.-Y. Toussaint et S. Vareilles, INSA de Lyon.

BARLES S., 1999, *La ville délétère. Médecins et ingénieurs dans l'espace urbain. xviiie-xixe siècles*, Seyssel, Ed. Champ Vallon, coll. « Milieux », 373 p.

BARLES S., 2005, *L'invention des déchets urbains. France : 1790-1970*, Seyssel, Editions Champ Vallon, 297 p.

BECKER H. S., 2009, *Comment parler de la société. Artistes, écrivains, chercheurs et représentations sociales*, Paris, Ed. La Découverte, coll. Grands repères-Guides, 316 p.

BÉGUIN P., RABARDEL P., 2000, « Mediating instruments: a developmental and anthropocentric point of view », *Scnadinavian Journal of Information Systems*, 12, pp. 173-190

BERDIER C., TOUSSAINT J.-Y., 2007, « Sept hypothèses sur l'acceptabilité des ouvrages alternatifs d'assainissement des eaux pluviales par infiltration », in *Actes de la 6ème Conférence Novatech 2007*, Villeurbanne, Editions du Graie, pp. 335-340

BERNOUX P., 1985, *La sociologie des organisations. Initiations*, Paris, Seuil, 378 p.

BOLTANSKI L., Thevenot L., 1991, *De la justification. Les économies de la grandeur*, Paris, Gallimard, coll. NRF Essais, 483 p.

BOUDON R., 2003, *Raison. Bonnes Raisons*, Paris, Presses Universitaires de France, coll. « Philosopher en sciences sociales », 184 p.

BOURDIEU P., 1994, *Raisons pratiques. Sur la théorie de l'action*, Paris, Ed. du Seuil, coll. Points essais, 246 p.

BOURDIEU P., 2001, *Science de la science et réflexivité. Cours du Collège de France 2000-2001*, Paris, Raisons d'agir éditions, coll. «Cours et travaux», 238 p.

BRUNDTLAND G. H. et al., 1989, *Notre avenir à tous. Rapport de la commission mondiale sur l'environnement et le développement, Oxford-Montréal*, Oxford University Press-Les éditions du fleuve, Les publications du Québec-Ministère des Communications du Québec, 438 p.

CERTU, 2008 (1ère éd. 1998), *L'assainissement pluvial intégré dans l'aménagement. Éléments clés pour le recours aux techniques alternatives*, Lyon, Editions du CERTU, 195 p.

CERTU, 1998, *L'assainissement pluvial intégré dans l'aménagement. Éléments clés pour le recours aux techniques alternatives*, Lyon, Editions du CERTU, 195 p.

CHATZIS K., 1993, *La régulation des systèmes socio-techniques sur la longue durée : le cas du système d'assainissement urbain*, Thèse de doctorat d'économie et sciences sociales sous la direction de J. Laterrasse, Ecole Nationale des Ponts et Chaussées, 516 p. + annexes.

CHOCAT B. (dir.), 1997, *Encyclopédie de l'hydrologie urbaine et de l'assainissement,* Paris, Lavoisier, 1124 p.

CIRIA, 2007, *The SuDS manual* (C697), Londres, 599 p.

CIRIA, 2000, *Sustainable urban drainage systems. Design manual for England and Wales* (C522), Londres, 124 p.

CLIFFORDE I. T., MORRIS G., 1995. « The UK response to the challenge of urban stormwater management », in *Actes de la 2ème Conférence Novatech 1995*, Villeurbanne, Editions du Graie, pp. 597-604.

DE CERTEAU M., e1990 (1ère éd. 1980), *L'invention du quotidien. 1. arts de faire*, Paris, Gallimard, coll. Folio essais, 349 p.

DEBOURDEAU A. (coord.), 2013, *Les Grands textes fondateurs de l'écologie*, Paris, Flammarion, coll. « Champs classiques », 379 p.

DEROUBAIX J. F., CARRÉ C., CHOULI E., DEUTSCH J.-C., 2010. « Hydrologie urbaine : vers une mondialisation des "bonnes pratiques" locales » in G. Schneier-Madanes (dir.), *L'eau mondialisée*, Paris, La découverte, pp 237–251.

DUPUY G., KNAEBEL G., 1982, *Assainir la ville, hier et aujourd'hui*, Paris, Dunod, 92 p.

FRIOUX S., 2009, *Les réseaux de la modernité : amélioration de l'environnement et diffusion de l'innovation dans le France urbaine (fin XIXe siècle - années 1950)*, Thèse de doctorat d'histoire sous la direction de J.-L. Pinol, Université Lyon 2, 685 p. + annexes

GALLOT-DELAMÉZIÈRE E., 2007, « Site périphérique - site stratégique : projet durable ou instrument de marketing territorial ? », *Territoire en mouvement*, n°3, pp. 40-52. disponible sur http://tem.revues.org/763 (consultation le 26 octobre 2012)

GIBSON J. J., e1986 (1ère éd. 1979), *The ecological approach to visual perception*, Londres, Ed. Lawrence Erlbaum Associates, 332 p.

GORZ A., 1988, *Métamorphoses du travail. Critique de la raison économique*, Paris, Ed. Gallimard, Coll. Folio essais, 438p.

GUILLERME A., 1983, *Les temps de l'eau. La cité, l'eau et les techniques. Nord de la France. Fin III^e^ -début XIX^e^ siècle*, Seyssel, Ed. Champ Vallon, coll. « Milieux », 259 p.

HASSAN J., 1998, *A history of water in modern England and Wales*, Manchester, Manchester University Press, 214 p.

ILLICH Y., 1973, *La convivialité*, Paris, Ed. Seuil, 158 p.

KOPP A., 1975, *Changer la vie, changer la ville. De la vie nouvelle aux problèmes urbains. U.R.S.S. 1917-1932*, Paris, Ed. Union Générale d'Editions, Coll. 10/18, 506 p.

LAHIRE B., e2001 (1ère éd. 1998), *L'homme pluriel. Les ressorts de l'action*, Paris, Nathan, 271 p.

LARNAUD F., 2011, *Changements climatiques et gestion des eaux pluviales : l'implication des acteurs dans la mise en place des techniques alternatives. Etude du cas gallois*, Rapport de PIRD sous la direction de J.-Y. Toussaint et S. Vareilles, EVS-INSA de Lyon-GCU, 144 p.

MAUSS M., e2002 (1ère éd. 1904-1905), *Essai sur les variations saisonnières des sociétés eskimo. Etude de morphologie sociale*, édition électronique Les classiques des sciences sociales, Saguenay, 70 p. disponible sur http://classiques.uqac.ca/classiques/mauss_marcel/socio_et_anthropo/7_essai_societes_eskimos/essai_societes_eskimos.html (consultation le 14 novembre 2012)

MCKISSOCK G., Jefferies C. et D'ARCY B. J., 1999, « An assessment of drainage best management practices in Scotland », J. IWEM, n°13, pp. 47-51.

MERLIN P., CHOAY F. (dir.), e2005 (1ère éd. 1988), *Dictionnaire de l'urbanisme et de l'aménagement*, Paris, PUF, coll. « Quadrige Dicos Poche », 963 p.

MONTOYA D., 2011, *Acteurs et objets techniques dans une gestion durable des eaux de pluie: les freins à la mise en place des SUDS ou techniques alternatives dans un projet d'aménagement*, Rapport de PIRD sous la direction de J.-Y. Toussaint et S. Vareilles, EVS-INSA de Lyon-GCU, 330 p.

ODUM E. P., 1954, *Fundamentals of Ecology*, Philadelphia, Saunders, 384 p.

PATÉ G., ARGILLET S., 2005, « Bancs publics. Regard sociologique sur l'ordinaire des espaces urbains », *Actes de la recherche en sciences sociales*, n°159 septembre 2005, p. 116-120

PATOUILLARD C., (en cours) *Modalités d'adoption des techniques alternatives d'assainissement pluvial urbain*, Thèse de doctorat sous la direction de J.-Y. Toussaint et J. Forest, INSA de Lyon, en cours

PATOUILLARD C., FOREST J., 2011. « The spread of sustainable urban drainage systems for managing urban stormwater: a multi-level perspective analysis », *Journal of innovation Economics*, vol. 2 n°8, pp 141-161.

PLAN URBAIN, 1985, *L'eau dans la Ville. Techniques alternatives en assainissement pluvial. Impact sur le milieu social et sur l'environnement. Tome 2 : études de cas*, Paris, 168 p.

POLANYI K., e1983 (1ère éd. 1944), *La Grande Transformation. Aux origines politiques et économiques de notre temps*, Paris, Gallimard, coll. NRF, 419 p.

RABARDEL P., 1995, *Les hommes et les technologies. Approches cognitives des instruments contemporains*, Paris, Armand Colin, coll. U. Psychologies, 239 p.

RENAULD V., 2012, *Fabrication et usage des écoquartiers français : éléments d'analyse à partir des quartiers De Bonne (Grenoble), Ginko (Bordeaux) et Bottière-Chénaie (Nantes)*, Thèse de doctorat en urbanisme sous la direction de J.-Y. Toussaint, INSA de Lyon, 460 p.

SIMONDON G., e1989 (1ère éd. 1958), *Du mode d'existence des objets techniques*, Paris, Aubier, coll. Philosophie, 335 p.

TOUSSAINT J.-Y., 1996, « Le collectif d'énonciation de l'espace : production contemporaine de l'espace et modalités de professionnalisation », *Espaces et sociétés*, n°84-85, pp. 83-98

TOUSSAINT J.-Y., 2003, *Projets et usages urbains. Fabriquer et utiliser les dispositifs techniques et spatiaux de l'urbain*, document en vue de l'Habilitation à Diriger des Recherches, coordonnée par Y. Grafmeyer, Université Lyon 2, 264 p.

TOUSSAINT J.-Y., 2009, « Les usages et les techniques », in J.-M. Stébé et H. Marchal (dir.), *Traité sur la ville*, Paris, PUF, pp. 461-512

TOUSSAINT J.-Y., VAREILLES S., 2010, « Handicap et reconquête de l'autonomie. Réflexions autour du rapport entre convivialité des objets et autonomie des individus. Le cas des dispositifs techniques et spatiaux de l'urbain », *Geographica Helvetica*, 4/65, pp. 249-256

TOUSSAINT J.-Y., VAREILLES S., 2013a, *Les conditions de réception des systèmes extensifs de gestion des eaux urbaines. L'exemple des pilotes de Craponne et du prototype de Marcy-l'Etoile. 1 : cadre d'analyse et premières enquêtes (2009-2011)*, Rapport final pour le compte de l'ANR PRECODD 2008-projet SEGTEUP ANR-08-ECOT-Oox, EVS-INSA de Lyon, 37 p.

TOUSSAINT J.-Y., VAREILLES S., 2013b, « Les clôtures ou l'expérience des limites dans les mondes urbains. Le cas de deux ouvrages de gestion des eaux urbaines dans l'agglomération lyonnaise », *Les Cahiers européens des Sciences sociales*, n°4/2013, pp. 69-85

TOUSSAINT J.-Y., VAREILLES S., ZIMMERMANN M., 2007, « Objets et usages de l'espace public dans les pratiques de concertation », in Y. Tsiomis, V. Ziegler, *Anatomie des projets urbains*, Paris, Editions de la Villette, pp. 133-144

TOUSSAINT J.-Y., ZIMMERMANN M. (dir.), 1998, *Projet urbain. Ménager les gens, aménager la ville*, Sprimont, Pierre Mardaga Editeur, coll. Architecture + Recherches, 199 p.

TOUSSAINT J.-Y., ZIMMERMANN M. (dir.), 2001, *User, observer, programmer et fabriquer l'espace public*, Lausanne, PPUR, coll. des sciences appliquées de l'INSA de Lyon, 290 p.

VAREILLES S., 2006, *Les dispositifs de concertation des espaces publics lyonnais. Eléments pour une analyse du rôle de la concertation des publics urbains dans la fabrication de la ville*, Thèse de doctorat sous la direction de Monique Zimmermann et Jean-Yves Toussaint, INSA de Lyon, 306 p.

VERMERSCH P., e2006 (1ère éd. 1994), *L'entretien d'explicitation. Nouvelles édition enrichie d'un glossaire*, Issy-les-Moulineaux, ESF Editeur, coll. « Pédagogie Outils », 221 p.

WEBER M., e2006 (1ère éd. 1904), *Essai sur la théorie de la science, premier essai*, édition électronique Les Classiques des sciences sociales, Saguenay, 168 p., disponible sur http://classiques.uqac.ca/classiques/Weber/essais_theorie_science/essais_theorie_science.html (consultation le 14 novembre 2012)

WOLMAN A., 1965, « The metabolism of cities », *Scientific American*, n°213(3)-septembre 1965, pp. 179-188

Documents

AGENCE D'URBANISME POUR LE DÉVELOPPEMENT DE L'AGGLOMÉRATION LYONNAISE, 2010, *1960-2010 : 50 ans de planification et de prospective*. 76 p.

ARCHITECTURE SA, 1995, *Aménagements paysagés. Affectation des coûts sommaires d'entretien*, Rapport pour le compte du Grand Lyon, 7 p. consulté en juillet 2011 aux Archives du Grand Lyon (réf. provisoire)

BRGM, 1997, *Etude hydrodynamique du couloir fluvioglaciaire d'Heyrieux et du bassin de l'Ozon. Rapport préliminaire sur possibilités d'infiltration des eaux pluviales*, Rapport pour le compte du Grand Lyon, 18 p. consulté en mars 2011 aux Archives du Grand Lyon (réf. provisoire)

DCWW, s.d, *Surface water management strategy*, brochure en anglais et gallois non paginée

GRAND LYON, 1992a, *Schéma directeur d'assainissement*, 233 p.

GRAND LYON, 1992b, *Porte des Alpes Champ du Pont (rapport interne)*, non paginé, consulté en mars 2011 aux Archives du Grand Lyon (réf. provisoire

GRAND LYON, 1993, *Champ du pont, APS (rapport de la direction de l'eau)*, non paginé, consulté en juillet 2011 aux Archives du Grand Lyon (réf. provisoire)

GRAND LYON, 1996, *La porte des alpes, un projet majeur pour le Grand Lyon (note interne)*, 5 p. consulté en juin 2011 aux Archives du Grand Lyon

GRAND LYON, 1998, *Reflets de l'eau, édition spéciale « Côté pluie »* (journal de la direction de l'eau du Grand Lyon), 14 p. consulté en juin 2011 aux Archives du Grand Lyon (réf. provisoire),

GRAND LYON, 2007, *Programme Local de l'Habitat. Diagnostic et programme d'action. Secteur Centre*, Tome 3. Ronéo, Lyon.

GRAND LYON, 2008, *La porte des alpes – le plan de référence*, publication de la Direction de la communication, 8 p.

GRAND LYON, 2010, *Vers une gestion intégrée des eaux pluviales. Référentiel conception et gestion des espaces publics,* ronéo, non paginé

GRAND LYON, e2012, *Règlement d'assainissement du service public adopté par le conseil de communauté le 18 octobre 2004 (et révisé partiellement les 14 novembre 2005, 15 décembre 2008 et 19 mars 2012)*, disponible sur www.grandlyon.com/Assainissement.58.0.html (consultation le 1avril 2013)

HYDER CONSULTING, 2010, *Dwr Cymru Welsh Water Surface Water Management Strategy. Task 10 SUDS Showcases – exemplar sites*, progress report – march 2010, 25 p.

MWH, 2010, *Surface water management strategy. Phase 2, final report*, 231 p.

OVE ARUP, 1993, Système de l'eau – Notice explicative, rapport pour le compte du Grand Lyon, 23 p + annexes consulté en mars 2011 aux Archives du Grand Lyon (réf. provisoire)

SERL, s.d., *Le parc technologique de Lyon, terre de réussite*, plaquette de présentation, disponible sur http://www.parctechnologique.com/ (consultation le 3 février 2013)

SIBEUD E., 2012, « L'eau dans la ville pour apporter du bien-être à la population », *Colloque Eau & santé*, Agence de l'eau Rhône-Méditerranée et Corse, Grand Lyon, 2012

SOULIER-BOUVIN T., 2012. « La nature revient en ville : les pratiques environnementales et la gestion différenciée à la ville de Lyon » in *Actes du colloque Jardiner Autrement 2012*, Société Nationale d'Horticulture de France, non paginé

WELSH ASSEMBLY GOVERNMENT, 2004, *Planning Policy Wales – Technical advice note 15: Development and flood risk*, 50 p. disponible sur : wales.gov.uk (consultation le 10 décembre 2013)

WELSH ASSEMBLY GOVERNMENT, 2012, *Planning Policy Wales (edition 5)*, 213 p. disponible sur : wales.gov.uk (consultation le 10 décembre 2013)

Annexes

Annex 1. The French Context for Stormwater Management: Stakeholders and Legal and Regulatory Frameworks

The management of stormwater is a municipal or inter-municipal responsibility. It principally involves local communities such as municipalities and groups of municipalities, sewer managers, design offices, landscape agencies, and construction companies. The Table 8 brings together the main public stakeholders in charge of stormwater. Stormwater management is governed by an ensemble of legal, regulatory, and technical texts (Table 9). Most of the legal texts date from the end of the 20th century and the beginning of the 21st century. Some of these texts are the result of European Directives. Regulatory texts come from the Civil Code, the Environmental Code, the Urban Planning Code, and the General Code of Local Communities.

Table 8. Main public and administrative institutions responsible for stormwater management in France (2013)[1].

Stakeholders	Role
STATE	
Central government	Legislates in areas under the jurisdiction of the State (devolution, environmental protection, organisation of water management, etc.) Finances projects and installations (especially through the Water Agencies)
Decentralised services DREAL (Regional Direction of the Environment, Urban Planning, and Housing) DDT (Departmental Direction of Territories)	Inspects applications and installations DREAL: for what concerns environmental protection DDT: for what concerns water law
Water agencies	Creates planning documents and action programs for hydrographic basins
LOCAL COMMUNITIES	
Municipalities (*Communes*)	Manages devolved responsibilities (water, urban planning, highways, green spaces, etc.) In the Lyon conurbation: municipalities are responsible for green spaces
Groups of municipalities (Public Establishments for Inter-municipal Cooperation), such as Urban Communities	Manages responsibilities transferred by the municipalities to the group (water, urban planning, highways, green spaces, etc.) Greater Lyon manages water, highways, urban planning, and hygiene

1- Possible variations among the case studies are indicated.

Table 9. Main legal and regulatory texts concerning stormwater management in France (2013)

Year	Text and Amendments	Content
1804	Civil Code (art. 640 and 641)	Owners of lower lands cannot prevent the flow of waters naturally flowing from upper lands Owners of upper lands cannot aggravate the situation of servitude of the lower lands
1992	Law n. 92-3 of Jan. 3, 1992 on water General Code of Local Communities (art. L224-10) Environmental Code (art. L214-1)	Local communities define the collective management zones for urban water (in which they are held to ensuring the storage, purification, and discharge or reuse of waters collected); non-collective management zones; zones where measures must be taken to limit the surface-sealing of soil and to ensure control over the rate and flow of stormwater and runoff; zones where it is necessary to foresee installations and to ensure the collection, eventual storage and, as much as is necessary, stormwater and runoff management since the pollution which they bring to wetlands risks to greatly harm the efficiency of water management devices. Since 2001, the regulation for the Local Urban Plan (PLU) can include special clauses linked to the delimitation of non-collective zones for urban water management (code d'urbanisme, art. R123-9), The law indicates that structures, works, and activities involving water removal, modifications of flow, or the discharge or deposits are subject to declaration or authorisation procedures by the administrative authority. The nomenclature of these structures is fixed by decree.
1993	Decree n. 93-743 of March 29, 1993 relative to the nomenclature of interventions requiring a declaration or authorisation Environmental Code (art. R214-1)	The decree specifies the interventions concerned either by declaration or by authorisation. The nomenclature has been modified several times since the decree's promulgation.
2003	Issue 70 of the Book of General Technical Clauses of Public Works Markets	The amendment includes storage and infiltration structures.
2004	Law n. 2004-338 of April 21, 2004 transposing Directive 2000/60/CE of the European Parliament and Council of Oct. 23, 2000 establishing a framework for a community policy in the domain of water The Environmental Code The Urban Planning Code The General Code of Local Communities	
2006	Law n.2006-1772 of Dec. 30, 2006 on water and wetlands (called LEMA) General Code of Local Communities (art. L2224-12 and L2333-97 to 100)	The municipalities and their groups establish a service rule for each water service for which they are responsible. The municipalities and their group can create a public administrative service for urban stormwater management. This public service includes the collection, transportation, storage, and treatment of stormwater for urban areas. If the municipality or group so decides, the service can be financed by a tax whose modalities must be fixed by decree (decree published July 2011). These articles were modified in 2010.
2010	Law n. 2010-788 of July 12, 2010 on national involvement for the environment (called the "*Loi Grenelle 2*") Urban Planning Code (art. L123-1-5, R123-9, L111-6-2) General Code of Local Communities (art. L2333-97 to 100)	The rules of the Local Urban Plan (PLU) can delimit zones concerned by article L222-10 of the General Code of Local Communities concerning stormwater management. These rules are defined by Article 4 in the PLU rules. Urban planning decisions (building permits, development, decision on prior declaration) cannot oppose the installation of devices favouring the detention of stormwater except under special conditions, for example protected areas and heritage buildings. The law modifies the articles covering the management of urban stormwater and the tax that can be created to finance this service.
2011	Decree n. 2011-815 of July 6, 2011 relative to the tax for the urban management of urban stormwater General Code of Local Communities (art. R2333-139 to 144)	The decree fixes the modalities for applying the "urban stormwater" tax.

Annex 2. The British Context for Stormwater Management: Stakeholders and Legal and Regulatory Frameworks

The Water Service in the United Kingdom has been privatised since 1989 and taken in charge by water companies. These companies manage the distribution of drinking water, of urban effluents, or both. Their activities are supervised by four public institutions: Ofwat, the economic regulator, the Environment Agency, the Consumer Council for Water, and the Drinking Water Inspectorate. Ofwat's role is very important, for it supervises the pricing and use of the benefits coming from the fees of urban water services. This economic regulation especially undergoes validation by Ofwat according to the five-year Asset Management Plan (AMP) as proposed by managing enterprises. The Table 10 recapitulates the main stakeholders involved in stormwater management in Wales.

The legal and regulatory framework governing stormwater management in Wales essentially comes from Acts passed in the British Parliament (Table 11). SUDS appear in legal text in 2010.

Table 10. Main stakeholders involved in stormwater management in Wales (2013)[1]

Stakeholders	Role
STATE	
British Government	Legislates in areas under its jurisdiction (devolution, organisation of the water sector, flood risks, etc.)
Welsh Government	Legislates in areas under its jurisdiction (devolution, organisation of the water sector, flood risks, etc.)
LOCAL COLLECTIVITES	
Counties, County Boroughs, Cities	Manage devolved jurisdictions: urban planning (local documents and building permits), rural drainage, local roads The County Borough of Wrexham and Flintshire can act in the management of stormwater through urban planning documents (local plans, building permits).
PUBLIC BODIES	
Ofwat	Is a regulatory body Supervises and regulates economic aspects
The Environment Agency	Is a regulatory body Supervises and regulates environmental aspects Intervenes in the granting of building permits
Rural Council of Wales	Intervenes within the limit of its jurisdiction during the issuing of building permits
Water Authorities	Intervenes within the limit of their jurisdictions during the issuing of building permits
MANAGING ENTERPRISES	
Water Companies	Manages drinking water services and/or wastewater treatment Especially establish the conditions for connecting stormwater to the wastewater treatment system and the measures for disconnecting stormwater. DCWW defines a surface water management strategy and actions within the framework of flood records.

1- Variations found in the case studies are also indicated.

Table 11. Main legal and regulatory texts concerning stormwater management drafted by the British Parliament (2013)

Year	Text	Contents
1980	Highways Act	Section 38 defines a legal framework for adoption agreements regarding highway infrastructure, including drainage devices accompanying them.
1990	Town and Country Planning Act	Section 106 defines a legal framework for developer contributions related to mitigation of the impact of development, notably SUDS construction.
1991	Water Industry Act	The text defines what constitutes a public sewer.
1999	Water Industry Act	
2004	Planning and Compulsory Purchase Act	The text defines jurisdictions for urban planning in Wales
2008	Community Infrastructure Levy (Planning Act)	The text replaces Section 106 of the Town and Country Planning Act
2010	Flood and Water Management Act	Develops national standards for the design and construction of sustainable stormwater management and mentions SUDS Creates a procedure for approval.